Managing Information Flows in Supplier-Customer Relationships: Issues, Methods and Emerging Problems

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1. Towards a new Supply Chain structure: from production rationalization to strategic rationalization

1.1. The new competitive pressures

The analysis of the recent evolution of the automobile supply chain shows that an extraordinary reorganization in the whole industry structure has begun[1]. This reorganization mainly stems from the effort carried on by OEMs to develop a new relationship with end customers, based upon a *make-and-deliver-to-order* approach, as opposed to the previous one, based upon the *stock order* approach. This implies a radical transformation in the internal organization of automobile firms, but it also requires a profound reorganization in the component supply chain. As a matter of fact, the component supply chain has been under pressure for about a decade, towards higher efficiency levels, but until now this pressure mainly related to forms of internal firm organization (OEMs and Suppliers), and to their work methods. The new feature of the emerging program of supply chain reorganization lies in the strategic dimension of the whole stream, mainly in the forms of interaction between different subjects in the chain: customers, manufacturers and suppliers. This transformation can be seen as a move from a "production" rationalization of the component supply chain to a "strategic" rationalization, where by *production* rationalization we mean a rationalization mainly (although not exclusively) based upon innovations applied on component manufacturing processes, while by *strategic* rationalization we mean a much wider process, which can influence the forms of component manufacturing, but which involves the competitive structure of automobile firms, and in particular their way of interacting: from design of whole vehicle to manufacturing and distribution of the final product to drivers. What we want to underline is that while the first thrust towards rationalization mainly applied *within individual firms* in the automobile supply chain, the second mainly applies to the way of *interaction among firms* in the chain, as elements of a more and more articulated and complex system.

The scope and the radical nature of the transformation in progress cannot be immediately grasped in its amplitude, since the objectives of automobile firms have not changed. They still aim at the supply of innovative components, capable of ensuring higher standards to the final product, with lower costs. But this objective cannot be pursued further in an effective and efficient way with the present structure of the manufacturing chain. About one decade ago, when competition triggered a further rationalization process, known

[1] On most recent analysis of the reorganization of the supply chain see: Camuffo e Volpato [1997], Sako and Helper [1999], de Banville and Chanaron [1999], Clark and Veloso [2000].

as *lean production*[2], this has translated into a *internal* reorganization of supplier firms (as well as some reorganization within automobile firms), through the definition of higher quality standards: in products, in manufacturing processes, and in servicing. This led to a stage of great managerial and technological effort which has generated considerable results[3]. Now, however, after this stage of intense innovation, the process of production internationalization[4] on a worldwide scale and the new stage of mergers & acquisitions[5], rapidly accelerating after May 1998, with the merger between Daimler and Chrysler, has led to a wider competitive confrontation, which requires broader and more complex initiatives than the previous ones, which were mainly aimed at higher internal efficiency within individual supplier firms. This previous line of action will continue further, but with less and less relevant results.

From the organizational model of the *lean organization* the greatest share of the potential for improvement has been extracted. In order to achieve additional important efficiencies of structural nature, and not based upon a continuous improvement process (*kaizen*), significant but marginal, a new and more advanced organizational model must be adopted, where the whole structure of the component supply chain is under scrutiny. The transformations in the last ten years have turned out to be undoubtedly effective, and have led to leaps both in innovation and in cost reduction, but margins of future improvement have become gradually thinner. If one wishes to maintain the trend of improvement expressed over the last decade, one must shift to a new organizational model which encompasses not just the internal structure of individual component manufacturers, but the whole structure of the international automobile supply chain.

1.2. The objectives of the reorganization

As it is known, the pressure towards this profound transformation stems from the quest of automobile manufacturers for higher profitability levels, which during recent years have decreased, along with the growing financial needs generated by production expansion in emerging markets. The "hunt" for higher profitability levels, made more important also by the inter-industry competition in capital acquisition brought by the new economy, lies in a set of dimensions, but it can be summarized as a hunt for larger scale and scope economies, accomplished through forms of mergers & acquisitions, and the focus by car

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[2] On these aspects see Womack, Jones, Roos [1990] and Womack, Jones [1996].

[3] On the specific aspects of strategic trajectories applied by individual car manufacturers see contributions in Freyssenet et al. [1998].

[4] In this paper the concept of internationalization means the geographic expansion of the activities (purchasing, design, manufacturing, selling) carried on by a firm.

[5] The most significant stages in merger & acquisition after the establishment of Daimler-Chrysler in May 1998 are the acquisition of Rolls Royce and Bentley by Volkswagen in June 1998, the acquisition of Dacia by Renault in July 1998, the acquisition of Bugatti by Volkswagen and GM purchasing 10% of Suzuki's capital in September 1998, the purchase of Kia and Asia Motor by Hyundai in October 1998, the purchase of Volvo Car by Ford in January 1999, the purchase of 49% of Isuzu by GM and of 36.8% Of Nissan and of 22.5% of Nissan Diesel by Renault in March 1999, the purchase by GM of 20% of Fuji Heavy Industries which controls the Subaru brand in December 1999, the growth of GM's control to 100% in January 2000 and, finally, the cross-participation between GM and Fiat Auto and the acquisition by Daimler-Chrysler of 34% of Mitsubishi in March 2000.

manufacturers on strategic activities which are believed to be capable of providing higher added value. On the whole, the key fact is to externalize all activities which a supplier can perform at a lower cost compared to an integrated production, allowing to reduce total capital investment and increase the net profit of both kinds of firm: suppliers and OEMs. The effective development of this scheme would lead to a higher ROE, thus to the possibility to fairly compensate all stakeholders, which represents a necessary condition in order to gain the substantial financial means required by the internationalization of the manufacturing structure and by the merger & acquisition operations.

This strategy of externalization of investments and costs, but not of rates of return which should rather increase, moves through a reorganization of the supply chain to an extent which would have appeared unthinkable just a few years ago[6], and whose key points are:

a) the growth in outsourcing,
b) the concentration in the number of first-tier suppliers,
c) the design of shared platforms;
d) the integration of systems and modularization;
e) the global sourcing.

All these initiatives, which must be moved further in parallel to the process of geographic expansion in all consolidated automobile markets (USA, W. Europe, and Japan), and more recently in all emerging markets, must then be linked to a scheme of integrated management which can be referred to as globalization[7].

1.3. The growth in outsourcing,

The most evident measure of the diffusion of outsourcing lies in the gradual reduction in employment levels of car manufacturers, linked to a marked increase in the production volume. A clear example of this trend is General Motors. Total employment for this manufacturer decreased from 761,000 units in 1990 to 388,000 units in 1999, though marking in the same period a growth in car & truck production from 7.45 million to 8.78 million units[8]. As it is known, a considerable share of this change has been accomplished through the de-merging of internal component manufacturing activities which led to the establishment of Delphi, but undoubtedly the growth in outsourcing extended far beyond this de-merging operation, which has been anticipated or followed by many other manufacturers such as Daimler-Chrysler, Ford, Fiat and Renault, which were previously more highly vertically integrated. The outcome of this policy has generated also a great

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[6] Another relevant aspect linked to this reorganization, but which cannot be dealt with in this paper, lies in the future evolution of the forms of public regulation, both on vehicle emissions and on future forms of distribution. On the impact of community regulation on the European supply chain see Volpato [2000].

