European Aeronautics

THE SOUTHWESTERN AXIS

Springer

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(Editor)

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With 80 Figures and 61 Tables

Springer

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Library of Congress Control Number: 2006934980

ISBN-10 3-540-35646-0 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-35646-2 Springer Berlin Heidelberg New York

Production: LE-TEX Jelonek, Schmidt & Vöckler GbR, Leipzig
Cover-design: Erich Kirchner, Heidelberg

SPIN 11783268 134/3100YL - 5 4 3 2 1 0 Printed on acid-free paper

Preface

This book is the result of a three-year research project called *"EADS and the Territorial Strategies in the Southwestern Europe"*. This project has been possible thanks to the work of the following research teams from European Institutes and Universities:

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We wish to thank the European Union (Regional Development Fund) for the financial support. Also, we will like to thank to the aeronautical entrepreneurs, professional associations and local and regional government policy advisers for their valuable comments and opinions during the seminars and conferences held in Toulouse, Bordeaux, Madrid, Seville and Lisbon. Thanks are also due to Ana Alfonso, Cathy Dunn and Gloria Mingo for their work on the translation into English.

Madrid, August 2006 Javier Alfonso-Gil

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1 Introduction: Objective and Scope of the Study

Project teams from five Institutes and European Universities - Universities of Montesquieu-Bordeaux IV in Bordeaux and Social Sciences in Toulouse, the University of Lisbon, the Institute for Regional Development in Seville and the Autonomous University of Madrid, acting as coordinator - have undertaken the following analysis of the aerospace industry in Southwestern Europe. The study encompasses the area from Aquitaine and the central Pyrenees in France to the Iberian "V" formed by Madrid in the extreme east of the vertex, Seville-Cadiz as the southern point and Lisbon as the western vertex. The area has undergone profound changes within the aviation sector, and in particular, civil aeronautics, over the last 25 years.

The epicenter of this change in Europe was the formation and progressive consolidation of Airbus in the 1970s, which later culminated in the formation of the firm EADS in 1998. EADS has drastically changed perspectives in the aerospace industry, even at the global level. The main characteristic of EADS is that its formation was strongly influenced by the states that originally created them. The creation of a European firm based on the willingness of four European states, clearly demonstrates how far one has come from those not so far away years in which these same countries were in conflict. Is this the first truly European firm in the sensitive aerospace sector? Was this sector not highly related to "national" defense? But the change has not only been due to the political will of the governments but also to a robust project, underlying political change, to form what was to be one of the most powerful aeronautical conglomerates of the 21st century.

Change has affected all the variables involved in the industry, from conglomerate and firm property, industrial organization, in-house production and externalization to the behavior of institutional agents including the territories themselves. Moreover, all of these actions have been possible due to the extraordinary contribution of technical change evident in the steady increment in knowledge in society in general and in the aeronautical firms, in particular.

It would be difficult to find an industrial sector that has undergone so many intense changes in such a sensitive activity. Besides the intensity of change, the most obvious transformation in the industry has been the evo-

lution of its institutional framework which was originally firmly anchored in the state, often considered "state policy", but has progressively moved away from the public sphere toward market modes of production, organization and ownership.

The industry's production model has evolved from an arsenal mentality, in which everything critical to building the product was made "in house", to an externalization process for more and more airplane components. This has brought about the appearance of a large number of small and medium firms in the industrial fabric which, depending on their technological and financial capability, eventually find their place within the value chain of contracting and subcontracting involved in the process of building an aircraft.

The organizational model has substantially changed as well, from highly centralized management tinged with aspects of a ministerial appendix, to transnational firms with decentralized management at various headquarters. In the new model, cost management, the goal of productivity, information technology and globalization, in its dual aspect as demander of inputs and knowledge and suppliers of goods and products, clearly define the present and future of the European aeronautical industry.

Strong ties to public property have increasingly given way to private ownership. However, the fact that civil aviation firms and, particularly, space and military firms may now be more distant from the public sector does not mean that there are not still close relations to the respective governments. This is true both for ownership and organization of the firms as will be shown in this report.

Chapter Two will analyze the basic theoretical aspects needed to understand the origin and evolution of the European aerospace sector from the first dreamers at the beginning of the twentieth century to the incorporation of the sector into national defense, making it a priority objective in state policy. Then the increasing significance of EADS will be described, its origin, main actors in its formation, participants and the complex structure of production and assembly locations, as well as its ownership and firm participation, whether subsidiary or not. An analysis of the industrial, organizational and financial model of EADS follows in which special emphasis is placed on the network of suppliers and their hierarchy (from the manufacturers of entire aircraft systems, legally and financially independent of EADS, to those firms located farthest from the technological frontier) which make up the broad base of enterprise associated through subcontracting. The chapter ends with a profile of the last airplane to exit Airbus factories, the A-380. Its basic characteristics, the technological effort required to build it and each country's participating firms and shares

are analyzed. Future tendencies and possible problems facing EADS and other firms in the aeronautics sector are also considered.

