Buyer-supplier best practices in product development: evidence from car industry

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Abstract

Continuous innovations in product and process technology, coupled with time to market pressure, have made rapid product development a key strategic. Consequently, many firms have started to redefine the ways in which products are designed, developed and produced, to reduce the time from conception to manufacture. The strategies employed to achieve this goal vary, and include the integration of functions through selective use of concurrent engineering, the formation of strategic project teams, and information technology.

A increasingly strategic role in product development has been played by suppliers and the purchasing department. Even though suppliers are in many cases considered to be integrated members of the development teams, they can not be compared to the internal functions. Communications patters in the external process chain are quite different than the internal ones. Product development requires a fundamental change in the attitudes of both buyers and suppliers.

Jel Classification: L32; O32

1. Introduction

The buyer-supplier relationship in product development can be seen under a fourfold innovative perspective. Firstly, the intense and constant flow of information. Secondly, early involvement from the beginning of the process before style approval. Thirdly, the extension of the connections to other buyer functions in addition to purchasing, and finally, the introduction of new tools, for example, co-location, co-design, co-habitation, resident engineering, data sharing systems, and so on.

Various benefits arise from a new way of involving suppliers in product development (Lamming, 1990; Clark and Fujimoto, 1991; Turnbull et al., 1992; Gadde and Hakansson, 1994; Bonaccorsi and Lipparini, 1994).

- Cost reduction. Product feasibilities are carried out directly by suppliers, so they are able to ensure design and process consistency and foster standardisation of components, new innovative solutions, ex-post change reduction, and so on.
- Quality improvement. Full responsibility for component development permits suppliers to apply their competence completely. In the past suppliers manufactured or developed details on the basis of the buyer's specifications. It was very difficult for customers to be acquainted with all their suppliers' production specifications.
- Time to market. The involvement of suppliers at the concept stage can contribute to the upstream identification of critical items and major technical uncertainties. The early definition of joint specifications enables suppliers to plan the manufacturing process in advance and overlap buyer and supplier activities.
- Voice of the client. The more complex the product, the less the final assembler is able to grasp all consumer needs alone. The involvement of suppliers in style activities expands the point of view on market expectations.

Benefits do not only relate to the execution of the project. A close buyer-supplier relationship fosters knowledge and learning transfer in both directions with regard to technology, human resources and organisation.

Following the experience of their customers in organisation, many suppliers have adopted matrix structures as well. Depending on the market structure, crossfunctional teams may be structured by the typology of product, buyer, market or technology. Suppliers' crossfunctional teams often follow-up on their components after the launch of the product in order to introduce further amendments and enhancements.

Personnel transfer may also occur. Suppliers have to replace their customers in a great deal of tasks, so they need more engineers, designers and workers. They are often recruited from their customers.

On the other hand, the opportunity of contact with many suppliers permits customers to become acquainted with many dissimilar ways of managing processes. In general, small suppliers are more flexible but reveal less initiative, suppliers which are members of the same industrial group pursue similar strategic approaches but the relationship is more bureaucratic, the leading suppliers are more rigorous but slower.

2. Supplier involvement in the car industry

The active presence of suppliers in the product development process is only one of the manifestations, perhaps the most involving and complex, which distinguishes the current approach to the relationship between suppliers and final car assemblers. The relationship change concentrates particularly on OEM suppliers, but also engineering service, raw materials and equipment.

The active involvement of suppliers in the car industry took place step by step: logistic integration, just in time and of product development have been added to production deverticalisation.

Lamming (1994) noted four phases in the supplier-buyer relationship, each of which changes the role of suppliers in the product development process.

At present, for American and European producers, the buyer-supplier relationship continues to be extremely tense due to the radical strategic change by final producers. In general, the Japanese model is progressively being introduced, where:

- internal production is inferior to 30% of the total value of the product. Mostly Japanese assemblers have maintained control of the production of the engines, the powertrain, the chassis and the body;
- the number of suppliers is limited to a few hundred, many of which are responsible for the assembly of module of components. Using direct contact with primary suppliers, the Japanese tiering structure helps the control of sub-suppliers;
- contracts are long term and allow the planning of cost reductions and the stabilisation of profits;
- the parts developed by suppliers form a large part of the total value of the project (up to 70%).

The only aspect not yet pursued by Western enterprises regards the financial control between suppliers and customers through crossover share investments (keiretsu) or associative ties (kyoryokukai). In the United States and in Europe increasing competitivity among assemblers and the market crisis have transformed growth strategies from the acquisition of suppliers to the acquisition of competitors, moving resources from vertical to horizontal integration.

Purchasing tactics in the automotive sector may therefore be synthesised into three consequential strategic directions: marked vertical disintegration, the reorganisation of the supply chain and the development of the buyer-supplier relationship.

2.1 Vertical disintegration

Vertical disintegration has undoubtedly contributed to the growth in the role of suppliers in the final enterprise's strategies.

However, the current choice of outsourcing cannot simply be categorised as part of the hierarchy-market system, where for the choice of turning to suppliers (buy), in the case of economies of scale or if co-ordination costs are modest (Williamson 1975), there is the alternative of internal production (make). For a complex product like a car outsourcing is not concentrated uniquely on minor added value components, but

interests specific production processes which call for increasingly complex technology in order to improve efficiency, optimise investments and processes, increase flexibility margins and lower the break-even point.

Vertical integration remains advantageous when the company deals in a market with limited changes in demand, products and production processes. However, in turbulent situations vertical integration may constitute a sort of rigidity and go against company profitability. Market turbulence and the increasing technological development in the automotive sector have called for the delegation to suppliers of non marginal tasks with a high research content and the possibility of carrying out effective economies of scale and experience.

In the past the degree of vertical integration was also conditioned by the national context, the institutional situation, and the characteristics of the component industry (size, technological level, financial capacity). Most suppliers were of the same nationality, generally with the head office near the car assembler. The process of globalisation of the economy has also effected the automotive suppliers, increasing the number of geographic locations of the major producers. The principal consequence has been a rise in the level of competition.