[7] In this paper globalization means: to implement a decision-making system able to integrate the managerial operations of an internationalized firm in all the most relevant aspects and functions (procurement, design manufacturing, distribution and so on. See Porter [1986]. On the Fiat Auto's globalization project see: Volpato [1999].

[8] Fiat Auto in the same period has reduced employment worldwide from 133,431 to 82,450 units (-38.2%) maintaining the same production level.

increase in the size of the component supply market, which presently is estimated at about $ 1,000 billion, for cars alone.

1.4. The concentration in the number of first-tier suppliers

As it has been said the effectiveness of the production decentralization is based upon the hypothesis that the supply system can take the place of direct production by OEMs, with reduction in component costs. Car manufacturers try to favour this objective through supply concentration and the more frequent adoption of relationships based upon single suppliers. This led to a transformation of the supply system from a flat structure, where each supplier, even of small size, had direct relationships with the car manufacturer, to a highly hierarchical structure, where only first-tier suppliers have direct contacts with the OEM, and are in charge of setting up in turn a hierarchical system of specialist sub-suppliers. The new division of labor between automobile firms and suppliers has in turn generated new opportunities of merger & acquisitions with a dramatic reduction in firms specialized in production dedicated to the automobile industry. According to estimates by the Economist Intelligence Unit the number of suppliers has declined dramatically over ten years, from approximately 30,000 in 1988 to less than 8,000 in 1999.

But this is just one side of the picture, although one of the most important in the transformation cycle triggered, given that individual suppliers are also redefining their respective areas of technological competency. In the previous "flat" supply scheme each supplier tried to maximize the range of products offered, as this tended to simplify the procedures of buyer evaluation and selection by car manufacturers. Now in the hierarchical structure this aspect does not represent an advantage, but rather a weakness since a broad product catalog implies too large investments and difficulties in sustaining an adequate level of innovation on the whole range of products offered. Hence the supply chain is experimenting a process where first-tier suppliers are focusing on a narrower and more homogeneous range of products, obtained through sale of activities where one is less competitive, and purchase from other suppliers of those where one already has a strong specialization.

Furthermore, the firms' concentration stems from specific technical needs. As suppliers must be activated with short lead times, if one wants to make them capable of supplying an effective development on parts to be inserted in new models, it is necessary to carry out a process of strong information exchange with manufacturer designers, and the establishment of a true culture sustaining *co-design*[9].

1.5. The design of shared platforms

The suppliers' move towards scale and scope economies can be adequately enriched only with forms of further standardization of products by car manufacturers. However it is now clear that "simple" forms of standardization based upon the offer world cars have proved to be a failure. This has already emerged from the difficulties encountered in the

[9] See Lecler and al. [1999].

transfer of products in more advanced markets of the triad (USA, Western Europe and Japan), but the inadequate standardization of models is going to worsen as emerging markets will consolidate (Eastern Europe, Latin America, China, India and so on).

As a consequence car manufacturers are experimenting new forms of standardization, which are more refined and complex, but partial since they aim at sharing parts without standardizing models as they must maintain margins of customization in different national markets and with respect to the needs of the individual end customer[10] as well. This process moves through the design of "common platforms" capable of using a considerable number of common sub-systems, but leaving room to develop the body and other elements which can be perceived by the consumer according to exigencies of different markets. It is a crucial step which no car manufacturer can claim to have satisfactorily accomplished so far, but towards which all manufacturers, with no exception, are striving, aware that it is the only way to solve the contradiction between market variety and manufacturing standardization.

1.6. System integration and modularization

Another key element of the strategic reorganization of the automobile supply chain lies in designing a vehicle as a sum of integrated systems and in assembly's modularization. These are different things which are worth distinguishing, although they evidently share common aspects. Vehicle design by integrated systems stems from the fact that the vehicle can be described as a set of functional elements, each in charge to carry out specific tasks: production of moving energy and its transmission to wheels (engine and powertrain), the braking system, the steering system, the exhaust system. In the past these systems had a low degree of internal integration from the design point of view, as they were made of individual mechanic elements which could be drawn and formed with limited forms of interdependence. Presently all these functional systems feature a very high degree of internal integration due to the fact that their operation is managed by electronic devices. In substance each functional system is not the mechanical sum of many different parts, but it represents an integrated complex which can be designed in an optimal way only through an unitary lead, managed by a supplier acting as system integrator[11].

On the other hand the aspect of modularization does not refer to the design of individual parts in a functional system, but focuses on its assembly and testing activities to be carried out in the stage immediately preceding its transfer onto the vehicle final assembly line. The module is then a macro-component, made with many parts which it is possible and economically convenient to assemble and test outside the vehicle final assembly line, in order to increase simplicity and speed. In some cases it can happen that a functional system coincides with a module, as in the case of powertrain and exhaust system, but in other cases this does not happen. For example, the vehicle lighting system or

[10] For an analysis of the evolution of variety strategies developed over time by car manufacturers see the essays in Lung et al. [1999]. On the issue of world car and common platforms see Camuffo and Volpato [1997], Volpato [1998].

[11] The key feature of a system integrator is that it assumes responsibility for the execution of the most relevant technical tasks in the product/system chain and the co-ordination of the chain's technical and operational performance over time.

the steering system clearly represent functional systems, but their complexity and their extension over a variety of vehicle parts prevents their pre-assembly as modules[12].

1.7. Global sourcing

Last, but not least, comes Global Sourcing (a buying system based upon a worldwide monitoring and selection of most convenient suppliers). A firm has a global sourcing system in place when it can source parts through a choice which compares supplier offers on a worldwide scale. The system requires a specific organizational structure which allows not just to monitor a large number of potential suppliers scattered around many continents, but also a system of evaluation and constant control for supplier performance (actual and potential), whose costs can be borne only by major car manufacturers. As it is known "integral" applications of this form of globalization do not presently exist, but scholars and practitioners agree in expecting this form of buying strategy to be enhanced.

According to some, this system would allow the selection of suppliers with the best quality/price ratio. The "would" relates to the fact that on the one hand this principle of globalization clashes with other forms of globalization and, on the other hand, the fact that it is systematically more convenient has yet to be demonstrated. With respect to the first aspect, it is clear that a global sourcing supply clashes with criteria of just-in-time service which privileges near suppliers. If the jit supply should be carried out by a supplier just for a few years, to be then replaced by a supplier capable of offering a higher cost reduction, it comes straightforward that the system could not work. Hence global sourcing represents an organizational form which can be applied effectively only to specific types of components such as highly standardized parts with commodity nature, or parts in manufacturer catalogs which, although of technological and sophisticated nature, do not require specific customization to the needs of different vehicle models (e.g. tires, alternators, batteries, brake pads, etc.).

However by considering this process of first-level supplier concentration and the growing usage of common platforms the share of parts negotiated through global sourcing procedures is likely to expand further[13].

2. The quest for new integration tools

2.1. The need for more qualified information

We could therefore agree that over the last decade the shift from a "production rationalization" to a "strategic rationalization" has resulted from a double action: competitive push and technology pull. These two forces shaped the actual automobile industry giving birth, about one decade ago, to new needs and opportunities at the same time.