Chapter Three looks at the territory in which EADS/Airbus and other aeronautical firms operate. The importance of this chapter lies in the fact that it proposes to demonstrate the existing consensus among research teams involved in this project that the territory is no longer so much a parameter as it is a variable in the firm/territory model. The reason is simple: numerous studies show that agglomeration is an essential characteristic of clusters or territorial districts and this study will demonstrate the existence of the agglomeration factor in the aeronautical sector of Southwestern Europe. However, the analysis has also discovered the presence not only of a strong agglomeration in the territory, but also of significant specialization both in type of firms and in organizational models emerging in the eighties and later consolidated.

Once these characteristics are demonstrated, the third chapter then hypothesizes, and the final chapter corroborates, the existence of territorial specification within the aeronautical clusters. The behavior of the various agents that converge on the territorial space, whether entrepreneurial (professional associations), workers unions, local or regional entities, official or commercial banking or, of course, national government, tends to transform the territory into a specific active agent in the economic trajectory. A sequence of **agglomeration**, **specialization** and, finally, **territorial specification** has been observed to exist in at least some of the territories studied.

Chapters Four, Five and Six discuss the specific territories studied: Bordeaux and Toulouse in France, Madrid and Sevilla-Cádiz in Spain and Lisbon in Portugal. This report organizes the respective national intermediate reports into three groups represented in the three chapters, Bordeaux (Aquitaine) and Toulouse (Midi-Pyrénées) in Chapter Four, Madrid and Andalusia in Chapter Five and Lisbon/Portugal in Chapter Six.

Chapter Four presents a thorough study of the French clusters beginning with an overview of the territories, employment, participation share, specialization in the aerospace sector and, finally, the role of institutional actors in the industry's evolution. Differences in the two territories are pointed out as to specialization and specification. While Bordeaux has evolved toward the aerospace and military industry, Toulouse strongly specializes in civil aviation. Distinctions between the two clusters are present throughout the study, specifically in the varying entrepreneurial strategies. While Toulouse has been relatively free of government intervention, Bordeaux, due to its specialization, continues to be strongly conditioned by governmental policy which, in times of bonanza in the civil industry, implies greater pessimism among Bordeaux entrepreneurs as to

investment, R&D action, productivity, employment, profits and, in general, future perspectives. In any case, the French aeronautical sectors studied here are perceived to be far superior to the rest of those analyzed. They are the most advanced both in terms of jobs, business, R&D investment or financial strength. They are therefore located at the frontier of financial and technological possibilities. It would be of critical interest to extend this study to other European countries with industrial capability in the aeronautical sector such as England, Germany and Italy to have a complete view of the aerospace industry in the EU.

Chapter Five analyzes the Madrid - Andalusia axis where the majority of the aeronautical industry is located, although the Basque country, Catalonia and Castille and León also have some activity in the sector. Both Madrid and Andalusia have obtained considerable experience in the sector since its origins in the beginning of the 20th century. However, the location of the former CASA in Madrid, a firm which had been building military and civil planes since the 40s, gave Madrid an edge over Andalusia, particularly when Spain first participated in the initial formation of Airbus and later in EADS. Since that time, the headquarters of the consortium in Spain are located in Madrid where the material and human resources of the disappearing firm, CASA, were located. Therefore, 60% of sales and personnel of the sector is concentrated in Madrid.

A more veridical image of the Spanish aeronautical industry fabric, one showing greater balance between the two territories, can be seen by subtracting the sales of EADS and Airbus from the territorial sectors. This image shows an industrial fabric where small and medium size firms (SME's) are prevalent and financial and knowledge capability is low, from whatever angle one analyzes. This fact poses serious questions as to the future of the sector in general where up-scaling has become essential the requirements of both the market and the title firms, whether EADS or Airbus, are to be met. Problems in quality and certification, delivery time, access to tenders, qualified personnel, investment in R&D, and financial capability suggest policies of cooperation, joint ventures and concentration should be designed as the best solution to the Spanish aeronautical sector in a globalized world.

The difference between the clusters in Madrid and Andalusia lies more in the greater presence of the main firms in Madrid, with all this entails, than it does differences in size of the industrial fabrics. As will be seen in Chapter Seven, there are quantitative differences between the two territories although this is compatible with the common weaknesses expressed above.

Chapter Six, undertaken by the team in Lisbon, will close the detailed analysis of each territory. The study was not only carried out in Lisbon but

throughout the entire Portuguese territory due to the fact that, of all the territories studied in this project, the industrial sector in Portugal is just beginning and is therefore the least developed. In fact, the sector is currently undergoing agglomeration of firms in specific areas such as Lisbon, Oporto and Evora. The aviation sector in Portugal is mainly involved in maintenance of both civil and military airplanes, some low-end manufactured parts and, marginally, the building of small fire-fighting planes. OMAG and TAPEM are examples of consolidated firms which may become the nucleus of a future Portuguese cluster. There are other industries in close proximity with these large firms which are not necessarily or exclusively related to aviation. Therefore, we are witnessing agglomeration more than specialization.

