1. INTRODUCTION

This paper is a report of empirical research on procurement strategies in the European commercial aircraft industry. Procurement strategy is seen as a framework against which we may examine the behaviour of airframe companies continuously interacting with their suppliers. We wish here to investigate whether and how the relationship with suppliers is managed by airframe companies in order to reach global competitive advantage and to ensure the flow of specific technological developments from related sectors. We have adopted here the interaction and network framework, trying to develop it in new directions.

There are several strong reasons behind the selection of the aircraft industry as a focus. Firstly, a great deal of work has been done on the concept of networks but few empirical studies have given a detailed view of how a network works. We focus here on the procurement network, i.e., the supply relationships between an airframe company and its suppliers.

Secondly, the aircraft industry holds a strong systemic nature, since the final product is the result of an extremely complex integration of many contributions coming from related sectors. Many organizational solutions and managerial techniques have been originated within the industry in order to cope with this complexity (Milliken and Morrison, 1973). But one of the major sources of variation and variability (i.e., of complexity) arises from the behaviour of external actors outwith the organizational control of the company. The inter-organizational aspects of project management, however, has not received much attention. This is not only an engineering or operational problem, but involves many economic, socio-cultural and personal aspects of the relationship. At the same time, because of the risks involved and the length of contracts, there is a strong tendency within the industry to cover as many contingencies as possible by means of sophisticated contractual procedures. Little is given to 'old-boy' agreements. Thus we feel that the aircraft industry is the ideal context within which to examine the relative importance of extra-contractual adaptations vs adaptations covered in the contract. This point will be important for evaluating, in future works, the relative effectiveness of the interaction/network approach vs the transaction cost approach for explaining the structure and dynamics of inter-company relationships (Johansson and Mattson).
Thirdly, the aircraft industry is an established industrial sector, with few worldwide actors, being in the business for many years and playing globally. Nevertheless, there is no indication of collusion among actors, instead, fierce price competition dominates the industry. This has implications for vertical relationships between airframe companies and their suppliers. As we shall see, a high degree of stability characterizes these relationships. However, the benefits of institutionalized relationships with suppliers are continuously being challenged by the need to maintain competition among suppliers and to stay with the state-of-the-art in technology. Thus the aircraft industry is an interesting environment in which to investigate the relation between co-operation and competition within vertical relationships in industrial markets.

2. THEORETICAL BACKGROUND

2.1 Procurement Strategy

From the procurement literature field, we have adopted the concept of procurement or purchasing strategy. This concept was introduced to call the attention of scholars and practitioners to the strategic implications of the buying activity in manufacturing companies (see Farmer 1978, 1981; Kiser 1976; Adamson 1980; Spekman and Hill 1980; Spekman 1981, 1985). It indicates a coherent pattern of decisions implemented at the procurement function level but made by several people and functions within the company, with the involvement of top management. Procurement policies are set on the basis of the goals of competitive strategy. The major areas include, for each item:

- the vertical integration decision
- the required number of suppliers (single vs multiple sourcing)
- the maximum geographical dispersion of suppliers (buying national vs international or global)
- the nature of the contractual framework
- the scope of the exchange
- the length of the contract

Many of these decisions are normally treated as operational, but they have a strategic as well as an operational dimension (Farmer, 1978).

The interaction approach proposes that purchasing strategy should not be seen as a pattern of punctual sequential decisions, but as a strategic process of establishing and maintaining relationships with suppliers over time. This important concept of a supply portfolio was introduced and developed by Cunningham, 1982; Turnbull & Poh Wah, 1989. It refers to the management of multiple sources of supply by a customer company in order to obtain
differentiated contributions. Within this portfolio it is explicit that purchasing strategies may be changed and adapted in response to changes from suppliers.

In introducing the concept of the interaction model to purchasing strategy, we propose that two points should receive prime attention. First of all, within the interaction literature the influence of purchasing strategies on the exchange episodes, on adaptation and on the atmosphere of the relationship has been relatively neglected. This is probably because the inter-personal level of the relationship has been emphasized as being central which is without doubt true. However, we wish to emphasize that the behaviour of individual buyers with respect to sellers is profoundly influenced by organizational structure and some of the results of our study underline that. In some cases we have found a contrast between the behaviour of buyers, as suggested by the organization, and the behaviour suggested by a good personal relationship with boundary personnel in the selling company. In one case we observed, the organization warned the purchasing manager against a particular supplier.

In another case, because of objective external economic conditions there was a clear need for a more collaborative relationship with a set of suppliers and this orientation was gradually emerging at the top level in the buying company. However, it was not being implemented and a typical adversarial approach was followed by line managers. Thus the perception of sales managers in the supplier company was that the buying organization was simply squeezing them and that there was no reason to expect any change in this approach.

This all shows that looking at purchasing strategies may provide remarkable insights on the buyer-seller relationship. It also stresses the need for organization congruence between purchasing strategy and the culture, motivation and attitudes of the personnel with buying responsibility.

The second point is that the inter-functional requirements of procurement strategy have to be explicitly recognized. So far, much of the organizational buying behaviour literature has gone in the direction of investigating how other functions intervene in procurement decisions. The organizational position and importance of the procurement function has been the object of several studies. (Abratt; Matthyssens and Faes; Mogee and Been; Nauman, Douglas and McWilliams)

On discrete purchasing decisions, we should take a process perspective and look at the communication flows between procurement and other functions, as well as the procedures for handling and solving conflicts.
We have found in our study that some inter-functional relationships deserve attention and further research. For example, the organizational conflict that sometimes arises between procurement and quality assurance has strong implications for the performance of the two functions.