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[12] For an analysis of the different aspects involved by module production see: Sako and Warburton [1999].

[13] On the global sourcing experience of Fiat Auto see Camuffo and Volpato [1999].

On the market side, the increasing competition and the multiplying customers' requirements played a major role, pushing car manufacturers to invest both looking for new sources of production economies and for continuous product improvement. On the technology side, the fast growing complexity of products and manufacturing processes increased the amount of know-how required for process operations. Moreover, the developments in Information and Communication Technologies (from now on ICT) create opportunities never experienced before.

Thus, from the early 1990s car manufacturers were urged to re-arrange the supply chain maps and their own operations; the reorganization encompassed both internal operations (trends towards lean production) and relationships with suppliers. Here the focus lies on the second issue: very shortly, the major steps in the process of supply chain re-organization could be summarized as follows:

1. to reduce the number of direct suppliers;
2. to re-arrange the supply chain in order to establish a sort of hierarchy which divides suppliers in tiers;
3. to outsource functions and operations previously considered as strategic, such as quality control, complex part design, design, assembly and test;
4. to extend strategic control through the supply chain – as far as their speficic business is concerned – through the management of inter-organizational relations in a way which is generally known as "network".

Clearly the ongoing process of supply chain reorganization has several consequences. Among these, the reshaping of information flows among supply chain contractors: relevant changes are taking place in the way supply chain agents have to manage information flows, not only with respect to the management of technical issues, but with respect to organizational consequences. In this picture, the most peculiar aspect of this move from production rationalization to strategic rationalization of the automobile supply chain is represented by a marked growth in integration needs. As a consequence the new supply chain structure is based upon operations which require:

a) downwards, a tighter link of production with automobile demand like the elements of make-and-delivery-to-order previously quoted, increase in product range and shortening of life-cycles of individual models, obtained through the compression of the time-to-market;
b) upwards, a stronger cooperation between operators such as co-design between first-tier suppliers and OEMs and co-makership between the system integrator and 2nd and 3rd tier supplier.

Then the success of this great transformation is linked to the capabilities of the actors to carry out system of information and organizational integration, with higher levels of quality and complexity compared to those reached so far.

The control of the system implies the capability to exchange information with a degree of completeness, speed and precision which is largely superior to the one which is presently available. The qualitative aspect of the new information required must be underlined and qualified, since this dimension appears much more relevant than the mere quantitative development of exchanged information. The move from an operations chain governed by a push logic to a pull logic, pulled by a demand which is differentiated and variable overtime, implies a different management of information. In the push logic the whole coordination of the supply chain relies upon the ex ante planning activities, carried out by car manufacturers and transmitted through a cascade-like approach on the whole

supply chain. In this scheme the chain slacks represent an efficiency loss which is considered as inevitable, and which can be partly recovered through an anticipation of times associated with initial operations (if one wants to arrive earlier must leave earlier).

On the contrary in a pull logic, where the starting point for operations is not governed by car manufacturers, but results from the composition of a large number of individual decisions by consumers, it must be taken as a given (without any possibility to be changed), and any reduction in the chain slack represents not just a cost reduction, but also (and most important) a strategic capability to anticipate the competitor in design, manufacturing and delivery of vehicles which are better synchronized with the evolution of the market. So far the difference between push and pull organization was applied only to manufacturing stages, but with the strategic reorganization of the supply chain the difference must be looked at within a wider context, which encompasses also the design and development stages both of new models and of components associated to them. In other words the system should evolve towards a supply chain which does not require only ex-ante coordination of decisions, which in turn is based upon information managed by planning activities, but also a simultaneous coordination of operations, based upon execution information.

2.2. From hierarchical links to network links in the whole supply chain

If we look at the relationship between a car manufacturer and its suppliers from the standpoint of information flow management, we could say that until the 1980s such relationship was quite simple. To make a long story short, the OEM was the one who led the whole project; parts and components were mainly designed and engineered by the car manufacturer, while suppliers were asked to manufacture them. In an oversimplified description, one could say that such as relationship consisted in a few key elements:

1. The decision making process related to product development – concept, design, engineering, product tests, changes – took place almost exclusively within the car manufacturer's organization; suppliers were more or less asked to manufacture some parts at some cost. None or very little interaction took place between the car manufacturer and its supplier with respect to product development issues. Consequently, key decisions were mainly taken in an intra-firm process, that is: if it was necessary to take a difficult decision (e.g. to choose among different and/or incompatible solutions) the problem could have been simply shifted to the higher hierarchical level in the organization, until someone took a decision. This is a form of coordination based upon ex ante planning, which has a key requirement: exclusively the final assembler must be fully aware of the whole supply chain operations.
2. In such condition the relationship with the supplier is a "market-hierarchical relationship" in its proper sense: the car manufacturers purchases a product (part or component) at a set price. Its overwhelming bargaining power is the main element which causes the agreements on price of the supply to take place almost in the form of a spot market auction; for suppliers, profitability comes from their capability to make the process as efficient as possible;
3. Consequently, the information involved in such as customer-supplier relationship mainly consisted in one-way flows of technical details, prices, quantities, billing, terms of payment, etc.

Let's now look at the actual supply chain as far as the customer-supplier relationship is concerned: as previously said, it is based upon an ex ante planning mechanism, thus some interesting asymmetry takes place with respect to the elements specified above. First, the fundamental aspect of coordination based upon ex ante planning is that any individual operator does not need information on the whole chain of operations. Any chain operator must know only start and end date for a given activity, and must be concerned about precisely meeting its specific deadline. This implies a hierarchical management of information. But forms of simultaneous coordination on the whole of operations, aimed at compressing chain slacks require on line access to the whole sequence of operations, in order to carry out adaptations any time in which downwards demand triggers a wave of change which involves the whole upward operation chain. In other words, this implies forms of network connections among operators.

The decision making processes related to product development involve both the car manufacturer and first tier suppliers. According to the continuous improvement both in product and process technology, nowadays the competencies that are necessary in order to manufacture a competitive car encompass a wide range of fields of expertise. As a result, critical decisions might often take place in an inter-firm process and thus an agreement among peers could be required. For instance, managers of both the car manufacturer and the supplier might be asked to share a strategic belief as, for instance, an idea of what will be positively evaluated from the market, or an opinion of what will be the technological trend, and so on.

In such a condition it is absolutely not advantageous to base the relationship with the first-tier supplier upon a mere spot-market agreement. Since the part supplied consists in a complex module which the first tier supplier develops for that specific customer, the idiosyncrasy of the relationship increases in a significant way. The price-fixing process shifts from a bargaining power-based process to a long-term / partnership-based one.

Since the car manufacturer needs a complex module to be developed and integrated in its vehicle, the amount of information exchanged with the first tier supplier is huge. The vehicle architecture definition is clearly still the core activity of the car manufacturer, but design and engineering of parts and modules deeply involve first tier suppliers. Consequently, the relationship will not only include the usual commercial terms (prices, quantities, billing, terms of payment), but will become a mutual exchange of designs, projects, suggestions, changes and technical details.