As of yet, Portuguese industrial fabric has not developed close relations with the leading European contractors, meaning that networks of cooperation with the rest of the clusters studied here have not been strong. Links with other firms not belonging *a priori* to the sector, such as aluminum or plastic injection and the automobile industry, have generated a significant number of industries on the verge of joining the aeronautical fabric. Portuguese firms in the aviation sector have traditionally collaborated with the American aeronautical industry (Boeing) in the maintenance of NATO airplanes, and with the aerospace industry in the United Kingdom. However, the recent privatization of OMAG suggests a tendency toward closer ties with firms working at various levels with EADS/Airbus or with EADS itself. Thus in the near future, Portugal may consolidate its aeronautical sector through its internal potential and its external associations and investments. Besides cooperating with existing private firms, Portuguese public institutions will have much to say, and do, to achieve this objective.

Chapter Seven reveals the statistical data obtained from the surveys. First a descriptive statistical analysis of each territory - with the reservations put forth above as to Lisbon - is carried out in order to determine the values of the variables selected to provide information at a theoretical level on relevant facts that come up repeatedly. Thus average values in the territories have been found for sales volume, total employees by job category, investment in R&D, number of persons employed full-time in R&D, number of patents obtained by the firms, etc. This descriptive data provides an adequate representation of the situation in each territory according to the values obtained.

This chapter also provides a factorial analysis to scrutinize possible relations existing between the variables (13 in this study) and their values, obtained from the standardized surveys in Toulouse, Bordeaux, Madrid and Andalusia. The aim of the factorial analysis is to identify the complex relationship existing in a set of observed variables with a relatively small

number of factors. This statistical technique will show the basic relations existing among the territories through aspects common to the variables but grouped into only a few factors. The matrix of rotated components demonstrates that four factors can, with significantly high values, explain the relations existing among the thirteen variables selected in the given territories. The result corroborates many of the premises put forth in this introduction, both in the general framework and in the analysis of the specific territories.

Finally, Chapter Eight offers the conclusions of the project as well as some of the policies that, in the opinion of the study teams, should be considered, debated and eventual adopted in the various territories. Although the project results show that the basic forces at work in these territories tend to be similar, their manifestations over time usually differ. Therefore it is probable that the diagnosis and consequent policy measures proposed should be specific to each territory depending on the nature and progress of the development of firms and/or territories in each case.

2 Sector and Territory

In the context of global competition in products and production factors, the question of the location of firms and, in broader terms, of productive activity is being considered in a new light. Local territories, whose differentiating characteristics are a reflection of institutional variety, to be defined below, participate in a competitive contest to attract productive investments as "firms tend to become increasingly nomad." In tune to product cycles, technologies and division of labor, firms must also carefully consider the reasons for locating in one place or another. This, of course, depends on the cost of production factors at each location, but also, and more important, the opportunities to insert into a global industrial organization. Thus they must choose between being territorially anchored and nomadism.

All industrial activity proceeds from a productive activity whose efficiency depends on access to resources (relative prices of the factors and accessibility) and markets, and on the creation of resources (production earnings, technology and innovation) aimed at guaranteeing continuing production. These two dimensions of industrial activity assume the creation of resources as well as the utilization of external resources. These resources are either acquired by contractual relations within the market (transaction costs) or outside of the market (cooperation). "Firms do not need a perpetual location." (Perrat, Zimmermann, p. 17).

The quantity of created or acquired resources, and the various types of contractual relations, is the basis of a firm's choice between anchorage in a territory or nomadism. This choice does not strictly involve determining the suitability of a territory for a firm's parameters. Rather a dialectic with reciprocal interaction takes place in which the firm modifies and is itself modified by the territory thus creating (or maybe not creating) a common dynamic which will lead to a decision.

2.1 Sector and Territory. Crossed Competencies

The consequences of recognizing the importance of the spatial location of activities and the existence of differentiated local dynamics from the capitalist point of view can be observed at two levels.

"In the first place, production is included in the competitive dynamics that vary depending on the location". In this respect, G. Benko and A. Lipietz (1993 and 1999) describe the debate on winning or losing locations (regions or urban nucleii). With this renaissance of economic geography, A.L. Saxenian (1990) and A. Scott (1990) explore the dynamics of California's Silicon Valley as an example of a specific model of collective cognitive learning inscribed into a geographical space. A method of located productive organization is created leading to a new way of being competitive.

W.W. Powell and L. Smith-Doerr (1994), when analyzing relations among firms as "contract networks", distinguish four types of networks: research and development networks, strategic alliances, business groups (in the sense of "affaires groups" defined by Granovetter) and regional networks based on the model of industrial districts. Combined in a sectorial dimension, product innovation and competitiveness can also be explained by the spatial dimension and localized institutional context which favor various learning situations (Lorenzen, 1998). Territorial "specificity", when it exists, clearly demonstrates new tendencies either in the way new use values are generated or in distribution modalities. Thus, productivity gains are clearly less linked to a "taylorist" exploitation of a scale economy than to the capability of adapting (C. Dutertre, El Mouhous, Ph. Moati and P. Petid, 2000).