Another area of interest regards the relationship between procurement and new product development, which was considered in a seminal article by Farmer (1974). Finally, we have tried to investigate the relationship between procurement and R & D. These last two areas will be covered in the paper on technical developments, where we analyze the importance of established suppliers for the development of new products and the influence of buying companies on the R & D decisions of their suppliers.

3. METHODOLOGY

The research methodology consisted of personal detailed interviews with boundary personnel in both buyer and seller companies. The buying companies includes some of the largest European airframe companies. The selling companies are those indicated by the buyer as the most important within different supply sets and we have analyzed the aluminium, engine, equipment and component sets.

In the buying company we interviewed procurement staff both at executive level and line levels. In the selling companies we interviewed marketing, sales and forecasting managers. Whenever possible, several respondents were looked for in each company. So far, a total of 21 interviews have been carried out in nine different companies. The interviews reported in this paper were carried out mainly during the period February, March and November, 1989, although this research project still continues. A semi-structured questionnaire was developed; the average duration of the interview was 1.5 hours. A follow-up procedure was adopted by sending a preliminary report to some of the interviewed managers and taking into account their observations.

It has to be underlined that it is quite difficult to gain the confidence of managers in the aircraft industry, not only because of its confidentiality fears and the fear of loss of information in a very concentrated incestuously interdependent sector.

There presently exist few studies on the industry which use an interview methodology. An interesting case is a non-academic volume written by a journalist (Newhouse 1985) which is a fascinating reconstruction of the fierce competition in the commercial aircraft industry, based on the memories of the top actors.
Elsewhere, Hartley (1981, 1986) had a mandate by NATO to check the opinions of the leading US and European aircraft manufacturers on collaborative ventures, thus obtaining collaboration from companies. Mowery (1987 and 1988) has recently published an important volume on collaborative ventures in the industry. These authors studied horizontal agreements or ventures, their purpose being not in testing theories when looking at vertical relationships. However, there have been five studies which followed a theory-testing approach and were interview-based. Masten (1984) obtained good collaboration from a large aerospace and engine company and studied the vertical integration decision using the transaction cost approach. Frear and Metcalf (1990) identified all the six US manufacturers of aircraft engines and obtained from senior executives in these companies the time and collaboration of a purchasing manager responsible for cast parts and the name of nine cast suppliers. Following the snowball procedure, 116 personal interviews were carried out using a structured questionnaire, with all people involved in the exchange.

We followed a qualitative approach, similar to those used by the first authors quoted. There are several reasons why we did not try to operationalize the constructs. Firstly, our purpose was to go through difficult supply sets (which was not done by Frear and Metcalf) and different companies (which was not done by Masten), in order to compare the nature of relationships and the purchasing strategies across them. It would have been extremely resource-consuming to follow a snowball procedure for each procurement set. Secondly, our study covers more than one country in Europe, so adding complexity. Thirdly, the relationships of airframe manufacturers with their suppliers is a more sensitive topic than the relationship backwards into the manufacturing channel; we did not expect to find collaboration from all the parties involved to complete a quantitative study. Last, but not least, while providing rigorous measures of the phenomena under investigation, structured questionnaires normally do not capture all the relevant evidence and require a sound and established theoretical base.

Procurement is a strategic area for aircraft companies. Procurement directors tend to have a high status in the company and to be quite powerful within the organization. Purchased items account for approximately 60% of the value of an aircraft, so profitability is largely dependent on the efficient management of procurement, much more than other industrial sectors. It is not only the importance of purchasing in terms of value that explains the relevance of this function for aircraft companies. Previous studies have shown that the achievement of most strategic goals for aircraft companies depends on the behaviour of suppliers.

In this section we will describe first the typical procurement procedure within the aircraft industry and then review the major trends in procurement strategy.
3.1 The Procurement Routine

The time framework of aircraft programmes is very long. The process usually begins with the so-called design concept, i.e., the broad definition of the mission of the new aircraft and its macro features. The entire process, from concept to design, prototype building, testing, first flight, certification and first batch production may require seven to twelve years. The whole life-cycle of the aircraft may go beyond twenty or twenty-five years. Note though that with the public announcement of a new model launch the process has by then already reached an advanced stage.

The involvement of suppliers takes place in the following way. First, an approved list of vendors is established. For instance for Airbus there is a list of approved suppliers for each piece of equipment, which is discussed and approved by Airbus Industrie and by the National Ministries involved. Generally speaking, each airframe supplier would maintain a list of approved suppliers, i.e., those suppliers able to meet a required standard of technical capability and quality assurance system. In the case of Airbus, all approved suppliers receive a brief outline of the equipment to be supplied for a programme and will then be requested to register an interest. A number of them will not reply, so only a selected group of suppliers will be involved at the second stage. At this stage, the customer will issue a request for proposal (RFP) or request for quotation, asking for proposals against full specifications and full commercial conditions. There are two types of specification:

1. the product specification, which comprises a detailed definition of the item to be supplied and the technology to be used for the manufacturing, and

2. the performance specification, which only states the functional requirements of the item and allows for a choice of alternative technologies by the supplier. Technical specifications often cross-refer to international technical specifications.

A supplier will reply with a quotation and a statement of technical compliance or non-compliance. The proposals are then reviewed by the customer:

a). First is a technical analysis, which is made by the people who wrote the specifications and ends with a list of preferences (technical selection report).

b). The second one is a commercial analysis and focuses on commercial terms, price, delivery, etc.
After the RFP, it takes 1-2 months for suppliers to reply and 1-2 months for the selection process. The selection usually ends with a short list of suppliers and negotiations are opened until the final choice of vendors is made. The whole process usually takes 6 months, at the end of which the contract document is signed. The contract document often contains cross-references to exchanges reached during contract negotiations. The contract document has to be totally comprehensive and is the basis for all future negotiations. If the contract includes a development programme the typical period of time from receiving the specifications to producing the prototype and going into manufacturing is two-three years.