If one considers that here the activities to be synchronized and integrated more closely are not just those of the manufacturing process (where the time frame of reference does not exceed a few weeks, and individual events can be forecasted rather effectively), but those related to the whole design, production and delivery process, where the time frame of reference amounts at least to a few years, and the variability game can apply to a largely more differentiated and complex level, it is easy to understand that the information exchange to be achieved in the move from the hierarchical information scheme to the network information scheme appears much more sophisticated than the one obtainable through the traditional information tools. For example, if one considers a variation in the levels of an information chain which is rigidly hierarchical, according to the coordination mode based upon planning, the addition of new operators implies the establishment of further stages, but from the information viewpoint complexity grows by an additional factor. If on the other hand new elements are added to a definite number of subjects who are linked in a network, information complexity due to the increase in the number of

potential subjects involved grows by a multiplying factor. Here we are facing a transformation which requires mechanisms of information integration which are largely more advanced and flexible.

Two steps are therefore needed in order to implement such evolution. First: a shift from the classic tools of data transmission (sheets of paper, phone calls and so on) towards electronic communication tools and standard protocols is needed, that is the adoption of Electronic Data Interchange (EDI) systems, in their broad sense (standard protocols of data sending and receiving). The first step is a move towards *information flow integration*.

Second: the whole supply chain might gain in efficiency if the internal processes of each firm are planned and scheduled on real-time requests. Significant shortening of cycle times might be obtained through the adoption of Enterprise Resource Planning (ERP) systems, intended as a system (based on software packages) which is supposed to synchronize the resources required to optimize manufacturing and delivery of products, considering constraints such as lack of materials or capacity limits. This second step is a move towards *production process integration*.

2.3. Integration is not just a technological event

The fast development in Information and Communication Technology (ICT) tools (e.g. EDI, ERP, communication networks as the internet, etc.) might give the idea that the integration process which car manufacturers aim at accomplishing can easily rely upon technological means with extraordinary power, capable of generating in a relatively short time the transformations which have been pointed out. This would be misleading. As a matter of fact, the evolution of relationships among car manufacturers and first tier suppliers is primarily an answer to a change in the competitive environment, although the trajectory of the reorganization has been deeply shaped by the opportunities offered by ICT.

No one could deny that the advantages deriving from the actual organization of automobile supply chains would not have been possible without the contribution of ICT. Nonetheless, the impact of ICT goes far beyond being just technical tolls making it easier, faster and cheaper the exchange of information. Here we claim that the chance to fully exploit the opportunities introduced by ICT is much more an organizational problem than a technological one.

A vast and complex reorganization such as the one here mentioned can never be accomplished through the mere adoption of innovative tools, even though powerful and flexible. In fact, if one remembers the old saying “information is power”, then it comes straightforward that the re-design of the supply chain, as based upon a different distribution of information compared to the past, implies also a restructuring in bargaining power among the subjects in the supply chain, and therefore in their capacity to gain portions of the added value generated by efficiency gains in the system. No transformation can take place leaving previous power relations unchanged, hence no transformation will then be accomplished if any decisional center expects no gains from the change, and believes to have the strength to stay away from the transformation.

As a consequence, the process of development of ICT systems is not determined by their intrinsic process of technological innovation, but rather by the evolution of the degree of convergence / divergence of interests borne by the participants of the chain. Only the

understanding of new power equilibria emerging in the chain show the actual forms of application and diffusion of new information[14] tools.

3. The field research

3.1 Questions and methodology

The aim of the field study was to highlight important issues related to supplier-customer relationships whose transactions and production process gets highly integrated through advanced ICT systems. In our opinion, although there is a common view on how ICT can improve productivity and competitiveness through a closer connection among contractors, little has been done to investigate some important issues that lie at the basis of this study. In other words, the applications of technological opportunities are largely unexplored. Main questions might be summarized as follows.

First: the advantage which a single firm can obtain from such integration is to some extent influenced by the specific kind of relationships established among firms in the supply chain; on the other hand, ICT integration will probably affect existing relations and the competitive position of supply chain contractors. The question is: how does ICT-based integration affect customer-supplier relationships? Is the relation changing in a significant way? Which trajectory should we expect?

Second: we have seen that the closer integration of supply chain's contractors is a key trend. But it is arguable that such a process might take place without disadvantages for one or both contractors, so: which kinds of obstacles and problems occur in the ICT integration process?

In our view the answer to those questions must be sought with respect to the various kinds of relationships that are likely to take place among supplier and customers; then focussing on the different kind of possible information flows. In such view, the research steps have been the following:

1. to identify a specific kind of relation to focus the empirical analysis on;
2. to carry out a field study trying to provide an answer to the above specified questions.

The empirical analysis included: a) in-depth interviews devoted to paradigmatic cases, b) a questionnaire-based survey on a sample of firms to attempt to shed light on the actual degree of diffusion of ICT-based customer supplier relationships.

3.2 Background no. 1: ICT relevance in small and big problems

The first main evidence is that as far as information flows are concerned it is not possible to speak about customer-supplier relationships in general, since a huge amount of possible situations might exists (fig. 1). For this reason a 360-degree oriented research would require a vast synthesis effort to evaluate every single possible situation

[14] The manufacturing industry has already met a similar occurrence with the introduction of flexible automation, when it has been widely recognized that technology in itself does not create major efficiency or effectiveness if it is not linked to the organizational and strategic design. See, for instance, Parthasarthy (1992), Boer and Krabbendam (1994).

Fig. 1 - Information flows and customer-supplier relationship: examples

Exchanged information:	**Main relation features**
- Prices - Product Codes - Time of delivery - Quantity	*Spot-market relation:* - buy on stock
Same as spot-market relation plus: - Production plan - Operation plan	*Medium-long term market relation:* - buy on stock - make on demand
same as other relations plus: - Demand forecast - Technical product data - Technical process data - Industry cost curves	*System integrator- customer relation:* - buy on stock - make on demand - product development on demand - strategic forecast

In this research we decided to focus on the specific relationships taking place among a system-integrator supplier and its customer; such relationship is at the same time the more complex and the one where the higher integration is required, since it implies a deep sharing of information. Such a decision came from the obvious opinion that the more intense the observed information flow would have been the more interesting situations we would meet.

Actually, this revealed to be only partially true; academic studies normally look at complexity (in its broad sense) as one of the problems that are better solved from ICT systems integration. Nevertheless, the interviews gave as a result that the obvious advantages regarding repetitive tasks (seemingly less important in the mind of a scholar) are evaluated with major attention by a practitioner's mind.

An element that emerged during the in-depth interview, as totally unexpected, is that one of the greater sources of efficiency gains comes from the role of "error-killer" played by electronic data transfer tools. For instance, in a traditional system a single document (e.g.: a bill, an order and so on) requires to copy a series of codes from a piece of paper to another piece of paper; then it is sent by fax to another firm where it has to be copied again. The probability of an error might be high or low, depending on the kind of information exchanged, but it is quite common that if an error occurs then a lot of time is wasted in trying to fix it. Therefore firms give great importance to the capability of EDI and other ICT technologies to eliminate errors attributable to manual transfer and keying of data.