Moreover, rigidity in the use of the work force, diseconomies of size, growing specialisation for limited phases of the processes, the increasing complexity of the products, the tendency to eliminate warehouses, the propensity to reduce the incidence of fixed costs and investment rigidity, all contribute to the process of vertical disintegration.

For the automotive sector in particular it is important to underline product complexity and the use of ever more sophisticated and differentiated technologies. Electronics is the most simple and pervasive example, but the use of composite materials, checking of pollution fumes, air-conditioning and soundproofing systems, active and passive security systems, the development of optionals and all the extras now seen as part of the automotive product should not be undervalued.

Considerable resources and knowledge are required in order to manage the innovative process in each of these areas, escaping the possible control of a single company. The use of specialist suppliers therefore represents a source of flexibility from the production point of view, guaranteeing a greater ability to adapt and defend against changes in demand.

Thus design deverticalisation is added to production deverticalisation in order to create unique responsibility for the specific component. Data in table 1 relative to the process of vertical disintegration which occurred in Fiat Auto are remarkable.

In order to deal with the increased co-operation required by common product development all the communication channels between the final product departments and the supplier are multiplied and made more urgent. The recognition of the design competence of the supplier induces a preference for black box type information flows rather than planning for the smallest details. With the black box system the final assembler supplies only the price and performance requirements, the external shape, the interfaces and the general information on design and the complete vehicle layout, whereas in design by details the buyer is responsible for product engineering, and the supplier for industrialisation and production.

The more prevalent this system becomes the more the communication between buyer and supplier becomes two-way and the exchange of information becomes informal. Designs become simpler, as part of the information is transferred informally

through the supplier's representatives on the customer's development teams (resident engineer) (Clark e Fujimoto, 1992).

Table1 - Vertical disintegration in Fiat Auto (%)

	1982	**1987**	**1992**	**1996**	**1998**
Production	50	52	65	70	70
Product development	30	30	45	59	70

2.2 Reorganisation of the supply base

In stable market conditions the final producer's advantage comes from increasing the number of suppliers that do not demonstrate large technological differences; relations are standardised and the great number favours the tendering of competitive prices. On the contrary, the presence of specific knowledge within each component immediately reduces the number of suppliers able to guarantee continuity in quality. Secondly, productive capacity is no longer a sufficient requisite, design ability must also be implemented.

The supplier evaluation mechanism traditionally based on price is integrated with other criteria, for example technological know how, reliability and quality, consignment precision and the ability to develop new products. The stability of the supply relationship is based mainly on this design capacity, given that efficiency criteria are no longer expressed solely in terms of productive processes, since a correctly defined design allows greater optimisation of the cost contents of the new component.

In parallel the product is simplified, with a reduction in the number of product lines per model and the diffusion of modules.

The sum of these factors causes an inevitable reduction in the number of direct suppliers, potentially few firms per product unit. In 1992 alone the suppliers of European and American producers ranged from the 700 at Fiat Auto to 2,000 at General Motors, while the number of Japanese suppliers was well below 200 (Toyota 196, Nissan 195, Honda 155)(Wells and Rawlinson, 1994). Currently the direct suppliers to Fiat Auto have been further reduced to 340 and those of General Motors to less than a thousand, with further concentration of purchases on the main suppliers. In fact 90% of the total supplies to Fiat Auto comes from 130 firms, and in the case of the last compact model as much as 80% of the supply value comes from only 64 firms.

This has caused profound changes in the supply base.

Firstly, a layered system of primary and secondary suppliers is set-up on the basis of the supplier capability to satisfy the new car makers's needs. Many of the excluded firms from the primary level are downgraded to the role of sub-suppliers.

Secondly, in the area of primary suppliers a classification is made based on product complexity - suppliers of modules, of complex components, of single and standardised parts - with an ever higher recourse to more articulated purchasing.

From researches carried out by Kamath and Liker (1994) we can see that among primary level suppliers of Japanese car makers only a dozen of these has a total partnership relationship; whereas the intensity of the bond for the remaining suppliers diminishes proportionally with the minor importance of the supplies. The suppliers are often firms which are too small to make the necessary investments in training, computer systems, and\or research and development to make an effective partnership with their customers. According to Kamath and Liker primary supplier taxonomy is: partner, mature, child and contractual.

Directly related to the logic of co-design and the reorganisation of the supply base is the widespread use of the concept of single-sourcing, whereby the firm which develops the component is potentially given the whole supply order. Single sourcing offers the highest risk to fail the buyer-seller relationship but the greatest opportunity for cost reduction. There are well known economies of scale to be had from single sourcing which are foregone by multiple sourcing. Cost reductions come through co-operation on waste elimination, problem solving, simplification and trust development.

If, on the one hand, it can be inefficient to assign the development of the same component to two suppliers, when it must necessarily be identical, on the other hand, single-sourcing becomes recognition of the investments made by the supplier during the design phase, costs which can only be recovered with the assurance of adequate production volumes.

Competition between suppliers in this context takes on new dimensions as it is no longer bound to a specific component. Nonetheless competition occurs mostly in a transversal sense between single suppliers of different models. Evaluation is valid for later projects. For this reason single source is preferred for strategical parts unless the type of supply does not allow the respect of quantities, variety and delivery times. For exceptionally high production volumes it may be risky to depend on one supplier. Multiple sources are potentially preferred for non-strategic parts.

Tiering, classification and single-sourcing contribute to the realisation of an information exchange network between suppliers and customers which allows the management of product development projects.

A structure of several levels simplifies the communications process in that customers limit their contacts to the highest levels and the primary suppliers co-ordinate the activities of those on the second and so on.

Classification renders the communications process efficient in that it reveals the correct attitude to adopt depending on the supplier’s real participation level.

Single-sourcing enriches the communications process in that the logic of co-design multiplies the interfacing points: product engineers talking to product engineers, the supplier’s process engineers talking to the customer’s product engineers and vice versa. All the members on the respective development teams including the people in charge of the customer’s purchasing and the supplier’s sales find themselves working in a context of widespread crossfunctionality.