In other words, the firm in itself or even the network of relations among firms are not the only modalities of obtaining productivity gains or the creation of wealth. The spatial component of production and the system of local relations can be determining factors in some configurations.

Secondly, despite the dynamics of differentiation, local or regional locations compete with each other which eventually complicates the function of competition among firms. From empirical observations, it is known that there are locations where the availability of factors is, a priori, comparable, but they show different capabilities to mobilize information and technical knowledge through institutional action. Competition among producers is therefore the result of firms searching for an optimal location and places competing to attract firms and this competition interferes with the organization of production. Competition is thus significantly modified (G. Colletis, Gilly, Pecqueur).

The progressive substitution of fordism by various forms of productive organization and by strategies no longer based on costs but rather on externalization and collective production of advantages suggests a change in the logic of location, from cost-based to a logic of territorialization based on innovation and the building of specific resources[1].

Hence, firms benefit from the "plasticity" of the territory, from the ability of the territory to reveal complementary competencies to a firm facing an unusual productive problem whose solution requires a creative combination of competencies both internal and external to the firm.

2.2 Variety of "Models" of Territorial Development

"The great variety of types of territorial development models and the fact that the territory is considered a factor a priori requires that the concept of territory and the factors of spatial competency be reconsidered." As a result of interaction among the main actors, the territory becomes a dynamic combination of three proximity dimensions - geographic, organizational and institutional - which will be defined below. "Competition among production centers" is an imperfect competition carried out in unique configurations. Institutional and organizational contexts are, in fact, very different from one territory to another and it could easily be said that the industrial history of any given firm would have been different if it had chosen to locate in another place. However, at a methodological level, it is possible to define three polar categories of territorial development, each corresponding to a particular productive organization and institutional dynamic: agglomeration, specialization and specification. (Colletis, Gilly, Pecqueur, p. 12).

2.2.1 The Factors of Spatial Competency

G. Colletis and B. Pecqueur (1993) analyze spatial competition factors by distinguishing two types: assets and resources which they qualify as specific and generic, respectively[2].

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[1] See below.

[2] The difference between assets and resources can be described as follows: while resources are potential factors, assets are activity factors. If resources, or generic assets exist independently of their participation in any productive process and are then totally transferable, specific assets do not exist except in a virtual sense and therefore cannot be transferred. Only this type of resource is inscribed in a

"Generic or active resources do not allow a territory to differentiate itself for any length of time since, by definition, they can exist elsewhere or can be transferred." A long-term differentiation, that is, one not susceptible to loss through geographic mobility of the factors, does not arise simply from the specific resources which only exist due to the conditions that have generated them. It is more important to understand these conditions than it is to look for what would constitute the identifiable potential of a territory. These conditions cannot be defined in an abstract way but require that the organization of local productive activities be taken into account.

This dynamic perspective obviates spatial competencies. Thus M. Bellet, G. Colletis and Y. Lung, (1993) have observed that the territory can be considered the result of a combination of three proximity dimensions: geographic, organizational and institutional (see, as well, J.P. Gilly and A, Torre, 2000).

Geographic proximity deals with spatial separation. The consideration of firm location integrates a social dimension into economic mechanisms, or what is called functional distance. This proximity cannot be reduced to mere physical distance but should be understood as a truly social construction where timing plays an essential role.[3]

Organizational proximity concerns the interactions among actors within and among organizations and unites the actors with complementary assets that participate in a given activity and belong to the same type of relations: a group and its subsidiaries, a network of actors, etc. It is based on a common cognitive framework that leads to structural coherence of relations among the actors.

Industrial proximity is based on the adhesion of main actors to a common performance space, shared norms of action and/or mental models and of "connivances" which orient collective behaviors. Industrial proximity leads to regularities in localized productive coordinations and facilitates organizational proximity.

creative process. The concept of specific resources thus implies a dynamic definition of territory based on the creation of constantly redefined competencies at the mercy of new configurations at work among the actors facing hitherto unknown situations.

[3] For example, the construction of a freeway or a high velocity railway as a result of a set of financial, administrative and technical decisions modified by geographic proximity.

2.2.2 Agglomeration, Specialization, Specification

Competition Among Production Centers and Types of Territorial Development

Competition among locations is imperfect because of the diversity of local institutional and organizational contexts. It is, however, possible to distinguish three methods or polar categories of local development each corresponding to specific productive organizations.

The process of agglomeration is based on the geographic concentration of diversified economic activities which are not *a priori* complementary. This concentration is the result of economies external to the firms and linked to scale economies in the division of some resources. It is mainly "pecuniary externalities" caused by the concentration of activities and persons that directly influences the price of production factors. The particularity of the agglomeration process is that it produces external effects that do not respond to industrial logic and do not necessarily affect the system. Agglomeration is essentially characterized by geographic proximity.

The process of specialization is based on a strong organizational structure of the economic fabric dominated by an industrial activity or product. The term "specialization" has a double meaning. On the one hand it is the process based on industrial logic whereby the economic fabric is structured; on the other hand, the uniqueness of the fabric is established which leads to the geographic concentration of related activities. The interdependencies arising from economic activities based on a given specialization create a "public good" which links the strategies of each one. The process of specialization occurs when organizational proximity is added to geographic proximity.