We then asked ourselves why such an important element is not given its legitimate importance; maybe the answer lies in the fact that frequently the comparison among ICT and traditional technology assumes an error-free environment. In other words, both traditional technology for supplier-customer information exchange and the ICT-based one

are considered at their best. On the contrary, as far as possible faults are concerned, they both feature peculiar aspects. ICT will probably suffer from its own possible faults, but for sure traditional technologies rely upon human activity for data transfer (and this causes problems) while ICT do not. In an EDI integrated system data are transferred without manual keying but with a simple "forward" input.

In conclusion, the range of possible information exchange situations is broad: there might be structured circumstances as well as de-structured ones, complex and simple ones, and so on. We tried to investigate the more relevant questions and therefore we have chosen to focus on the relationship among first tier and/or system-integrator and assembler, but this does not mean that more common situations have to be less interesting.

3.3 Background no. 2: ICT advantages

Leaving apart the unexpected relevance of rudimentary ICT benefits, there is a shared view about the potential advantages deriving from the integration of production processes through ICT.

Here we talk about Information and Communication Technologies as including all those tools (hardware and software) which are based on electronic devices and which allow to transmit and process information such as data, sound, images, movies and so on. The "physical" elements include hardware, software and communication networks. Fields of application of ICT in supplier-customer relationship potentially find no limits; just to give some examples:

- Exchange of information and data
- Sending and processing of messages
- Preparing support to allow the diffusion of information
- Collecting information
- Exchanging documents
- Preparing supports to control and evaluate firms activities
- Preparing supports to collect past information
- Search for new business opportunities

Since customer/supplier relationships require a great amount of work in several activities involving several actors, ICT aims at providing a set of tools that help in each of these activities through automation of routinary/repetitive procedures and through easier and faster access to information.

Specifically, the main sources of benefits might be summarized as follows:

a) Automation of procedures connected with in-bound and out-bound information flows. Electronic Data Interchange (EDI) should eliminate the manual handling of information and forms concerning, for instance, delivery calls, dispatch advice, invoice, confirmation of receipt and so on;

b) Automation of procedures connected with the inner information flows related to order fulfilment. The recent developments of the so called Enterprise Resource Planning Systems (ERP) should give the opportunity of co-ordinating the information flows coming from the outside with the internal production system. For instance, the whole planning of order fulfilment - from purchasing of parts and material to delivering the order - might be

managed, in theory, through an advanced ERP system, within the time constraints applying to that specific order[15].
c) Electronic communication of data of various kind: from draft and technical notes to vocal comments. GroupWare allows teamwork at distance, significantly improving the chance to implement practices as co-design and co-engineering among contractors without increasing transactional costs.

The potential improvement brought by such practices in supplier-customer relationships is often taken for granted. Actually, if it would be possible to integrate at its best the available ICT, we could observe an immediate effect on the competitiveness of both contractors, due to:
- Shortened time-to-market, due to faster and safer exchange of data and its effect on work phases, like design, engineering, prototyping and development.
- Faster planning and production scheduling,
- Work-in-progress reduction,
- Reduction in idle times.

In reality, ICT advantages stands in the overcoming of spatial distances and in the substitution of manual operations with automated ones; for instance:
- Videoconferencing substitutes meetings
- EDI substitutes manual keying of orders, billings and so on
- ERP substitutes manual operational planning
- MRP substitutes manual calculation of needs, re-ordering, scheduling and so on.
- CAD substitutes manual design and calculations of components
etc.

3.4 First results from the interviews

Six supplier firms have been selected for in-depth visits and interviews:
1. Two OEM first-tier auto-industry supplier;
2. One auto-industry first tier supplier;
3. One producer of ERP systems;
4. One OEM first-tier mechanical firm producing components for agriculture;
5. One firm LAN-WAN administrator and software producer.

All the manufacturing companies interviewed have adopted EDI and MRP and/or ERP systems. Except in the case of the ERP producer and of the agricultural-machine producer, the subjects interviewed were the CEO together with another executive and with personnel both from manufacturing and from the technical staff. In the case of the ERP producer the person interviewed was the product-manager responsible for specific software, while for the agriculture industry firm the interviewed was a production engineer responsible for inventory management.

The interviews have been carried out between June 1999 and March 2000.

The main results can be summarized in just a few words: problems are not related to technical issues but to the management of production processes and to the management of relations with customers.

[15] The CEO of one of the company analyzed in our research calculates in 56 hour of one-man work each week the total amount of time-saving related to the use of EDI interfaced with ERP supply management.

1. ICT-based integration and firm organization

According to almost all the subjects interviewed ICT improves profitability but advantages are anyway connected to the internal organization of production. ICT improves but does not overcome the problem connected to the upward design of the production flow.

For instance, the implementation of advanced systems like ERP systems requires responsibility and decision processes within the firm to be well defined and efficient. In other words, it must be clear: a) who is responsible for each activity within each process, b) which procedure has to be activated for each situation.

Actually we cannot agree with the common statement that "ERP systems allow the re-design and improvement of organizational structure of a firm" [Cerruti, 1999]. On the contrary, a re-design is likely to be needed for an ERP system to work properly. According to the product manager of the ERP producer interviewed, when the management of a medium-sized firm decides to invest in advanced planning systems and ICT integration, they roughly know what they are buying. Very often it is up to the ERP seller to suggest the introduction of workflow management systems together with a re-design of tasks and responsibilities.

One of the OEM suppliers declared that the huge problems encountered in adopting SAP-R3 derived from difficulties in interfacing personnel dedicated to managing the information system and the rest of the firm organization. Just considering the bare money implications, it resulted that the starting proposal of investment was about Euro 2.5 million, but the period of set-up has been longer than expected and total investment increased up to Euro 15 million over six years[16].

2. ICT and relationships among firms

In one of the two carmaker's OEM suppliers interviewed (working mainly on batch productions) the whole process of order fulfillment is managed through an EDI-MRP system; the implementation of ICT tools has been required by car manufacturers with whom the firm is operating.

Thanks to the EDI connection the firm's customers (carmakers) can send their orders almost continuously[17]. Together with one of its customers, individually, the supplier has developed a system that allows the carmaker to "see" the inventory of the firm and to set the orders and the production schedule according to what is in stock.[18].

All other carmakers do not know, in fact, the level of inventory for the specific item they need, nor if and how the production capacity of the supplier is allocated at that time.

[16] In our view there is a significant difference between this case and other (even worse) cases that Davenport calls "horror stories about failed or out-of-control projects" [Davenport, 1998]. A certain amount of problems and failures might be considered physiological among first-adopters, but the interviewed company started to adopt advanced planning systems after several years of experience in the field.

[17] Company CEO said that they were just testing during those days a 24-hours connection for continuos ordering.

[18] This might be a nice example of those kind of benefits from ICT integration that make Dudenhöffer [2000] predict that the carmaker in the future will have online access up to tier 7 supplier with systems to systems data exchange.

Since all carmakers ask the supplier to fulfil just in time delivery with intense scheduling (from 1 to 5 deliveries a week), as a result the company has to face a trade-off between:
- keeping a slack of production capacity to be sure that it can fulfil the order on time;
- keeping a higher level of inventory than it would be necessary.