The communication model is somewhat complicated in the case where the development of the supply know-how is assigned to an external engineering service firm.

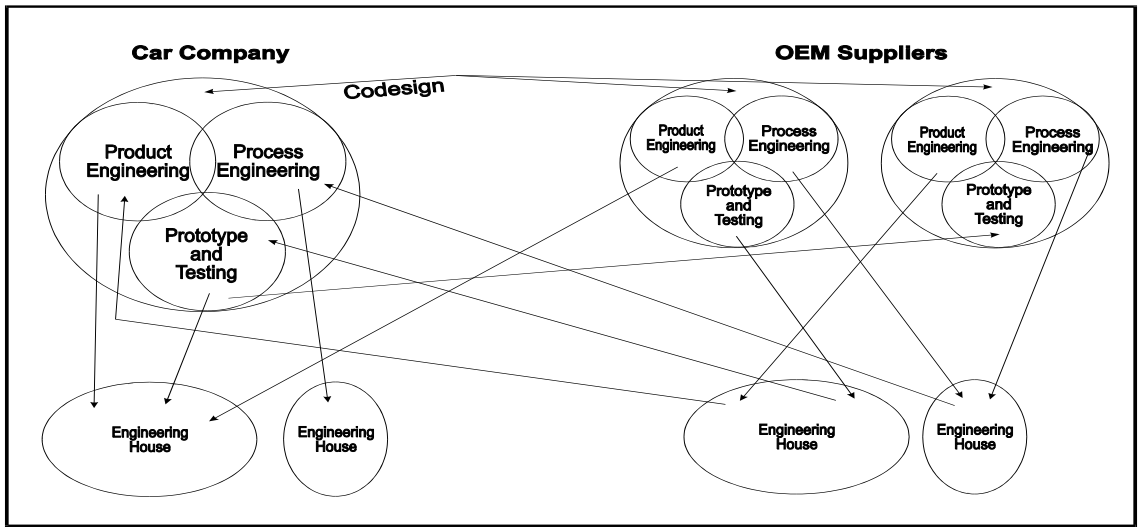
The sudden development of the automotive component industry has left many suppliers ill-prepared to take on the activity of design in the short term. Moreover, for some of these their small size does not consent the set-up of efficient internal technical departments. On the other hand, even car assemblers and the main suppliers constantly refer to external engineering service firms for less important tasks and to deal with unexpected work loads.

The variety offered by engineering service firms is vast, there are small offices with obsolete technology and firms which can offer a whole range of services; from concept to assembling and even prototyping. The know-how developed by these firms is great enough to be able to acquire whole phases of the development process from the supplier.

The external engineering service firms do not act as mere sub-suppliers in the supply chain, but they directly communicate and elaborate information with the car maker.

Therefore a third element is inserted between the buyer and supplier which can notably weigh down the communication flow and cause decomposition of information and deresponsabilisation (Fig. 1). Suppliers' lack of background in product development induce engineering service companies to play a no neutral role and increase the connections in the network.

Figure 1 - Networks of product and process engineering



Given the tendency to stabilise supply relationships it may be useful for suppliers without the necessary expertise to form associations to carry out the design activity. The CAD consortium would guarantee a greater organisational dimension, fidelity to the final buyer and ensure data transfer.

2.3 Development of the buyer-supplier relationship

If on the one hand single-sourcing has undoubtedly simplified the procedural management of the buyer-supplier relationship, on the other it needs to be continuously and carefully monitored, as well as needing a radical change in the synergetic aspects of mutual collaboration on an interpersonal level (Bonaccorsi and Gandolfo, 1995).

Before the diffusion of the partnership model the buyer-supplier relationship was characterised by dominance, opportunist behaviour, and the lack of both clarity and collaboration. Factors which still tarry in being removed from the business culture.

Above all, there is a need to speed up the unlearning of consolidated practises such as: the short term view of the single supply operation, contingency tactics, the reluctance to abandon (buyer) and take on (supplier) specialist parts of the production process, reciprocal lack of trust, and the placing of relationship management at the border functions (purchasing for the buyer and sales for the supplier).

Secondly, the partnership must be seen as a common path of reciprocal learning leading to change and the overcoming of inevitable and countless incomprehensions and difficulties.

Just in time and co-design characterise the co-ordination mechanisms privileged in production and process deverticalisation and would be of less value if they were not autoregulated respectively by delegation systems like self-certification and self-qualification.

In the first instance the supplier guarantees the delivery of the components certifying their conformity to the predefined standards, in this way acceptance checks and quality control within the car makers are eliminated.

In the second instance the supplier guarantees that the new component conforms to all the size requirements on the supply specifications by means of a final test report. Using self-qualification checking and testing are delegated to the component supplier who personally guarantees the quality of the component, the product and process qualifications, coherence of the results to requirements and the certification of the production equipment.

The creation of a relationship based on trust in the partnership is an inalienable basis in electronic data interchange of production orders, emission of invoices and delivery notes, and technical and design data. Especially the develop of product data management systems has been slow due to both the complexity of transmission and the protection of intellectual property rights.

With respect to traditional prints, designs deposited in databases can be more easily intercepted by the competition or be wrongfully appropriated by one of the two partners.

The presence of specific investments and the progressive building up of trust leads to the formulation of long term contracts and penalties in the case of default which bind behaviour for the whole relationship period. In this case the concept of “quasi-integration” is used, a term which highlights the existence of close operative connections aside from purely legal ties. Quasi-integration, in a situation of market globalisation requires that the supplier be willing to follow the buyer to the new production locations spread over the whole world.

The length of the contract period depends on the state of development of the relationship, it may be for only one year or for the whole product life cycle.

In long term contracts the two partners retain their autonomy, but all the same accept that for certain aspects there will be shared decision making in order to reduce the risk of opportunism (Grillo and Silva, 1989). This last requirement is particularly felt by the buyer who, not being able to interrupt the transactions and act on the price variable, has been deprived of a typical exit control mechanism and so have to transfer their attention to voice type mechanisms to control the management of the situation (Helper, 1991). In the contracts stipulated by Fiat Auto with suppliers in co-design, for example, investments for equipment are no longer acknowledged separately but become a part of the unit cost, thus underlining the risk sharing and becoming a stimulus for the suppliers to search for process efficiency. Moreover the development costs are reported to assess the financial repercussions of *ex-post* changes.