The process of specification characterizes a territory when the method of coordination among the economic agents and the effects of organizational complementarity lead to flexibility in the display of resources, activities and competencies without shattering territorial context. Specification refers to the capability of the territory to define new development potential and organize the display of its resources and assets to bring about development. This is a dynamic perspective in that the problem is no longer to perpetuate a long-term productive combination but rather to endow the industrial fabric with the capability of reorganizing into new productive configurations and of creating new resources (G. Colletis and J.P. Gilly, 1999).

The strategies of firms and the dynamics of territories may or may not coincide and lead to more or less long-term "productive encounters". In the

same way that firms wish to permanently maintain or even increase the flexibility of their organization, territories wish to progress and transform even as they avoid the effects of irreversibility and being "fenced in" with one method of local development or another.

2.3 From Territorial Governance to Global Regulation

The evolution of spatial location and organization of activities in developed countries could cause increasing differences between firm strategies and territorial evolution. The autonomy of competition strategies among territories and competition strategies among firms are two related dynamics.

Territorial strategies, in fact, submit more or less to competition among firms who benefit to differing degrees from local externalities arising from territorial dynamics. The territorial paths of agglomeration, specialization and specification arise, as seen above, from the relation between firms and territories.

The process of coordination between firms and the other main actors in the territories can now be analyzed within the concept of local governance. These processes are inserted within global regulation as will be explained below.

2.3.1 The Concept of Territorial Governance

Territorial governance, or the building of local agreements among main actors, is an extension of the concept of institutional proximity. It is characterized by the degree of cohesion of institutional proximities specified by territories. An initial definition concerns the polar situations of agglomeration, specialization and specification leading to different, more or less dense, forms of coordination in and out of the market. To analyze these relations, it is not possible to directly resort to the concept of regulation which is designed to understand macroeconomic regularities. Thus territorial governance is discussed here before exploring its relation to overall regulation.

The literature on the concept of governance is abundant but, generally, quite imprecise.

Unlike O.E. Williiamson's proposal (1988), the concept as used here is not limited to a process of coordination centered exclusively on logic of costs among the main economic actors in the framework of contractual re-

lations to the extent of excluding institutional actors from the environment of economic exchange (J.P. Gilly and B. Pecqueur, 2000).

On the other hand, the desire to "endogenize" the spatial variable into economic analysis leads one to reject the definition of governance as mere network relations among firms (G. Benko, 1998; G. Benko and A. Lipietz, 1999). The definition needs to be broadened to include all fundamental social relations existing in a local economic space.

The conventionalist approach, in which power is reduced to an assymetry of cognitive resources, is also rejected in this definition since power is extended to all resources (particularly financial resources) available to the main actors in the solution of coordination problems. This approach, seemingly essential in discovering the evolution of territorial governance mechanisms, also differs from evolutionist papers on organizations (Nelson and Winter, (1982); de Egidi, Marengo, Narduzzo, 1994), for whom the evolution of types of coordination is merely a cognitive phenomenon of the type "change in routine".

The concept of territorial governance in this study also varies from the instrumental approach often used by some policy-makers (Almacenista, 1998) or sociologists (Kooiman, 1993; B. Jessop, 1997). Territorial governance is considered in a more structural light here, a view less tied to a particular historical contingency. Territorial governance, as understood here, is partially produced by the articulation of tensions between local and global levels which constitute the territorial regularities and specificities.

Finally, this study does not share the idea of "social construction of the market" proposed by A Bagnasco and C. Triglia (1993). These authors, we believe, define the effects of proximity coordination by a regulation of local societies in empirical cases in "la terza Italia". These researchers did, however, point out the importance of non-state policy (i.e. local government).

By insisting on the plurality of compromise that constitutes territorial governance, this analysis is not limited to formal institutional actors or the "industrial district" line of thought. An attempt is made here to define the concept of proximity coordination in all hypothetical cases of localized productive systems. This implies admitting that territorial governance not only results from institutional decisions as to location, but also from the dynamics of other agents from existing sectors.

Territorial governance, then, is defined here as a process of construction of compatibility among various institutional proximities that brings together main actors (economic, institutional, social, etc.) who are geographically near, for the resolution of a new productive problem, or, by extension, for the accomplishment of a local development project. This

definition basically emphasizes the idea of "process", that is, the collective institutional dynamic that uniquely articulates various logics of main actors who either cooperate or are confronted within a territory.

Territorial governance always combines elements of stability and instability, whose relative importance evolves over time, to define inflexions in territorial development paths. But territorial governance implies that elements of stability must be predominant, that is, agreement among main actors must be sufficiently stable and coherent to eventually decrease the uncertainty inherent in collective action and thus reduce rivalry and conflict. Only when a system of social interdependencies and common representations generate localized productive regularities will we be able to talk about governance structures. When elements of instability, that is, rivalries and conflicts, question accepted agreements, territorial regulation enters into a crisis phase.