Anyway, such a solution has been implemented under the condition of a long-term, almost *partenarial*, relation among the supplier and the customer.

On the other hand, out of such assumption the "viewable inventory" has been labeled as "dangerous" from another executive interviewed. According to the engineer from the OEM agricultural machine producer (batch production), to let the customers know the internal plan of production and operational scheduling might create the conditions for renegotiations of terms (prices and times) for each batch. Such a situation exist, in his opinion, since very often in that specific industry the customer has a bargaining power towards first-tier suppliers which is greater than in the car industry. As a consequence, final assemblers seldom seek a long-term partnership agreement and an opportunistic attitude is therefore common from both parts.

For instance, a problem takes place whenever parts or components in stock are not enough to fulfil DELJIT-request from two different customers[19]; in this case it is necessary to establish a priority or, possibly, to find out a compromise to displease none of the customers.

So, it should be clear that such problems as those described above do not come from ICT, of course, but from the balancing of bargaining power between the supplier and its customers, together with the intent of both contractors to exploit ICT advantages. This bring to a twofold consideration:

From the supplier's point of view ICT have created a situation in which the performance required to the supplier is much higher[20]. For instance, the OEM supplier shifted from one delivery every 15 days to one to five deliveries a week. At the moment of the interview the lead time was supposed to decrease from 16 days down to 48 hours (make and delivery) and 24 hours (just delivery).

From both the carmakers' and supplier's point of view, relationships became much more idiosyncratic, since sunk costs take place according to: a) the nature of ICT tools and production capacity[21], b) high importance of supply for the car manufacturer and the lack of possibility of replacing it in short times. Therefore, if it is reasonable to think that advantages of ICT-based integration are connected to the stability of relationships in the supply chain, a question is: might such a deep integration (paradoxically) drive towards a less flexible relationship?

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[19] DELJIT is an EDI-ODETTE acronym standing for Delivery Just In Time; it indicates the request of implementation of a previous confirmed order. It can be of a twofold kind: 1. pure Just in Time, which allows the supplier to adjust the delivery normally within 24 or 48 hours; 2. Pick-Up-Sheet, not adjustable, announce that the carrier is already on the way to pick up the items. The situation described above is related to the first kind of order.

[20] The bargaining power is, of course, one of the main determinants on carmakers relation strategies towards supplier, together with the criticality of purchased items. See, for instance, Kraljic [1983].

[21] As we'll see in the next paragraph, the questionnaire survey show that almost 50% of firms decide for their ICT investments considering ICT equipment of their customer and 70% considering customer's ICT equipment.

3.5 First results from the questionnaire survey

The other part of the empirical research aimed at evaluating the actual diffusion of ICT system in supplier-customer relations. A certain number of firms have been chosen for a questionnaire survey; selected firms were first-tier manufacturer suppliers. The survey is still going on and at the moment 31 questionnaires have been collected.

The questionnaire is made of 70 questions and therefore it requires a considerable amount of time to be filled. It is also evident that a great amount of different information is given; anyway, since the research is still ongoing here will be presented only a first brief evaluation of what we considered to be the most relevant signals. The questionnaire is divided into five sections:

- Section 1 and 2 aim at collecting general company information. Firms are anyway nameless; we decided to allow firms to remain anonymous, since we think that this would increase the redemption level.
- Section 3 is devoted to ICT availability and investments.
- Section 4 regards the relationships with firm's suppliers, that in fact are sub-suppliers since the sample is itself made of first-tier suppliers.
- Section 5 regards relationships with customers; these could be final assemblers but also other suppliers.

In table 1 the main features of the sample are presented; later on, the main results concerning section from three to five will be shown.

Table 1 - Distinctive features of the sample

No. of firms	Number of employees (average)			Turnover (million Euros):				Company structure		
	Direct workers	Indirect (empl.)	Total	< 5	5-25	25-50	> 50	Snc*	Srl*	Spa*
31	393	87	393	22,6%	45,2%	12,9%	19,4%	6,5%	38,7%	54,8%

** = Snc stands for a non-limited company (people's company); Srl stands for a limited company; Spa is a limited incorporated company of higher size*

As a whole the sample is mainly made of small sized firms[22]: the average number of employees is 393 and less than 20% of the sample has a turnover which overcome 50 million Euros. Almost 13% of the sample (that is: four firms out of thirty-one) have more than 500 employees; for these firms turnover is greater than 100 million Euros. On the other hand, 45.1% of the sample has less than 100 employees.

ICT Investments

The third section of the questionnaire looked upon investments in ICT.

As a first we asked them to check boxes according to the ICT facility possessed. First results evidence a widespread use of ICT as a generic communication tool, but a much less common use of ICT tools devoted to specific firm-network relations. As one can see (table

[22] Accordingly with EU commonly used classifications, a firm is small-sized when has less than 500 employees.

2) all the interviewed firms own e-mail and internet connection[23] and more than 70% own a web site. On the other hand, only 57% of firms own a company-network, that is an instrument presumably devoted to internal operations management. Moreover, only 40% of the sample use EDI and 43% use intranet connections, both ICT tools specifically fit for inter-firm information exchange.

Table 2 - ICT tools availability

E-mail and internet	Web site	Company-wide information network	Intranet	EDI	Mobile phone network	Video-Conferencing	Network for GroupWare applications
100.0%	73.3%	56.7%	40.0%	43.3%	30.0%	26.7%	20.0%

An obvious justification for the lag existing between non-specific communication instruments (e-mail, web site) and specific ones could be found in the different amount of investment required. It's also conceivable, anyway, that the pre-requisite for diffusion of ICT tools stands in the diffusion of common protocols. A tool with a universal interface, like e-mail or fax, finds no obstacle in diffusion, while instruments like EDI, GroupWare and so on, require, as a pre-requisite, partners equipped with the same kind of facilities.

Videoconferencing and network for GroupWare applications are the less common ICT equipment present in the sample: videoconference is owned by the 26.7% of firms (all sharing production among more than one plant), while GroupWare is present in 20% of firms.

The questionnaire also asked to declare the amount of investments in ICT over the last year and to specify the percentage of expenditure on turnover; results are shown in table 3.

[23] In the questionnaire e-mail and internet have been presented with different boxes, although nowadays providers always offers both internet and e-mail together.

Table 3 - ICT investments over last year

Tab. 3/a

Amount of investments (,000 Euros)					Average (,000 Euros)
over 500	*between 250 and 500*	*between 50 and 249*	*between 25 and 50*	*less than 25*	
22.6%	6.5%	25.8%	12.9%	32.2%	935.0

Tab. 3/b

ICT investment as a % of turnover					Average
0.2% or less	*0.2% - 0.5%*	*0.51% - 1%*	*1.1% - 2%*	*Over 2%*	
26.7%	30.0%	20.0%	10.0%	13.3%	0.85%

The high value of the average investment (935,000 Euros) comes from relatively few big firms that declared to have heavily invested on ICT over last years. In fact, the greater 13% ICT-investor of the sample account for the 83.7% of the total investment; this means that the first four investors (out of thirty-one) have spent 25 million Euros on a total investment of 29 million Euros. Anyway, about 55% of the firms in our sample have spent more than the considerable amount of 50,000 Euros in ICT (tab 3/a). The effort towards improvement is also testified from the weight of investments on turnover: on an average ICT absorbs 0.85% of turnover. Moreover, almost one quarter of the sample (23.3%) has invested more than 1% of turnover in ICT and the 13.3% have invested more than 2%. (tab 3/b)

The questionnaire also asked to specify if any other ICT investment were foreseen in the next six months, and to check boxes to specify the kind of investment (table 4).