This sequence may sometimes be modified. The notification of the outline programme to all approved suppliers is sometimes omitted and the process begins with technical discussions with only a selected number of suppliers. Approximately six months may be spent in technical discussions with several vendors in order to obtain a more detailed idea of requirements. At the end of this period a request for proposals is issued.

For new developments, airframe manufacturers usually put forward a request for information (RFI) to open discussions with suppliers before defining the specifications. In this document customers state what they want and suppliers can come up with their ideas.

There is heavy involvement by several departments and functions in procurement decisions: usually R&D, design, production, marketing, customer support and the pilot team play a role in supplier evaluation and selection.

The most important selection criteria are quality, reliability, product support and price. The relative importance of those criteria is variable, with price as an important factor for quite technologically mature products.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Procurement process in the aircraft industry</th>
<th>notification to all approved suppliers</th>
<th>replies from some suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>or</td>
<td>technical discussion with selected suppliers</td>
<td>request for quotation</td>
<td>quotation</td>
</tr>
<tr>
<td>or</td>
<td>request for information</td>
<td>reply of suppliers</td>
<td></td>
</tr>
</tbody>
</table>
3.2 The Sourcing Strategy

Table 2 summarizes the main aspects of procurement strategy in the aircraft industry.

<table>
<thead>
<tr>
<th>Procurement set</th>
<th>Aluminium</th>
<th>Engine</th>
<th>Equipment</th>
<th>Components</th>
<th>Machine tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals of procure-</td>
<td>Ensure production capacity.</td>
<td>Obtain a marketing leverage.</td>
<td>Get the funding of front-up costs.</td>
<td>Problem solving through systems integration</td>
<td>Maintain manufacturing superiority in some stages of the process</td>
</tr>
<tr>
<td>ment strategy</td>
<td>Reduce dependence on suppliers. Get investment in new alloys</td>
<td>Reduce dependence</td>
<td>Product support and customer support. Get investment in related technologies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single vs. multiple sourcing</td>
<td>Clear multiple sourcing policy</td>
<td>Single for small aircraft; multiple for large aircraft</td>
<td>Single sourcing in Europe; multiple sourcing in the US</td>
<td>Clear multiple sourcing policy</td>
<td>Single sourcing</td>
</tr>
<tr>
<td>National vs. global sourcing</td>
<td>Bulk of business national but foreign suppliers are also used</td>
<td>Global for the structure of the offer and options to airlines</td>
<td>Global for large programmes; on collaborative ventures it is more a political decision</td>
<td>Global</td>
<td>Global due to the structure of the machine industry</td>
</tr>
</tbody>
</table>

3.3 Supplier Switching Costs and the Stability of the Relationship

The description of various procurement sets has shown that, in general, supplier switching costs are very relevant in the industry. Major costs are in terms of design activity, because there is high interdependence between the design of the customer and the design of the supplier. We have to distinguish between supplier switching between programmes and within a programme.

The first refers to the choice of a completely new supplier when a new programme is undertaken. This is very common for engines; for mechanical systems it is quite frequent while in the avionics field, it is becoming more frequent. We have seen examples of supplier
switching for a new airplane programme in the air conditioning system, propellers, navigation equipment, and radio equipment. There may be several reasons for changing suppliers from one programme to another.

1). One is, of course, poor performance.

2). The second is that the existing supplier did not invest in the specific area of interest to the customer.

3). Thirdly, there are sometimes strategic reasons, where a particular supplier is selected to make a new aircraft more marketable in a foreign market.

4). Fourthly, airlines will frequently ask for particular equipment on a new programme. To cope with those requirements, airframe manufacturers sometimes offer optional equipment. For instance on the Airbus Z310, both Smiths and Sperry equipment are offered to airlines as options.

In general, inter-programme supplier switching costs are relevant but not overwhelming. In practice the carry-over rate of suppliers is high, so that a number of preferred suppliers would invariably receive some of the orders for equipment. In the multiple sourcing areas (materials and components) suppliers have long-lasting relationships with the customer; if their performance becomes unsatisfactory, they are not dropped but their share of the business temporarily decreases.

Within a programme the switching of suppliers may happen after a batch of production or during a contract. The first occurs when, after the first batch of production, the airframe manufacturer rebids for the same product, i.e., in components and materials. In the equipment field there is a difference between US and European practice. In Europe contracts usually cover the entire life of the programme, even though there are exceptions. But even in the US system, where several suppliers are invited for the same equipment and there are re-quotations for each batch, it seems that the stability of the relationship is quite high and the carry-over rate is extremely high. The second possibility (switching suppliers during a contract) may occur only in extreme cases, where supplier performance is particularly unsatisfactory. We have found only one such occurrence: in that case a window screen supplier was dropped before expiration of the contract.

Once the customer has entered into an agreement with a supplier, to exit from it is always a very costly exercise. Even where the performance of a particular supplier may not be entirely satisfactory, the airframe manufacturer will always try to solve problems with him rather than drop him. It is very much a matter of problem-solving rather than simply changing supplier. Once locked into agreement, the threat of switching supplier is not the strongest argument to induce a supplier to perform well.
The entry of a completely new competitor for the business of a particular airframe manufacturer is a very rare event, except in the case of engines. To get the business, a new entrant should have a worldwide reputation in a specific field or offer a technically superior solution. Furthermore, he should offer competitive advantages in terms of price.

To substitute a current supplier is a costly activity even when dealing with established suppliers. Typically, when a supplier is dropped, the new supplier is asked to absorb part of the extra design cost needed.

4. TRENDS IN THE PROCUREMENT STRATEGY

We have found that some important trends do exist in the procurement strategy of aircraft companies. They are summarized in the following paragraphs.