Finally, our approach leads us to an open, non-localist, view of the territory. The actors in a territory build institutional proximities with external actors, which introduces the question of the articulation of local governance with broader scales (national and even multi-national). The concept of territorial governance is based on a framework of dialectic articulation between territorial and macroeconomic regularities.

2.3.2 Governance Structure relations with Local Models

Dynamic Relations Between Governance Structure and Local Development Models

The main actors that participate in the appearance or in the stabilization of territorial governance are economic (firms in a group, associations of firms) institutional (territorial collectives, State, Chambers of Commerce, etc.) and/or social actors (unions, associations, etc.). Governance in this sense is not merely a configuration of strictly socio-economic or strictly political coordinations. It is a combination of these dimensions characterized by a variable density of the interactions between the two categories of actors.

Interactions are particularly complex because administrative intervention of local organisms does not coincide with the intervene tion of socio-economic agents, and the strategic temporal horizon (how time is conceived) of public and private actors can differ. These differences are the cause of imbalance in territorial compromise. But institutional actors often play an essential role in the building of territorial governance, in particular,

through formal promotion and networking institutions (country contract or competitive poles, for example).

By extending the question of cooperation to social groups, territorial governance becomes much more than mere coalitions among firms to obtain combinations of various groups within a complex society. The relations among formal institutions of various types such as firms, banks, unions or territorial collectives can be considered group to group relations or, more specifically, the creation of a more extensive group that discriminates between members and non-members and organizes itself according to specific organizational models that describe the process of local governance. Among the actors that participate in territorial dynamics there are *key* actors who play a leading role because they are an institutional reference for all of the actors and structure the mechanisms of coordination among all the actors (Colletis, Gilly, Pecqueur).

"All of these main actors are 'located' which means that the actor is 'here', that is, located in a given territory, but at the same time the actor is elsewhere, (for example, because of his relations with firms in a particular industrial group and/or with actors of a cooperative firm network)". The 'located' actor adheres to an institutional commitment that either leads to rooting in the territory or moving. This is the case of firms in industrial groups (Dupuy C. and Gilly J.P., 1995[a]) included in three types of institutional proximities - the territory where the unit is implanted, the group to which it belongs and the activity sector. Therefore, the ever-changing articulation is based on an institutional commitment that can be questioned if, for example, the group's organizational method and strategies lead it to 'withdraw' from the territory (Gilly, Leroux, p. 10).

2.3.3 Local Governance[4] Between Macro and Micro

At the macro level, the Theory of Regulation[5] analyzes transformations in time and space of the system of accumulation and institutional forms of an

[4] If we use the term "local" to designate a subset at macro level, it may refer either to a sectorial subset or a territorial subset.

[5] The Theory of Regulation analyzes transformations in the economic system and adopts a certain typology for the relations that link people. This typology classically involves the five areas of wage relation, types of competition, type of insertion of the State in the economy, currency and insertion in the international division of labor. In each one of these areas or dimensions, the relations are codified or normalized and this codification creates "structural" or "institutional" forms. A given configuration of these dimensions characterizes a system of accumulation.

economic system (national, for example). The meso-level is that of intermediary regroupings of actors coordinating in a common financial objective (sector, territory, network, group, etc.).

The meso-level, in our opinion, is particularly useful in the analysis of periods of transformation and change in economic systems in which the actors locally introduce new forms of coordination and organization that challenge existing "rules of the game" to attain higher levels of economic efficacy. The meso level is of interest in explaining the dialectic between structures (whether productive or institutional) and interaction among the actors.

The following figure synthesizes these observations. The two rectangles at the top refer to the macro level in its economic and institutional dimension. The two rectangles at the bottom of the figure correspond to the meso level.

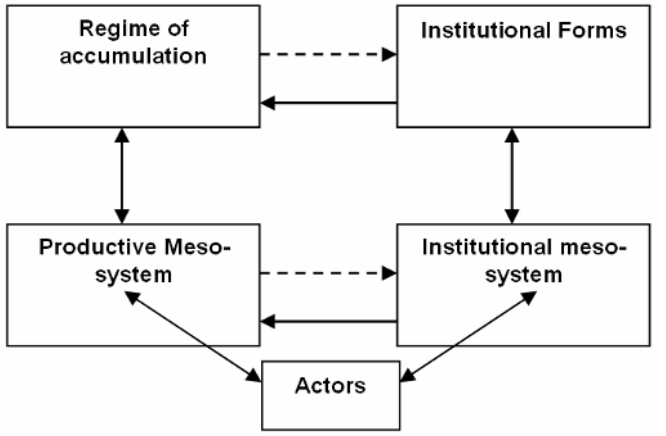

Fig. 2.1. Macro and meso levels

The institutional meso system (or governance) corresponds to the institutional forms and designates the set of norms and codifications that regulate the productive meso system. These norms are designed, interpreted and modified by the actors (formal institutions and firms). From among these actors one or several may be chosen as key actor(s) who will serve as institutional references for the other actors in the meso system. Thus governance (meso) allows formal and informal institutional processes to harmonize for a period of time the behaviors of actors whose strategies and objectives are often contradictory. Two dimensions of the meso level can be distinguished: the sectorial approach and the territorial approach. These two dimensions analytically define a productive (or technical, organizational) aspect and an institutional aspect.