Table 4 - ICT investments expected within the next 6 months

Manufacturing		Management and Administration		Internet	Network Connections	
Hardware	*software*	*hardware*	*software*	*internet presence*	*updating / developing existing ones*	*Development of new ones*
61.3%	51.6%	48.4%	41.9%	58.1%	45.2%	29.0%

All the firm in the sample but one declared the intent to invest in one or more of the option proposed. Table 4 show the most frequent answers: suppliers will mainly invest in production hardware and software (in order 61.3% and 51.6%) but will also expand the firm's presence on internet (58.1%). As far as network connections regards, 45.2% of the firms plan to update the existing ones, while only the 29% will develop new connections (tab 4). About this topic, we have already noticed how a straight integration might create the premises for an increase in idiosyncrasy; coherently with such a view, we didn't expect to find signals of a more definite trend towards dedicated connections, rather towards more easy-to-interface tools. In fact, the CEO of one of the OEM supplier interviewed said that a

common trend is towards dropping dedicated network infrastructures, which result to be expensive, towards a larger use of internet, thanks to achieved reliability, data-security and adequate speed of connections. Such a trend would be after all induced by the rationale of the search for flexibility. We therefore wanted to verify if decisions concerning ICT investments were to some extent influenced by the firms' position upstream and downstream of. So, in the questionnaire we asked whether ICT facilities were chosen considering suppliers' and/or customer's equipment (tab. 5)

Table 5 - ICT investments and contractors equipment

Tab 5/a

Are ICT investments taken considering ICT equipment at suppliers?	
Yes	48,4%
No	51,6%
	100,0%

Tab 5/b

Are ICT investments taken considering ICT equipment at customer?	
Yes	70,4%
No	29,6%
	100,0%

As we can see, both sub-suppliers and customers have a remarkable influence in orienting ICT investment of our sample: in almost 50% of the sample ICT facilities are bought considering sub-suppliers' equipment (tab 5/a), while customer's ICT are relevant for 70% of suppliers (tab 5/b).

Relationships with sub-suppliers

In the fourth section of the questionnaire the firms were asked to details some features of relationships with their suppliers; first we tried to understand how much intense could be the information exchange as far as product development is concerned. We therefore asked to specify how parts and components purchased were developed. The exact questions and the results are shown in table 6.

Table 6 – Forms of developments for purchased parts and components

Which of the following forms of development of purchased parts and components take place? (check the box if the situation is present)	
Design wholly developed by supplier	41.9%
Co-design between firm and supplier	64.5%
Design wholly developed by firm	67.7%
Design by third parties	22.6%

Results show that a variety of situations take place in each firm: in 64% of the sample co-design between the firm and its sub-supplier take place, that is the more "information-exchange intense" relation. Other, less intense, kind relations take place as well, since are common both the in-house design (67.7%) and the external design (41.9%). A minority of firms (22.6%) purchase parts and components that are designed by third parties.

Another interesting aspect to evaluate was the use of ICT tools in relations with sub-suppliers, so we asked to specify which ICT tools were commonly used for this purpose (table 7).

Table 7 - ICT tools used in relationships with sub-suppliers

Which of the following information systems and tools are commonly used in relationships with suppliers?	
email	96.7%
EDI	43.3%
Intranet-Extranet-LAN-dedicated network	30.0%
GroupWare	10.0%
Video-conference	10.0%

As we expected, e-mail is the most commonly used communication instrument. It is more interesting to notice that all the firms having EDI use it for data exchange with suppliers: the percentage are 43,3% in both cases. On the contrary, while 40% of the interviewed companies own a dedicated network, only 30% use it with sub-suppliers. The same happens with regard to GroupWare and videoconference: 20% of firms owns GroupWare network but only half of them (10%) use it with suppliers; similarly, 26% of firms have video-conference equipment but only 10% use it with suppliers.

A specific attention has been devoted to the use of internet as a general way of exploring the market. It is commonly known how one of the most interesting capabilities of internet rely upon the possibility of developing a low-cost contact tool in the search for new business opportunity. We were fully aware that an in-depth exploration of this issue would require a specifically oriented research, but the questionnaire-based research seemed to us a good opportunity to start exploring this topic. We therefore decided to scrutinize the attitude of the firm of our sample towards internet as a tool for searching both new supplier and new customers. So, we put two question on this issue: one asked if the firm ever

experienced the search of supplier via internet; the other one asked an opinion about how much easy is to find a supplier via internet (tab. 8).

Table 8 - Searching suppliers via internet

Tab. 8/a

Does the firm search (or searched) supplier via internet?	
Yes	71.0%
No	29.0%
	100.0%

Tab 8/b

In your opinion, finding new suppliers via internet is:	
basically impossible	13.8%
hard	20.7%
not easy	34.5%
easy	20.7%
very easy	10.3%
	100.0%

We found out that the use of internet as a way to look for suppliers is a common practice, much more than we expected: 71% of the sample do search or have performed such search (tab 8/a). On the other hand, opinions on how useful might be such a search are almost perfectly divided in three main groups: the "optimistic", those who think that it is easy or very easy to find a new supplier in this way are 31%. A similar percentage (34.5%) think that is not easy, instead, but another 34.5% find that it is hard or basically impossible (tab 8/b).

Probably the opinions gathered on such topic from the various firms are strictly related to the kind of business were each firm operates. For instance, the more "hi-tech-intense" are the parts and the components required, the more difficult it will be to find a convenient supplier, but this is not a problem of the internet, but a problem of an overall scarcity of competencies. In other words, in order to verify the actual potential of the internet as a tool for developing new business (both for purchasing and selling) one should be able to compare the effectiveness of the internet against traditional tools in one specific industry, under similar conditions. The firms in our sample, instead, belong to different industries, although all of them are somehow related to the auto supply-chain.

We also wanted to verify the presence of just-in-time logistics of first-tier suppliers with sub-suppliers, although this is an element that is not directly connected with the use of ICT. We found out that more than 70% of the sample do not ask to their sub-suppliers to operate in JIT (tab. 8).

Table 9 - Just in Time with sub-suppliers

Do firm suppliers operate just in time?	
No	71.0%
Some	25.8%
All	3.2%
	100.0%

Relationships with customers

The fifth section of the questionnaire aimed at investigating the relationships of the firms of the sample with their customers. Since the sample is made of first-tier producers, customers are supposedly carmakers, but, as we said before, there might be included also other kinds of firm since the production of the sample is highly diversified.

Again, as in the section regarding relationships with sub-suppliers, we wanted to check the degree of customer's involvement in product development. The exact questions and the results are shown in table 10.