4.1 The Funding of Development Costs

As we noted in describing the equipment set, airframe manufacturers increasingly ask their suppliers to fund development costs from overhead. There is a powerful trend in the commercial aircraft industry, from cost-plus contracts to fixed-price contracts. Fixing the price, airframe manufacturers avoid all the unknowns, which are very common in the design process. Furthermore, they enlarge the financial base of the programme, as many companies put money into development, in return for a share of the business. The contractual mechanisms through which the funding is managed have already been described.

It should be noted, however, that the risk of opportunistic behaviour of suppliers is enhanced using a fixed price contract with no funding of development costs. The typical mechanism is as follows. The supplier has to recover development costs, in theory, over the business on which he is secure, i.e., on the first batch of the order. On the other hand, competition to get the business is strong and reducing the quoted price increases the probability of winning. What happens is that suppliers may quote a price which does not cover development costs so as to win the business and recover their costs over the life of the contract. The most common way to recover costs after the signature of the contract is charging high fees for design modifications. Design modifications are very frequent during the design process of an aircraft, because it is impossible to foresee all details and all interface problems at the very beginning of the process. Yet they may be asked for by both customers and suppliers. They have to be negotiated and written down in a very detailed way; a price modification is then agreed. When customers (airframe manufacturers) ask for a design modification, suppliers are in the position to charge an expensive modification fee, well beyond the real value of the engineering effort needed and recover part of their up-front
costs. Airframe manufacturers used to making detailed cost audits in order to evaluate the real engineering value of the modifications. However, the opportunity of behaving in an opportunistic way, increases when the technology involved is not well known by the customer or presents great uncertainty. This behaviour is called within the industry "buying in". It is quite frequent in the military field, where the customer is a Government Department. In the commercial field it is present, but apparently to a more limited extent. Customers are much more cost-conscious in the commercial business. Furthermore, the relationships between suppliers and customers have a high degree of mutual trust. Information exchange is very great, so that customers can more easily detect opportunistic behaviour. They think they can "sense" whether suppliers are cheating. They also know that sometimes drawing modifications are asked for by suppliers, so mutual compliance should be expected. They often have a continuous relationship with suppliers, so that the probability of being detected and so losing the next order is sufficient deterrent for them. Nevertheless, it is interesting to note that the contractual framework may favour a kind of opportunism.

4.2 The Systems Buying Approach and Reduction of the Supplier Base

We have found a general trend within the industry, which is the reduction of the vendor base. This is the consequence of two different phenomena: the movement from multiple sourcing to single sourcing over a wide range of systems, and the reduction in the number of suppliers involved in multiple sourcing.

As we have seen, power systems and avionics are generally single sourced, while components, standard parts and materials are multiple sourced. The adoption of single sourcing and a systems approach in these two areas is now established and is the general-rule, except for the multiple sourcing approach for engines and for optional equipment. Ten years ago, however, it was not uncommon to find multiple sourcing for systems.

On the other hand, we have observed a reduction of suppliers even in an area in which multiple sourcing is at the moment adopted as a strategy, i.e., components. In this area single sourcing would be too risky and the purchasing requirements for the same item or for very similar items usually split among several suppliers. The responsibility for integrating several components into a system would be that of the buying company. We have observed that major customers have reduced the number of components suppliers involved. In one case observed, the order of magnitude was from 300-400 to approximately 50.

This phenomenon is driven by two major forces:

- the adoption of 'systems selling' strategies by component suppliers and
- the concept of product liability. Aircraft companies are delegating part of the integration
task to component suppliers, through the purchasing of complete systems (e.g., a set
of wires with a wire integration unit) rather than several separate components (wires).
By this means they have reduced the number of suppliers. What we might call a 'system
buying' approach has been adopted, matching the 'systems selling' strategy of some
suppliers.

Systems buying is a rather risky activity, however. The contribution of suppliers may be
quantified and compared with more difficulty since the value of the knowhow required for the
integration task is not well understood before the task is accomplished (Paliwoda, Thomson
1987). The purchasing of standard items is, on the other hand, an activity in which risk may
be reduced by means of several widely known purchasing strategies.

The first reason why aircraft companies are inclined to adopt such an approach lies in the
product liability, which is a general problem within the industry. Each supplier is normally
responsible for the performance of his own component or piece of equipment. A perfor­
mance fault would clearly lead to both economic and non-economic sanctions for the
supplier, which according to the damages sustained may include a criminal or civil action,
commercial penalties, loss of further supplies, withdrawal of the qualification issued by the
customer and loss of reputation with the customer and within the industry. The problem with
product liability is that, once several components have been integrated, the failure of the
integrated system or subsystem may not be attributable with certainty to a specific
component, i.e., to a specific supplier. Even though failure may be due to a particular
component, the supplier might argue that there have been defects in one or other related
components. Settling the dispute may be costly. According to one manager interviewed,
liability claims are the main area of conflict between airframe manufacturers and suppliers.
Systems buying is a means of reducing this problem, since by definition a system supplier
is responsible for the integration and performance of a set of different components. The
problem is not eliminated but the number of possible disputes is reduced.

Furthermore, the adoption of a system buying policy, as opposed to a traditional
commodities buying policy, ties in with:

- the existence of an ongoing relationship with component suppliers;

- the degree of knowledge of the technology involved in the integration task.

These two factors relate to the high commercial risk involved in systems buying. Technical
risks in terms of performance and reliability may be reduced by purchasing component
systems, but the commercial risk (i.e., paying extra-money to the supplier) becomes a factor.
So systems buying generally emerges as an evolution of an existing, long-established and satisfactory relationship between the customer and the supplier, where the customer knows exactly the skills, procedures and commercial policies of the supplier. Systems buying may also be a method to pre-select vendors before a bid.