Self-certification, self-qualification, authorisation to consult central databases and long term contracts are successive stages in which the degree of reciprocal collaboration and trust are documented. A path which may require a less expert partner to participate in specific support programmes organised by the buyer aimed at reducing the costs of non quality, encouraging the process of growth and reciprocal adaptation, explaining the customer's organisational culture and focusing the supplier's attention on innovative potential. A key factor in this context regards the joint management of human resources through common training programmes within the crossfunctional organisational environment and transfer of the customer's personnel to the supplier to compensate outsourcing and contextually aid the information flow. Great attention must be paid to on the job training and to organisational integration so that at the end of the period of collaboration the professionalism of the supplier's personnel's has been amply enriched.

2.4 Critical aspects in the product development partnership

The involvement of suppliers in the product development process is mainly conditioned by the time variable, when the calling and selection of supplier occur - before style approval, during design or at the end of this phase- and how long it takes between these two events.

Two alternative models and a variant stand out:

- the traditional type model in which calling and selection are almost contemporary and take place after the release of the technical specifications carried out by the buyer and based on tenders by many suppliers. The result is not necessarily a single-souring relationship;
- the Japanese model in which suppliers are few and calling occurs at the beginning of the process in order to select the single-supplier before style approval.

According to some authors the Japanese method does not consent the recovery of innovative ideas by rejected suppliers. The variant therefore, consists in postponing the selection until the end of the studies (Bonaccorsi and Lipparini, 1994).

At present in the automotive sector the Japanese model is the most widespread with some significant adaptations. For example in Renault the moment of selection is divided into two phases. Firstly, the project idea is chosen and its contents distributed to all the suppliers convened. Successively the best offer is selected.

The principal difference regards the type of supplier involved. According to Kamath and Liker taxonomy for the partnering firm cannot be defined as a true beginning because it takes its shape as a company extension, so deeply integrated with the buyer as to influence strongly the car assembler's project specifics. The so-called mature supplier will instead follow Japanese type involvement, while the remaining suppliers will have an ever more traditional type relationship. Moreover, for each type of supply substantially different roles may be identified in the common development of new products in distribution of responsibility (onus on the supplier, the buyer or both), in the specifications given (none, few or complete), in the influence and competence of the supplier (autonomous, high or minimal), in the execution of products and testing (onus on the supplier, the buyer or both). In each of these cases relationships not in conformity with the purpose of the supply could generate inefficiency and waste of resources (Tab. 2).

Table 2 - Supplier roles in product development

	Partner	**Mature**	**Child**	**Contractual**
Design responsibility	Supplier	Supplier	Joint	Buyer
Product complexity	Entire subsystem	Complex assembly	Simple assembly	Simple parts
Specifications provided	Concept	Critical specifications	Detailed specifications	Complete design
Suppliers's influence on specifications	Collaborate	Negotiate	Present capabilities	None
Stage of supplier's involvement	Preconcept	Concept	Postconcept	Prototyping
Component-testing responsibility	Complete	Major	Moderate	Minor
Supplier's technological capabilities	Autonomous	High	Medium	Low

Source: Kamath and Liker

Early involvement of the supplier implies parallelisation and overlapping of activities and the need to manage partial information.

Co-location and design deverticalisation are two strategic options that are deeply interconnected. Co-location means that the members of a crossfunctional team work all together in the same office. It is important to underline that co-location can not restricted solely to the members of the team that develops the single component, but can effected simultaneously among all the development teams.

Their gathering together in one large room, without divisions or paratia has certainly facilitated communication and co-operation. It is no coincidence that informal communication is preferred to formal or written communication.

As well as highlighting co-location as the most resolutive approach for the integration of internal partners, the results shown in table 3 underline the problematic

relationship with suppliers. For car makers A and B the principal functional problems mentioned in the product development activity originate from suppliers and in particular from OEM suppliers. The greater the co-design activity, the more attention will have to be paid to the problems caused by external partners. Deverticalisation in product development hardly matches the traditional trade-off between make or buy, but requires the creation of advanced relations between buyer and supplier.

It is not by chance that the car makers A and B, who have most involved suppliers in product development activities are those that most believe in co-location. In many companies simultaneous engineering has obtained lesser results precisely because effective integration instruments were not put into practice.

Even though suppliers are in many cases considered to be integrated members of the development teams, they can not be compared to the internal functions. The buyer-supplier relationship is more conditioned by factors external to the process, for example spatial distance, bureaucracy and hierarchy instead of quality, competence, technical incompatibilities. In these cases the partnership can suffer from lack of motivation, overly rigid procedures, limited decision-making ability.

Table 3 - Functional source of reported problems

	Co-location		**Limited Co-location**	**NO Co-location**	
	Car Maker A	*Car Maker B*	*Car Maker C*	*Car Maker D*	*Car Maker E*
Product development	6	22	15	50	24
Test/prototype	12	7	2	6	10
Production planning	10	10	5	10	11
Purchasing	8	0	8	9	13
Tool and die	14	12	6	3	8
Quality control	8	2	7	6	10
Marketing	12	2	6	0	3
Supplier OEM	20	23	23	3	8
Supplier Process Equipment	8	17	5	0	6
Engineering Service firm	2	5	23	13	7
TOTAL	100	100	100	100	100
Co-design degree	High	High	Medium	Low	Low

In general the same conflicts arise with respect to suppliers as with the different internal partners: respect for the defined timetables, costs and performances, finding compromise solutions etc.

In spite of the resident engineers on the development teams, not all activities can be carried out at the customer's. The presence of spatial distance renders collaboration between the partners difficult.

In particular interfirm collaboration during the earliest stages of conception of the new product requires the supplier to endure the buyer in style activities and not only in feasibility studies. Few Western suppliers have internal designers solely dedicated to the development of new product concepts.