The sector[6] is a meso system that is also an abstract space of competition among economic actors who explicitly participate in the dynamics of accumulation. The perimeter of a sector, defined by all of the actors involved in producing a good, is obviously variable due to the entry and exit of firms in a given market, and above all, to productive transformations: increased externalization of activities, non-materials and services, increased relations between science and industry that are decisive in innovation. An example in the aeronautical sector is the relation of designer-assembler Airbus with its "systémiers" or systems manufacturers, the hierarchy of subcontracting, etc.)

Productive activities integrating activities (in particular, services or research) related to the technical-industrial center can also emerge. Nevertheless, the concept of sector does not disappear but rather focuses on the vital center of technical and industrial competition within the productive configuration dynamizing the content and the perimeter. This constitutes a socio-economic construction, not fact.[7]

Sectorial governance is structured by the actor(s) in the productive configuration defining the industrial references to which the other actors adhere, and by the norms derived as to wage relation, cooperation and competition among firms, relations with the State and public action and funding of activities at the international level. In order to define the symbolic foundation and sector rules, the role of the key actors who orient the sector's institutional structure (for example the GIFAS or French Aerospace Industries Association for aeronautics in France, workers unions, etc.) should be analyzed.

The change of content in the sectors, a factor in the dynamics of productive activities in contemporary capitalism, also affects public action and the role of the State. Thus new administrative-institutional sectors arise (e.g. environment) which include activities that were formerly autonomous. The process of administrative decentralization, on the other hand, has facilitated these recombinations as can be seen in some territories where decentralized social, industrial, and training services of the state are coordinated.

Territory, like sector, is not defined *a priori.* It is a construction generated by geographically proximate actors participating in a common finished product. Territory is not to be confused with administrative spaces

[6] This term is used here in a broader sense than that used in industrial nomenclatures.

[7] It is important to point out that a sectorial meso system does not have the autonomous capability of reproduction. This would only make sense, according to macro-economic logic, in the intersectorial plane.

although the actors of these spaces often play a decisive role. Territorial dynamic is fed by processes both endogenous (the interplay of local actors, their strategic evolutions, the displacement of compromises, etc.) and exogenous (the impact of macro structures, sectorial evolution, the gaps between local and global logics, etc.). These distinct processes give birth to a multiplicity of territories whose typology has been defined above - agglomeration, specialization and specification - and whose reproductive capability is extremely variable. The emblematic case is the specification territory in whose center the actors can create specific territorial resources primarily aimed at conferring productive flexibility on the territories and opening them to diverse development paths. As in the case of sectors, key actors will be detected and the components of territorial governance (wage relation, competition and cooperation among firms, relations between science and industry, public, local and national action and the method of internationalization of the meso-territorial system) will be defined.

2.4 Relations Sector-Territory[8]

Sector and territory are historic forms of the meso economy each with their own dynamic and inscribed in variable time and space, although predominant organizational and institutional forms are normally located in the long term. Sector-territory relations are thus inscribed in variable time configurations in which certain sectors are prevalent in some periods (the case of Fordist activities during the "Thirty Glorious") and certain territories predominate in others such as the last twenty years. In an attempt to understand these evolutions, two hypotheses will guide our analysis.

The first is that geographic proximity between actors within the territory plays a decisive role in initial stages of changes or crises in productive sectors (the automobile sector in Detroit, electronics and computer science in Silicon Valley are examples). In this last case, the actors impulsed territorial reconversion, thus moving from an industrial logic to a territorial logic. On the other hand, some territories will generate new types of relations between industrial actors and research centers, industrial actors and service firms, etc., creating new productive configurations, new connections among sectors and new external factors, as occurred in the aerospace and aeronautical industries in the Midi-Pyrenees.

The second hypothesis is that key actors are very often macro-actors who play a decisive role in the process of articulation between sectors and

[8] Abbreviated denomination for sectorial méso-system and territorial méso-system.

territories, whether as productive macro-actors (large groups) or institutional macro-actors (the State, the EU, professional unions, etc.)[9]

Based on these hypotheses, it can be said that the large groups guarantee mediations between sectorial markets, where international competition is the yardstick, and the territories in which their R&D and/or product development centers are located in the same way that the State decentralizes the services of its large national administrations into regional and departmental territories.