In some cases, however, the customer company may be reluctant to enter into a system contract, mainly because it lacks the technological task. The purchasing of software is one case in point. In one case we came across, the customer company didn’t buy the numerical control machine integrated with the control software, but selected two separate vendors for software and hardware. In the software area, systems buying is not the preferred policy. That is because the integration task of software with hardware would be managed by the software or systems supplier in such a way as to increase the dependence of the customer.

4.3 The Preferred Supplier System

The adoption of single sourcing in the power system and avionics areas and the reduction of suppliers in the components area have been associated with a shift of procurement policies to a sort of preferred supplier system, even though this is not always a deliberate policy. In this system, vendors are not treated in the same way but are rated according to their performance with the customer. This may be done with a formal vendor rating scheme but more often is the result of experience and the subjective judgements of people in the customer company. According to this system, established suppliers are always in competition for business, but the probability of obtaining the business is higher for them then for new entrants. The result is that customers are prepared to deal only with certain suppliers and vice versa, so that over time a preferential relationship is established. In the European industry, that has led to the establishment of long-term agreements with high value equipment suppliers. In the past, contracts used to cover only batches of production and re-quotations were frequently requested. There is now a shift towards high levels of supplier involvement within long term agreements and fixed price contracts. There is a strong movement away from the cost-plus type of contract towards the fixed-price contract. Managerial skills in the equipment industry are called for, as the control of costs becomes their responsibility. Approximately 80% of the total purchases of an airframe manufacturer fall within the long term business agreement category; 20% are purchased through competitive procedures and multiple sourcing.

There are two different types of barriers to entry for new suppliers wishing to grow within the industry:

1). The first is a technical one - becoming a supplier approved by customers, which means meeting stringent requirements of quality control;
2). The second is a relational one - becoming the preferred supplier of customers.

There is an interesting and recent trend in this procurement approach. Traditionally, in the procurement areas in which price competition is quite important, new entrants had the opportunity of acquiring a share of business by offering prices lower than established competitors. At the moment, it seems that the customer is reluctant to award a share of the business to non-established suppliers; he prefers to work together with preferred vendors in order to obtain cost reduction from them. So the approach would be: "how can you, our preferred supplier, and we the customer work together to obtain the level of price offered by your competitor?"

The advantage of this approach are in terms of quality and reducing the search and negotiation costs.

It is interesting to note that certain similarities exist with the Japanese approach.

4.4 Increased Pressures on Suppliers for Customer Services

Another powerful trend in the procurement strategy of airframe companies is the progressive adoption of the "just in time" delivery philosophy, which is widely adopted in the automotive industry. Airframe manufacturing is less rigid than car manufacturing on the assembly line but is much more expensive in terms of working capital committed to production (inventory of raw materials, subassemblies, components, work in progress). There is now a strong movement of aircraft manufacturing towards more "industrialized" production methods. Aircraft manufacturing is becoming more a production line. A component of this evolution is the sharp reduction in the inventory of purchased materials and items. Airframe manufacturers do not want to plan all stocks in-house. The aluminium area is one example of that. Airframe manufacturers are looking for "just in time" delivery, where most of the aluminium plants (mills) have long lead times. Specific lead times are the consequence of the rigidity of the aluminium production process and, at the moment, of the existence of capacity constraints for some products (plates). Traditionally a mill lead time would be twenty weeks. In this situation, aluminium suppliers are forced to set up a distribution network and to invest in warehouses which are located near the customer’s sites in order to counterbalance the rigidity of the manufacturing process with the need for flexibility in customer delivery requirements. In some countries such a role is also played by independent distributors or stockists. They are very important in the UK (approximately 35% of the market) but not in Europe, where they cover only 10%. The vast majority of them are independent, while others are linked to a particular supplier. Their role is twofold.
1). Firstly, they buy from aluminium suppliers a number of standard sections or plates which they feel from their experience they are likely to sell within one year. They take a risk and charge what they want for these quantities, selling the benefits of 'just in time', close form, etc. This is a typical stockist role.

2). Secondly, they distribute to airframe manufacturers the materials according to a schedule and at a price which have been negotiated directly between the mill and the customer.

The agreement works as follows: the airframe manufacturers negotiate with the aluminium supplier the quantities required for the following year, the specifications and the price. They place the orders with the stockists but tell the stockists which mill they have to buy from. They split their requirements among suppliers and among distributors and ask each distributor to purchase his share from one or more specific suppliers. So doing, they reap the benefits of a high level of customer service and do not lose contact with the mills, which are extremely important from a technical point of view. Technical changes and refinements, in fact, take place at the mill level. So customers want a stockist service but with mill contact.

Another area of customer service which is becoming important is the quantity and size of items. In the aluminium area, customers are looking for small parts, whereas in the component area the problem is of the purchasing of minimum quantities. Customers are asking with increasing frequency to be supplied with a desired size and quantity of items. This is sometimes costly for the supplier, as a compromise has to be managed between customer requirements and cost economies in the manufacturing of long runs of products. It also requires managerial skills.

4.5 Early Involvement of Suppliers in the Design Process

Airframe companies need the contribution of suppliers at a very early stage of the design process. Normally the involvement of suppliers takes place not more than twelve months after the launch of an aircraft programme and not much before the public announcement is given. An example is the new generation of Airbus, the A330 and A340. They are scheduled to have the first flight in 1992 but the involvement of suppliers took place in 1986.