For car assemblers the development of a detailed global vision of the product becomes a primary qualification in order to integrate all the specialistic contributions of the various suppliers coherently. Even when it regards complex components consigned by a single supplier all the critical interfaces must be highlighted and priorities noted.

The co-ordination between two suppliers in the boundary areas is the responsibility of the car maker. The supplier often defaults in exactly those contents that are outside his specialistic know-how and that have to be matched with other components. Assuming a system mentality means the buyer must develop alternative solutions in advance (shelf system engineering) even more necessary when the same component can be used in various models and standardised by the supplier. The rationing of the proliferation of product codes is a need felt even more by suppliers that have to correspond to all the particular versions studied by the marketing departments of various customers.

Clarity in the definition of the different roles, of the specific know-how, has reduced the unclear areas of responsibility which once led to the creation of incomprehensions and ambiguities. The existence of promiscuity induces the hiding of respective criticisms and the maximising of one's own interests. As opposed to this contractual formality, with the definition and acceptance of explicit contents, has favoured informal communication through interpersonal relations. Most conflicts are resolved within the trusting environment of the development teams avoiding the company's hierarchical paths.

Checking anomalies and noting improvements to be made to the project is a task for both partners and no longer only for the buyer. In this context the supplier must take on a purely proposing role.

Moreover, the acknowledgement of the specialistic know-how about the component responsabilises the supplier to inopportune requests by the buyer. The onus is on the supplier to correctly interpret the objectives set in his domain.

Finally, interpretation problems can be solved by sharing methodologies, tolerances, assembly tests and all possible preventive activities, working together in all the phases of the process of product development.

3. Supplier involvement in the product development process of Fiat Auto

In Fiat Auto the Technical department is responsible for product development and has a matrix structure.

Horizontally, the new product is developed by cross-functional teams (platforms). Platforms have to meet the times, contents, costs and quality expectations defined by the mission statement of the new model.

Vertically, the Technical department sectors have to guarantee the know-how of the resources: labour, facilities and technologies. Moreover, contribution to the development of a new vehicle also takes place by improving the shelf engineering. The other functions involved in product development are structured either by functions, or by projects (platforms) or both.

Matrix structures are formed in order to overcome the problems posed by functional structures (Galbraith, 1973). A basic element of any form of matrix type organisation is the crossfunctional team. Teams with different goals can be formed depending on the objectives and tasks set.

In Fiat Auto the management of new model development projects becomes directly connected to marketing strategies, thus passing from a single product market perspective to a strategy based on a range of connected yet diverse models. The use of the term platform refers to a series of highly coherent products distinguished by the same technical origin of the vehicle chassis. Starting from this basic vehicle a specific organisational structure is defined to head the development of all the models included in the same market segment. In this way the development of the interdependence between similar projects is favoured and there are more common areas in the project studies: carry over components, specialist know-how, formulae and parametric relations, competence and experiences, human and financial resources, etc.

Platform structures can also assume the conformation of an autonomous project team, where the team is set up as a separate organisation and spatial distances are sensibly reduced. The application of co-location as the operative mode within the platform may be considered as a particular product development structure, dictated by business control systems, reduced bureaucracy, instant communication and active co-operation.

Platforms are normally structured on several functional levels. Each level corresponds to a specific team with a team leader at its head.

In a platform the general tasks can be divided as follows:

- The lower level, development team, has the task of following all the phases in the development of a specific part of the new model;
- The intermediate level, product team, co-ordinates and harmonises the development team's activities and defines the overall product planning;

The upper level, core team, pursues the optimum conditions between similar products, plans the overall tasks, manages resources and reports directly to the Board of Directors.

The divisions between the different levels are by no means schematic or rigid. Some individuals may appear in more than one level, for example team leaders and some functional representatives, in order to facilitate the flow of data within the platform. So communication and co-operation is facilitated through the direct contact between the members of the operative work groups and those above who have been delegated more of the management and co-ordination aspects.

The actual configuration of the platform is, therefore, closer to a continuum of interconnected structures forming a pseudo organisational chain, than to a series of hierarchical, superimposed and distanced structures.

As a part of a widely extended deverticalisation strategy, Fiat Auto asked suppliers for greater involvement, exceeding purely operative execution. Thus suppliers have already begun to contribute in the lay-out stage of the product specifications, and can be

included, full-time, in team work, in order to safeguard the best implementation of their component.

The co-design work enables a reduction in planning times for both parties. In fact, as soon as the pre-studies are ready, the suppliers can begin the lay-out of the design for which they are entirely responsible. Formerly, the supplier had to wait for the final design from Fiat Auto, and then adapt it to its own technologies: this meant a waste of time and efficacy in terms of unsuitable solutions to the needs of Fiat Auto and the supplier. This shared work also continues during pre-series production and therefore eliminates the risk of carrying out modifications at the moment of production.

At the greatest degree of design deverticalisation (now 59%, in the future 70%) suppliers will be required to test components or the whole assigned system. Consequently, Fiat Auto will intervene only to check the compatibility of the details with the vehicle.

The level of the design specifications depends on the typology of the detail and supplier. If the supplier ranks among the leaders the specifications become only the essential ones.

The definition of contracts with suppliers is certainly one of the organisational structures that has been changed most, affecting their whole relationship.

First of all, the procedures have changed. The contract is not made solely by the Purchasing department but together with the Platform. In fact it is the Platform Manager who signs any agreement made.

The drawing up of the contract, even if it is in co-design, takes place during or even at the end of the development stage and includes each part of the product details: first and foremost the qualitative standards, costs, weights and development times.

The delay in the wording of the contracts was considered as being a strong limitation to co-operation between suppliers especially by the development teams. This was because the respective responsibilities were not immediately defined (e.g. whose job it is to transcode the CAD data if the systems are not homogeneous) and the certainty of the supplier offering complete collaboration is therefore reduced.

The choice of supplier is not always made quickly enough, and this should happen as soon as possible for everyone, right from style definition and the feasibility studies. This way, the ability and responsibility of the supplier would be put to the test and ascertained.