Table 10 - Product development and customer relations

Which of the following forms of development of product takes place? (check the box if the situation is present)	
Product wholly designed and manufactured on customer specifications	83.9%
Product developed on a base project and customized to customer	58.1%
Product developed in co-design with customer	54.8%
Product developed in simultaneous-engineering with customer	35.5%
Product defined by firm and put into market without specific customization	25.8%

In almost all the firms of the sample (84%) part of the production is completely designed and manufactured on customer specifications. Co-design is a pretty common practice (54.8%), while simultaneous engineering involves a bit more than one-third of the sample (35.5%).

These data make evident a framework of intense information exchange between first-tier suppliers and customers; however data about the use of ICT systems does not differ too much from those regarding relation with sub-suppliers (tab. 11). All the firms of the sample use e-mail to communicate with customers, but only 37% use EDI (while 43.3% of firms use EDI with suppliers) and less than 30% utilize a dedicated network.

GroupWare is as common in supplier-customer communications as in supplier-sub-suppliers ones (20%), while video-conference is more common in supplier-customer relations (18.5%, while only 10% use video-conference with sub-suppliers).

Table 11 - ICT tools used in relationships with sub-suppliers

Usage of information systems in relationships with customers	
Email	100.0%
EDI	37.0%
Intranet-Extranet-LAN-dedicated network	29.6%
GroupWare	20.0%
Video-conference	18.5%

The personal contacts still play an important role in inter-firm relations; table 12 shows that 73% of firms bases the definition of supply specification to long and reiterated meetings of both technical and administrative staff. This is to be considered an expensive form of information exchange, compared to video-conference, but however an essential one. Moreover, 42% of firms temporarily locate personnel at customer's plants.

Table 12 - Contacts among customers and suppliers for supply specification

Which kinds of personal contact with customers take place for the definition of supply specification? (check the box if the situation is present)	
Longer / multiple visits of technical and administrative personnel	73.1%
Brief meetings with technical personnel	65.4%
Personnel temporarily located at customer plants	42.3%

As it was easy to foresee, bounds between customers and first-tier suppliers are tighter than those existing between suppliers and sub-suppliers. While only 29% of the firms interviewed ask to one or more sub-suppliers to operate just in time (tab. 9), 45% of the sample are asked to operate jit from their customers (tab. 13)

Table 13 - Just in Time with customers

Do your customers ask you to operate just in time?	
Yes	45.2%
No	54.8%

A high level of integration also presume an exchange of information on production plans; so we tried to verify this aspect asking which information the firm have about customers' plans (tab. 14). Results indicate that 48.1% of are firms informed about annual or long-term production plan of the customer; a greater percentage (66.7%) have information about medium term production plan, while operations scheduling is known only by the 40.7% of firms in the sample.

Table 14 - Information on customer's production plans

Which information do you have about your customer's production plans? (check boxes the situation is present	
Annual or medium/long term production plan	48,1%
medium term production plan	66,7%
Operations scheduling	40,7%

Finally, as we found out that the internet is a tool commonly used to look for new suppliers (tab.8), we also discovered that it is commonly used to look for new customers as well (tab.15), since 73.1% of the firms declared to practice it (tab. 15/a). Actually, this was an easily predictable result, but it was not equally predictable the good success of the internet in such task: we have seen that 31% of the firms interviewed consider it "easy" or "very easy" to find a supplier via internet. A similar percentage (29.2%) think that to find new customers via internet is common or frequent (tab. 15/b); half of the sample is convinced that gaining a new customer thanks to the internet is a "rare" event. Finally, 20.8% is rather pessimistic thinking that opportunities in this field are "basically zero".

Table 15 Searching customers via internet

Tab. 15/a

Does the firm search (or searched) customers via internet?	
Yes	73.1%
No	26.9%
	100.0%

Tab 15/b

In your opinion, finding new customers via internet is:	
basically zero	20.8%
rare	50.0%
common	25.0%
frequent	4.2%
very frequent	0.0%
	100.0%

1. Conclusions

This paper is a draft version of an ongoing research so the emerging evidences mast be taken with caution. We wish to say that some first evidences from managers' interviews went far beyond our expectations; for sure, ICT integration bring problems and advantages not described in literature[24].

Making a long story short, we think that three main aspects have emerged.

1. The possibility to reduce the number of errors in routinary operations is one of the ICT benefit executives seem to appreciate more. On the one hand it is an objective that could be easily reached thanks to a relatively simple technology, but on the other hand it suggests a constraint to be kept in mind when thinking about developing ICT solutions: does it reduce errors or can it cause new ones? Does it simplify work-life (reduce number of operations to be carried out, make decisions easier) or does it make it more complicate?

It might be useful to recall the experience that the car industry has undergone when flexible automation was first introduced[25]. Although the great benefits of automation were definitively visible, obtaining those benefits was not so instantaneous as it was first believed. The technological questions which emerged caused concern on organizational problems related to the production process as a whole. In short, the lesson was that to insert in a complex process a machine that use and manipulate information is hardly a "neutral" or "technological" improvement as it could be to use an electric-power screwdriver instead than a manual one.

ICT integration goes even beyond, presenting problems which are much more complex than those introduced at that time by flexible automation, since it involves both the internal organizational processes and the relations with other firms.

2. It's necessary not to underestimate the problems connected to the existing organizational process. An example: if an irregularity occurs in a purchase order coming from EDI into ERP, the system automatically addresses a message to a pre-defined organizational position responsible for that specific task. Some little irregularities frequently occur in day-to-day activities of the firm. Problems might be due, for instance, to a little deviation from contractually pre-defined terms (e.g.: that specific customer by contract is supposed to have paid the last batch before ordering a new one, but he has made a new order although he didn't pay last one yet). In a traditional planning process the person who receives that order will look for someone who takes the responsibility to say "go ahead", or rather "let me check the situation with Mr. X". An ERP can do the same thing in a faster and more effective way: using the internal net, the ERP can automatically inform the responsible via computer, sending him a message and letting him retrieving all the documents related to the situation (contracts, addresses, telephone numbers and so on). The problem is that it is necessary a pre-defined hierarchy of positions responsible for each situation that might happen. In a traditional organization this happen informally (a secretary goes around searching for the boss); in a ERP-based organization one must be sure that someone will guard that position. In short, a complete workflow of internal processes must be defined; this might not be an easy task.

[24] See, for instance, Davenport [1998], Cerruti [1999].
[25] In Italy an explanatory case is the Cassino experience [Volpato, 1996].

3. It might be necessary to drop several established notions about the firm's competitiveness and to shift towards a vision regarding integrated-process competitiveness. In our opinion a single firm would hardly get higher competitiveness merely from ICT tools, since ICT-based process innovation in a firm takes place mainly in the form of external purchase of instruments (hardware and software), while competitive advantages are supposed to be *distinct* and *enduring*. Neither of such features seems to apply to ICT tools in themselves; the true source of competitive advantage stands in the net of internal and external relationships that are improved by ICT. For this reason, we should expect a strive of both carmakers and first-tier suppliers towards the fastening of reciprocal relations. In a sentence, we could say that increasing integration seems to originate increasing idiosyncrasy, mainly because in order the fully exploited, the quite evident benefits of interconnections among their own production processes need a relatively stable environment and the absence of opportunistic behavior from both sides.

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