The typical purchasing process, as described in the literature, begins with the establishment of the need of the buying company and the definition of the characteristics of the product or service to be purchased. That is normally described as an internal process to the buying company, after which a message is sent to the market on requirements and the selection process takes place.
We wish to emphasize that the definition of requirements is, in itself, the result of continuous interaction with suppliers. Technical discussions with several suppliers are opened long before the specifications are written and the request for proposals is issued. Furthermore, we have to consider that some specifications command others. Structural materials, engines and large systems are specified very early. In the systems area, the flight control system and electrical power generator would normally be the first to be specified. Airframe manufactures need to analyze all contributions and ideas from suppliers before defining full specification. The normal period of time for technical discussions before specifications are written is six months, but sometimes they take a year or more, particularly in the engine field. During this period all suppliers involved invest their own money in preliminary design activity and in solving the technical problems of the customer. At the same time, they become aware of the real nature of technical problems facing the customer and develop new ideas for application. This stage could be properly defined an investment stage, as each supplier company carries out activities which do not necessarily lead to the awarding of business.

4.6 Centralization of Purchasing Activities at Divisional Level

In large airframe companies, each plant has its own purchasing department responsible for all items which actually go into the aircraft. The level of autonomy of each plant in purchasing decisions is generally high, so that it is not uncommon for a supplier to agree different prices for the same product with different plants within the same division. This reflects also a defect in internal communications within purchasing companies.

We have noted at divisional level a movement towards the centralization of purchasing for common requirements for all sites. A committee is responsible for consolidating requirements from different sites. General agreements are negotiated at divisional level and sites operate under the umbrella of these agreements. This is not an easy process, from an organizational point of view. The centralization and pooling of requirements, in fact, should lead to the standardization of specifications, in the sense that each site should adopt the same specifications as much as possible. Specifications, however, are very often idiosyncratic to the design team. Sometimes standard specifications do not match with new design criteria; furthermore manufacturers which have a particular expertise in one field tend to be protective of their own skills and willingly adopt customer specifications. In theory, a standardization programme might be implemented within the company over time, but organizational resistance has to be expected.

In general, there are conflicting pressures within the industry. One is the standardization trend, which is pervasive within the industry and is driven by economic and military/strategic factors. This trend affects, for instance, materials, electric components, and all standard parts. Many military contracts force main contractors to adopt standard parts and components. The benefits of standardization have to be weighed, however, against the
benefits of customization. In the design of airframe and equipment, the adoption of non-standard parts may sometimes lead to savings in design times. This is a major problem not only at a company level, but also at an international level. In many international collaborative ventures like Airbus or EFA it is frequently found that different specifications are being used for exactly the same item by manufacturers from the different countries. In theory all manufacturers will accept national standards, but in practice there is a blend of standard and customer specifications. National standards are used as they cover general things like quality assurance, testing, packaging, but in addition to those standards, each customer would normally write his own specifications.

The centralization of procurement at a divisional level decreases the number of autonomous purchasing sites. On the other hand, in the case of materials the number of purchasing sites is increasing, because of subcontracting activity.

### 4.7 Information Sharing Among Companies Involved in International Collaborative Ventures

Airframe manufacturers involved in European collaborative ventures have strong linkages at the design and technical level but maintain a separate purchasing organization. In the past, they did not have much information exchange at the purchasing level. Each supplier could negotiate the price with the supplier in a separate way and different prices were usually agreed with different suppliers. It seems that more recently, over the last three or four years, airframe manufacturers have begun to share information about their negotiations with suppliers. The consequence of this practice is that very similar prices have been adopted and that purchasing power increases.

### 4.8 Subcontracting

The extent to which airframe manufacturers subcontract work is increasing. Subcontracting is a typical characteristic of the aircraft industry. Subcontracting activity refers to an activity, mainly in the mechanical and machining field, which could be carried out by a subcontractor on the basis of his current knowledge and expertise. Airbus subcontract work in countries like Korea, Indonesia, India, Australia, Taiwan. Aeritalia has recently reached an agreement with Airbus for the manufacturing of a section of the fuselage of the new A321 and is a subcontractor for the Boeing 767 and for the McDonnell Douglas Md80 and Md11.

Increasingly, airframe manufacturers subcontract part of their production to foreign companies, sometimes in the Third World or in NICs. Work is subcontracted for a variety of reasons.
1). Firstly, there is a production capacity problem within the airframe manufacturer. Subcontracting is a means for shortening the length of the manufacturing stage.

2). Secondly, they can save on labour cost in NICs or in the Third World. This saving may be more apparent than real, however, since quality problems in airframes subcontracting are very severe. Probably the most powerful reason for wide subcontracting activity is that foreign governments ask for an involvement of the national aircraft industry, in return for the purchasing by the national carrier of a particular airplane. This is a classical path for the development of a national industrial base.

3). Thirdly, since national airlines are frequently owned by the government and their purchasing policies may be strongly influenced, the government may put forward a policy where the national airline would buy a new airplane if part of it is manufactured within the country. This is called an "offset" agreement. (Paliwoda, 1989)

Sometimes the process is driven by airframe manufacturers, which identify the potential market for their programmes. For instance, all forecasts for airline market say that the highest growth in traffic over the next few decades is expected from the Far East. There is increasing attention being paid by airframe manufacturers to placing subcontracting work within this area, because they would then be in the best position to cope with the growth of demand. Subcontracting is also preferred by airframe companies as an alternative to countertrade or other compensation trade practices, which are acquiring increasing importance within the industry.

1). The most important managerial problem with subcontracting is the degree of control. Subcontracting is a complex relationship. The first area of control is over the responsibility for design. Airframe manufacturers tend to keep the design in-house when they have technical superiority in a specific area, i.e., are at the 'state of the art'. They transfer drawings to subcontractors on magnetic tapes and ensure that the tapes are compatible with the equipment used by the subcontractors. We suspect that large airframe manufacturers like Boeing impose a particular standard on their subcontractors for computer compatibility. It is interesting to note that the adoption of new techniques like CAD has not only had an effect on internal design activity, but may act as a force for standardization over a network of subcontractors. Even when delegating responsibility for design, however, strict guidelines and parameters are fixed so that, in the words of one subcontract manager, "subcontractors really are an extension of the design team".