The greatest number of conflicts arise due to technical incompatibilities, in qualitative controls and reaching fixed goals. The strong deverticalisation process focused attention on the principles of transparency, crucial moments, collaboration and team work.

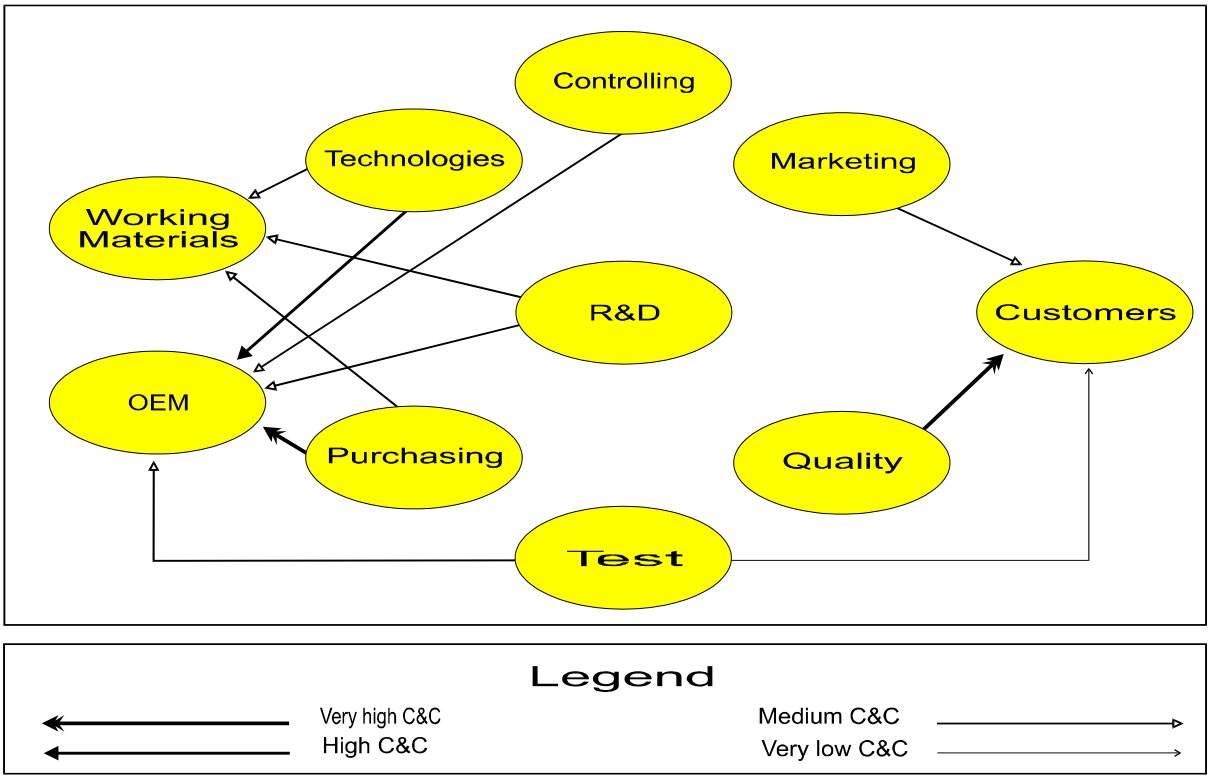
Three more problems arose during the development in co-design. The first two problems concern all the suppliers, whereas the third mainly concerns small firms.

- The Fiat Auto experience found the suppliers lacking in sensitivity regarding the border areas between the components. The focus is more specialistic and less on the system. In this case the car maker must probably make a greater effort in defining points of contact;
- the principles of single-sourcing have not always turned out to be efficient. In some cases a greater level of competition could be considered necessary;
- many suppliers are able producers but are not so skilled in product development. In many cases they are completely lacking and therefore make use of external

engineering service firms that in fact form an intermediate step and make the information flow between the buyer and the supplier difficult.

With some suppliers the co-design partnership has been extended to the creation of permanent design offices within the customer's technical department. The passage from co-design to co-habitation reduces the distance between the partners and consequently improves communication and co-operation. Using co-habitation the similarities between just in time and simultaneous engineering are enriched by the physical closeness of the supplier, a particular element in the integrated factory.

Figure 2 - Communication and co-operation in the external process chain



4. Communication patterns in the external process chain of Fiat Auto

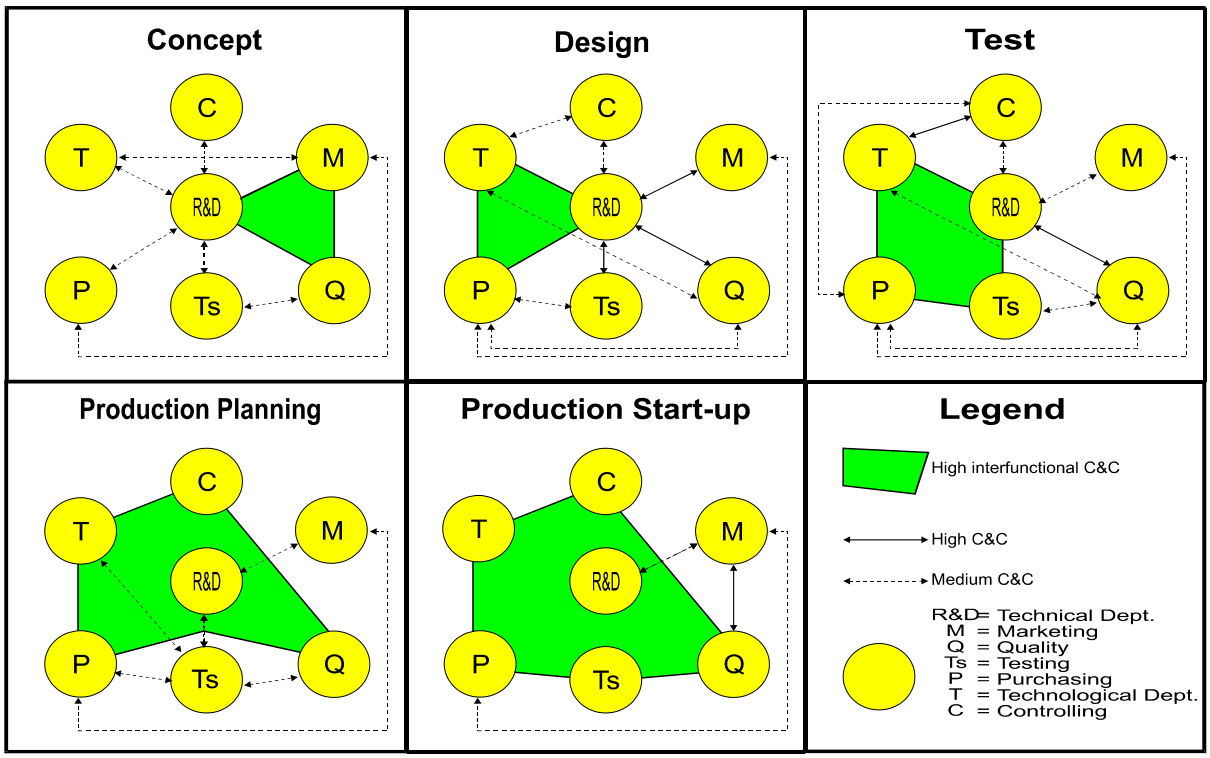
Despite the fact that communication and co-operation within the platforms have been widely recognised as fundamental and are the subject of continual extension, preferential relations undoubtedly exist dictated by the needs of the moment or situations embedded in company culture. Figures 2 and 3 show the degree of communication and co-operation in the internal and external process chain. Every member of the platform core team were asked how much they communicate and co-operate with the other partners.

The intensity of co-operation is differently shown in the two figures. A minimum level of interdependence exists at any stage between the functions involved in product development but it has not been shown graphically for simplicity. With regard to external partners, however, if no arrow has been included, it is because no interrelations have been declared.

The importance of the platforms as a bonding factor between the functional areas involved in the development of the product is further confirmed by the fact that all the components of the core team have declared that on average 70-80% of the informative flow takes place within this structure, whereas the other forms of contact turn out to be computerised systems (10%) and less importantly written communication and telephone conversations (5% for each). With the complete development of the CAD model it is thought that the communicative flow through the computerised systems can double.

As far as suppliers involvement concerns, purchasing role, external interface, co-design and cad integration will be focused later.

Figure 3 - Communication and co-operation in the internal process chain



4.1 The new purchasing role

Apart from the Technical department, figure 3 shows the *trait d'union* role of Purchasing among all the partners. Purchasing plays a fundamental role in the connection between external and internal interfaces. According to Grando and Siamesi (1991) the Purchasing function is more and more a boundary organ between internal and external, attempting to render the company's needs compatible with respect to

volumes, means and time. Here lie the principal analogies with marketing, and the constant connection highlighted by figure 3. Both functions lie on the extremes of the process of purchasing, transformation and sales. Purchasing and marketing, in particular, seem to reach out in their constant monitoring of the external environment and interfirm negotiational processes.

Product development is a process characterised by uncertainty, by continuous problem solving, by elaboration of marketing data which may also be inferred through suppliers. In the traditional organisational model (Sandell, 1994) environmental uncertainty was correlated to an increase in specialisation and differentiation between the functional organs in order to distribute the uncertainty between them. Increasing interaction between company and the environment, induced by global competition and product complexity requires instead, a progressive integration between functions focused on internal processes and functions outwardly oriented to improve the process of conversion of market expectations into adequate solutions.

Using platforms, the operative flows have not only been modified but also extended, greater involvement of suppliers in co-design requires attention and complexity. Moreover, purchasing represents one of the principal cost centres where more incisive leverage can be carried out than for other expenditure (Mediobanca, 1993).

The common ground between marketing and purchasing on the internal-external boundary has caused a new orientation within the purchasing function with respect to the management of medium to long term objectives. Through buyer's marketing and procurement mix the purchasing function becomes a strategic interface to respond efficaciously to market changes, registering technological development. The move towards externalisation changes the traditional role of purchasing from the administrative management of suppliers, to the management of suppliers integrated with company needs, thus improving communication and co-operation flows, transfer of technology and competence.

In the past design was mostly carried out internally. The Purchasing function's task was, therefore, to ensure the availability of supplies at the lowest price. This related the purchasing function to production, while under the current situation the connection is more with product and process development (Burt, 1985).

There is a large amount of potential conflicts in the integration between purchasing and technical functions (Bonaccorsi, 1997). The background is traditionally different (legal-commercial vs. technical). The functional objectives are not consistent as well. Technical functions strive for excellence in product performance, while purchasing people are measured against cost reduction achievements.

This organisational change also has new operative implications for the buyer and the controller, the principal professional figures in the purchasing function. The buyer, who formally dealt only with price and the arrival times and modes of the goods has moved his interest to the management of design components, to the management relations in order to be at the suppliers' disposal and to active participation in the complete product development cycle.

The controller, for his part, has given up the role of supervisor to become a consultant to the production flow in order to adapt the reciprocal needs in the buyer-supplier relationship.

The role played by the purchasing function loses the content of simple interfacing with suppliers and takes on that of operative support.

Figure 2 highlights the absence of an exclusive relationship between suppliers and the Purchasing function, but it is open to the other members of the development team and has increased over time. Suppliers are also selected by technical function, commercial negotiations are overcome by parallel discussions, price bargaining and cost control are jointly approved. Using traditional interpretation such a situation could have been judged as a bypassing of the Purchasing function whereas now it signals a plurality in interfacing. Nevertheless it requires more co-ordination.

Final responsibility with respect to suppliers no longer belongs to the Purchasing function but to the platform core team. For example, in Fiat Auto the ratification of co-design contracts is up also to the Platform Manager and not only to the relative functional head.