The control of design includes the control of design modifications. Subcontractors may want to change something in the drawings in order to save work or to improve the
product. Every change has to be authorized by the airframe manufacturer and then recorded and documented. It does not seem to be an interactive process, as airframe manufacturers maintain very strict control over design modifications.

2). The second area of control is price. Subcontracting usually takes the form of long-term contracts, sometimes with an associated risk-sharing formula. There is an important difference between contracts in the equipment field and in subcontracting: in the latter the customer holds almost complete knowledge of the activities carried out by subcontractors. They know the content of materials, the content of labour, the rates of pay per hour, etc., simply because they have already carried out the same activity. It has to be noted the subcontracted activities are not the most complex from a technical point of view. To give an example, in 1987 British Aerospace subcontracted a number of packages for the manufacturing of A330 and A340 wings to several companies, mainly in the US. The major package was the top part of the wing, while the bottom part was not subcontracted, because it is too complex. This point should be further examined. We think that the higher the degree of complexity of the activity, the less is the control on price that the subcontracting company may exert. When the purchased item stems from a technology that the airframe manufacturer does not control, outside purchasing is a forced choice in the short run. In subcontracting, where the skills are within the company and the problem is one of capacity, the choice of activities to be decentralized has more degrees of freedom. In that situation, we might hypothesize that the company would subcontract only those activities in which they can control the technical content of the work in order to control the price.

3). The third area of control is quality. A number of airframe manufacturers have experienced poor quality performance in subcontracting work to Third World countries.

5. QUALITY ASSURANCE AND PROCUREMENT

Quality is an absolute in the aircraft industry. The central concept in quality assurance is that conformity of the product to requirements has to be assured, as far as possible, before the manufacturing process takes place. Quality assurance is a much more advanced managerial philosophy than quality control. Quality control is an ex-post procedure, where statistical techniques are used to detect deviations from requirements in single batches of products, once they are delivered to the customer's factory. Quality assurance tries to eliminate at source the possibility of receiving a defective product, in other words a policy of 'zero defects'.
6. **ORGANIZATIONAL AND MANAGERIAL PROBLEMS IN AIRFRAME COMPANIES' PROCUREMENT**

Managing large programmes is a high-skill managerial activity. A large literature does exist on project management, but little attention has been devoted to the coordination of procurement functions within the management of projects. We have found some typical problems to include:

a). **Inter-functional coordination and conflicts**

The procurement process includes two separate sub-processes for the technical and commercial evaluation of suppliers' proposals. Conflicts may exist between the two teams. That is not a negative phenomenon, however. The real managerial task is weighing the two viewpoints.

Furthermore, during the life of the contract, procurement people and technical people (design and production) have to establish a continuous communication flow. This does not appear a simple organizational task.

b). **Inter-site communication and coordination**

Airframe manufacturers usually are multi-plant firms. The autonomy of each site is very high because they have the entire responsibility for one or more programmes. The related problem, however, is that communication and coordination between sites is very difficult and not very common, even within the same Division. This requires a direct and strong commitment of the Division Headquarters.

c). **Achieving consistency between inter-firm and inter-personal relationships**

In a number of cases, buyer-seller relationships reflect a good cooperative atmosphere. That is achieved by good human relationships between a lot of people in the two companies. Getting consistency among the various levels of the relationship is a difficult managerial task. Sometimes there is dissonance. For instance, to implement a procurement strategy where an adversarial approach to suppliers is replaced by a partner-oriented, long-term approach also involves modifying the pay and incentive system for procurement personnel, particularly for line managers. Sometimes price reduction is the top priority goal in procurement, simply because it has a high visibility within the organization. Even though no monetary reward is related to price reduction, the organizational culture may reward it as a contribution to the company and status improvement within the organization. In this respect, senior buyers tend to be more partner-oriented than young ones. The level of pay and the status within the organization of procurement people have important consequences on the management of the relationship with suppliers.
7. THE PATTERN ON INTERACTION BETWEEN AIRFRAME MANUFACTURERS AND SUPPLIERS

7.1 The Dimensions of Exchange

The previous discussion has clearly shown that marketing and purchasing in the aircraft industry consists really of episodes within long-term relationships. Some of these relationships (aluminium, components) include a sequence of short term contractual arrangements, with a high degree of stability between subsequent programmes. Some others are long-term in nature (risk-sharing agreements for equipment), while a minority have a short-term nature (first batch orders) and a low degree of stability.

We have already described the pattern of interaction between suppliers and customers. A few things should be added.

7.2 Information Exchange

There is usually free technical discussion between people within the two companies. There are not only formal and regular meetings. Engineers in the supplier company have a more than daily interaction with their counterparts in the airframe company to solve design problems. This is very important, as design uncertainties cannot be faced without free discussion. Communication flows between the two sites do not have to be approved (i.e., the Programme Manager or people in the Procurement Department). Technical discussions are also free at the plant level, where manufacturing and machining practices are always changing so as to improve quality and reliability and reduce costs.

There is an important exception to that: engineers are not allowed to make any unauthorized design or drawing modification. All modifications have to be discussed, evaluated, audited and approved by the two parties. A document is signed and the modifications are recorded in case of future liability problems.

Technical discussions begin well before the contract is signed. When receiving RFP, the supplier company compiles a list of questions and several specification meetings are held. During the contract, the supplier may place their engineers in the customer’s factory.