4.2 External interfaces

Figure 2 shows the external interfaces in the early phases. The traditional net separation in the management of external relations stands out. The industrial departments - Technical, Purchasing, Technological and Test function - as well as the Financial Control function were assigned the task of interacting with suppliers, in particular with OEM suppliers. Communication and co-operation with regards to suppliers were rated highly during the entire development cycle of the new model. On the other hand, the product management sectors - Marketing and Quality - had the task of finding the voice of the client and the Test function alone made direct reference to the customers. This is due to the fact that during prototype checking it is not only the reliability of the solutions which are taken into consideration, but also the feel of driving the vehicle which is seen as a distinctive brand feature within Fiat Auto.

At the end of the process the external interfaces had changed slightly, particularly the Technical department. A more intense relationship with suppliers and weak signals of unmediated openings to clientele were noted.

4.3 Co-design implementation

Co-design is a different way to develop a component or a system together with a supplier.

On the one hand, the automotive producer makes its general automotive knowledge available: the customer's expectations, the mission required of the product, the competitor's performance, and presides the correct interaction between the various components and the whole vehicle. On the other the suppliers offer their specialist knowledge about the component to be developed, on the best way to industrialise it and produce it.

Once a suitable supplier has been chosen to develop the part in question, the collaboration process begins.

Not all co-design work is carried out together with the same intensity. Collaboration is urgent especially in the first phase when feasibility has to be reckoned, style frozen and the project studies carried out and in the final two phases beginning from the pilot factory for process testing. The supplier's work is mainly carried out internally when

components have to be developed and the assembly and style prototypes have to be constructed in parallel.

The space allocated within the platform to the supplier is large: from the style approval stage they are an important part of the crossfunctional teams, and for the duration of the work together, have all the data regarding the component performance requirements (reliability, weight, bulk.....), the product details, as well as desks, telephones and necessary work instruments, as in CAD workstations. They may also use the internal canteen service. For this purpose one or two of the supplier's designers, called resident engineers, are transferred to the buyer with a role of support and direct responsibility.

The resident's preparation is purely technical with competence in design and engineering. Good interpersonal relationship qualities are also required and predisposition for group work. The development team may even be moved to the supplier's premises and the presence of a resident engineer from Fiat Auto at the supplier's is also possible.

The choice of resident is made by the supplier. At the end of the stay a final evaluation is made. The resident experience has been judged very positively. In some cases the resident has been assigned the role of team leader within the work group to which he was assigned.

The relationship with the resident is based on complete trust built up by the conviction that it is to both sides' advantage to collaborate fully. By definition the team cannot be other than transparent. In some cases it was even the supplier's representative who realised the basic plan for the new component.

Contacts during the development phases must be continuous. Due to the tasks carried out the resident is treated as an internal employee, thus in the case of problems he must refer to the team leader. The platform manager is involved only if there is a serious disagreement. The resident is also present at production start-up.

Common work carries on through the pre-series checks and this reduces the risk of having to make changes during the countdown to production. Suppliers are called on to participate actively during the product development phases carried out at the pilot factory with assembly testing and afterwards along the assembly lines at the final plant in direct contact with the integrated factory team. Any hitches in assembly, emerging criticisms, or logistic problems are dealt with in real time and action to resolve or refine can be taken in time before the large production volumes start up. Suppliers are directly involved in the various operative design reviews to verify and revise objectives.

4.4 Data transfer with suppliers

In order to continue the improvement of the integration of suppliers in the Fiat Auto system, a supplier development plan has also been devised as an integral part of the CAD/CAM company development plan.

This plan aims at ensuring that the substitution of the traditional planning and design in Fiat Auto with CAD does not have its impact on an unprepared supply base, but favours a development that is parallel and coherent with the company.

Firstly a CAD/CAM supplier data bank has been set-up, where all the suppliers with this system, their hardware and software organisation, their dedicated resources and the type of activities developed with CAD, are recorded.

Particular attention must be paid to suppliers in co-design. In this case data must be as compatible with the company system as possible.

An initial group of suppliers belonging to the Fiat Auto Group has been allowed direct access to the central master database (MDB), with the same procedures as the internal Fiat Auto users, organised and controlled by information access authorisations.

Suppliers external to the Fiat Auto Group may have access only via a specific database (DBF), that operates like an intelligent box number, filtering and endorsing the operations carried out on identification of the supplier. Two procedures are used: if the supplier has been certified, he can operate directly on the MDB, even if it is filtered by the DBF; should the supplier not be certified, the transfer of the information from MDB to DBF, and vice versa, is activated by an internal designer as well as being filtered by authorisations.

The transmission link with suppliers is increasingly on line.

In all the above-mentioned situations, as well as for internal information exchanges, a standard definition, structure and format of data rules are essential, to ensure the correct use and interpretation by all the users involved, whether they be internal or external. Seven integration levels have been devised to outline the rules and interchange procedures from the physical transportation of the data to CAD planning methods.

5. Conclusions

In product development communication and co-operation take on a greater level of complexity. External subjects such as customers and suppliers must be considered, and relations with the factory must be intensified to a maximum.

Interfirm relationships can bring a significant reciprocal advantage of medium or long term duration (Lamming, 1993). It involves product development and production not based on conflicting market transactions.

Product development is an organisational process that tends to integrate with the whole firm. Supplier involvement in product development is more and more a key aspect in the overall buyer-supplier relationship.

Close relationships in product development are only possible on a basis of mutual trust. Such relationship can not develop immediately. It takes long time of intense co-operation and best practices. It requires more intense and constant information flows, early involvement in the process, integration in crossfunctional teams, the introduction of new tools such as, co-location, co-design, cohabitation, resident engineering, data sharing systems, and so on.

In particular co-location is basic to reduce spatial distance and improve communication and co-operation between buyers and suppliers in product development.

Some suppliers are incapable of dialogue and are not predisposed to propose alternative solutions. Initially the supplier often takes on a defensive position. The buyer, on the other hand, there is a need to speed up the unlearning of consolidated practises such as: the short term view of the single supply operation, contingency tactics, the reluctance to abandon specialist parts of the production process, lack of trust, and the placing of relationship management at the border functions.

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