All technical discussions are strictly confidential. There is an absolute rule in the industry, whereby no one would pass information to a competitor of his customer or his supplier. There are many occasions where this confidentiality is important. For instance, aluminium alloys are normally patented. Patents are strong in the industry, so normal practice is to find cross-licensing. During the development process of new alloys, however, a patent does not yet exist and the aluminium company has to trust the customer about the secrecy of their ideas. Another case arises where a good idea is generated by engineers of the supplier...
company during the discussion and negotiation stages of the procurement process. The supplier has simply to trust the customer.

Other important areas for information exchange are: forecasts for new programmes, production scheduling and programme changes. As far as forecasts are concerned, we have found different attitudes in supplier companies with respect to information provided by the airframe companies on the market potential of new programmes. In some cases people seem to trust the customer and to rely on their own estimates. In other cases, as we have already seen, internal forecasts are used and customer information is distrusted.

As far as production scheduling is concerned, information at the shop-floor level is not openly disclosed by airframe companies. Suppliers may however ask to know the real scheduling if they are involved in just-in-time delivery and in joint quality assurance programmes. That leads to a high level of confidentiality.

Programme changes are another area for information exchange, covered by the contract. Usually the contract states that "if the rate of production falls, the customer expects the price to remain the same" but airframe manufacturers should communicate very quickly every change to suppliers in order to maintain a good relationship.

7.3 Resource Exchange

The airframe company usually provides help to suppliers for several problems.

1). Firstly, they can help the supplier to get new orders in difficult or distant markets.

2). Secondly, when feeling financial constraints, suppliers sometimes ask for financial help. Generally speaking, customers are greatly interested in the financial health of suppliers. When a good relationship does exist, the customer may find it useful to help the supplier. That is possible because during the contract, if the supplier company is heavily committed to the programme, the customer company can really fine tune its profits. Even though acting within a fixed price contract, some opportunities for financial adaptations do exist (for instance, modification fees).

3). Thirdly, managerial resources are also exchanged. When a supplier starts to experience severe difficulties in the management of a project, the customer company may send a manager to help them solve their problems. This is well accepted by supplier companies.
8. CONTRACTUAL AND EXTRA-CONTRACTUAL ADAPTATIONS

The aircraft industry is dominated by quality and safety concerns. Each detail of the design and manufacturing process has to be recorded and stored as documentation in case of liability claims. This leads to a high level of formalization in business relationships. Furthermore, contracts have such a long life that informal agreements would not be an effective means of administering a relationship. Suppliers seem to avoid "old-boy" agreements. They ensure that informal agreements are formalized with a contract agreement or a letter. A typical feature of the industry is therefore that contracts try to cover all possible contingencies within the relationship. That is, of course, impossible. There are adaptations which are covered by the contract and further integration and adaptations which are managed extra-contractually.

Among the first, delivery schedule changes are covered by the contract. For delays in delivery of supply there may be a penalty for the supplier. It is interesting to note that the reverse case is not covered. For instance, there have recently been prolonged strikes at the factories of many large airframe manufacturers: in which case, they may want to delay the supply of purchased items in order to avoid the extra-costs of inventories. As that is not covered by the original contract, they have to re-negotiate it on commercial terms.

Another area of contractually defined adaptations is in specification changes and drawing modifications. The airframe manufacturer may ask for changes to specifications, the same request may arise from suppliers. This happens after the contract, until certification and even beyond. It is a very common event. To give one example, on Airbus A320 the specifications for the nose landing gear were modified after the contract, because it was found that they were incompatible with other parts. These modifications were all managed contractually. It seems that US airframe manufacturers follow a different way of working, giving absolute specifications to suppliers, without allowing any modification.

Despite the high degree of formalization, there is room for some extra-contractual adaptation. It may happen, for instance, that the airframe manufacturer would not penalize the supplier for a delay in order to keep a good relationship. For some components, some extra-contractual variations in delivery times may be arranged. That may be very important, since in many cases, particularly in general aviation, airlines want to buy an airplane within a limited lead time, otherwise they may go to the competition. When customers try to accelerate the programme, the main problem is always to get the collaboration of suppliers. Extra-contractual adaptations are also frequent in the component area regarding the size of individual shipments, when customers ask for very small batches.

Another area is price: sometimes suppliers are asked to ignore the escalation formula built into the contract.
Moreover, there are areas in which it is technically impossible to cover all contingencies in the contract. One of them is engine repair: it is impossible to define ex-ante the price of repair of an engine, because it depends on too many parameters. In this case airframe manufacturers ask engine producers to charge a "reasonable price" to customer airlines.

9. THE ATMOSPHERE OF THE RELATIONSHIP

The atmosphere of the relationship comprises a difficult set of variables to identify and evaluate. We made no effort to operationalize constructs like power/dependence or cooperation/conflict. A detailed observation, however, clearly illustrates certain points.

All relationships we analyzed are a combination of cooperation and competition. We cannot define them as simply cooperative relationships, even though a high level of mutual dependence and some common goals do exist. Cooperation and competition clearly coexist.

The degree to which cooperation and competition coexist is a function of several variables. The atmosphere is perceived as more adversarial when price competition is fierce because of the maturity of the business, a multiple sourcing policy is adopted and contracts have a short duration. Nevertheless, within those relationships a high degree of resource exchange and joint activities on new developments do exist. The atmosphere is perceived as more cooperative when a single sourcing situation exists, the level of technology is higher, the development effort is important and long term agreements are adopted. Nevertheless, suppliers may distrust information provided by customers on market forecasts.

Business relationships are also mediated by good human relationships. The words used by managers from both sides to describe human relationships are: friendliness, truth, honesty, trust. The repetition over time of interaction episodes builds a good relationship. Two managers used a particular word to describe the aircraft industry: it is an "incestuous" industry, they said.
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