For groups, sector-territory mediation refers to the relation of global productive, financial and commercial strategies to the local policy of their firms. The nature of this relation is based on the kind of activity developed locally and on the organizational and social devices and common representations that characterize the relation. Relative autonomy is granted to subsidiaries and firms in the management of wage relations and potential conflicts between wage earners and employers. The result varies according to the activity of the firm or firms and the degree of local implantation of the firms in the territory, ranging from the 'non-grounded' Fordist-type unit, completely disconnected from its location space and determined by its group strategy or sectorial logic, to those units developing complex production processes and permanent innovation activity. This type of firm, staunchly implanted in the territory, participates in a collective process of creation of specific resources and can therefore increase resources for the group.[10]

For institutional actors, the mediation territory-sector is carried out in a similar fashion. Thus, for example, the role of decentralized State services at the local level depends on policy designed at the national level and, particularly, on the amount of decentralization in policy implementation (see

[9] Of course there are situations in which key actors are not macrostructures and where processes are led by SMEs or local development agencies (industrial districts, local innovation systems, etc.) There are a variety of local productive models but we will focus here on the most frequent cases in which groups are the key actors.

[10] This last case is of great interest in comprehending transformations in relations between sector and territory in the dynamic of contemporary capitalism. Here, group strategy and organizational method participate in the mediation between territory and sector which involves not only the firm of the group but also the other actors (firms, laboratories, etc.) involved in the process of technological creation. External territory factors as well as the institutional dynamic resulting from this process thus feed the sectorial dynamic and its method of governance. The group of key actors and other groups with activities in the territory and who participate in the process can internalize technological projections carried out locally and diffuse them within the sectors to which they belong.

for instance the 1983 laws in France). The type of official sectorial policies carried out - industrial, technological, and territorial ordenance policies - is also an important factor. Regional and local administration of the large Ministries therefore must juggle requirements and norms coming from "the Capital" through the usual hierarchical routes and those that originate from "in situ" collaboration with their colleagues from other Ministries. For instance, a local or regional labor manager will act in a given way depending on instructions he receives from his Ministry but also on the contacts he may have with the local or regional representative of the national entity for Industry. The way the norms will be interpreted is deflected by local environment.

The following figure illustrates these observations by showing the role of actors in the articulation between a sectorial meso system (S) and territorial meso system (T). In this general presentation, no hypothesis is made about the direction and intensity of the relations.

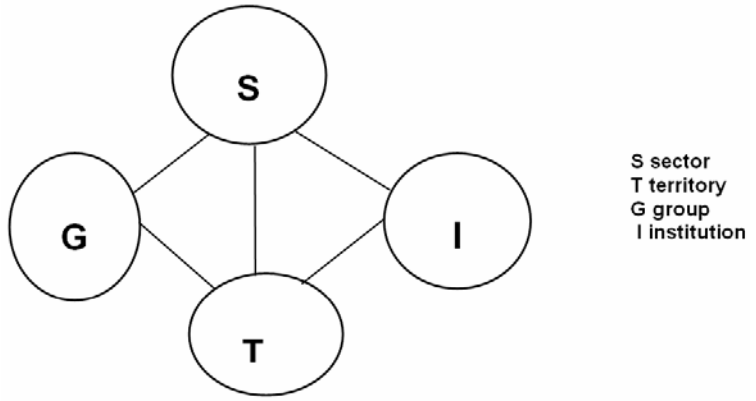

Fig. 2.2. Sectorial and territorial meso level

This figure is logical only when G and I are key actors simultaneously with S and T. The industrial (G) and institutional (I) actors orient the norms constructed by S and T. Due to their definition and commitments, both the groups and national institutions participate at the basis of articulation between territorial and sectorial governance.

The following figures attempt to apply this presentation to agglomeration and specification territories.

In the process of agglomeration, the territory is the receptacle of logics elaborated in the various sectors that introduce activities. In the process of specification, there is interaction between territorial governance and sectorial governance owing to the mediation of economic and institutional actors.

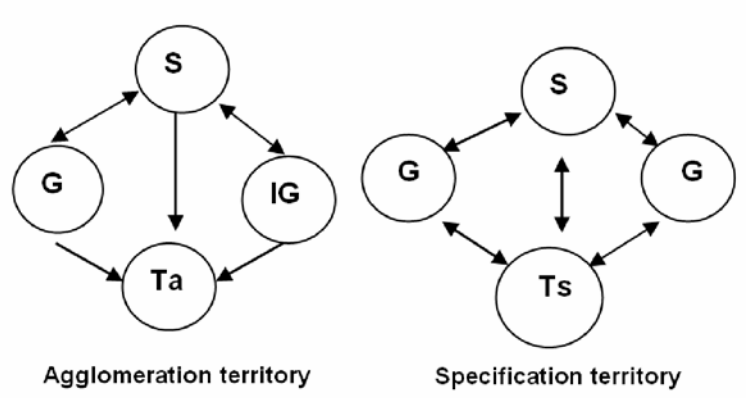

Fig. 2.3. Agglomeration and specification territories

The results of the present study will adopt this approach in which the participation of both industrial and institutional actors will be examined in order to point out the norms and codifications that articulate territorial and sectorial governance.

Industrial actors are the productive units inscribed in the logic of aeronautical production (Airbus A380 and, more broadly, other aerospace activities) in the five locations discussed, Toulouse, Bordeaux, Madrid, Andalucia and Lisbon. The study approaches the sector from the perspective of both the technical productive organization and territorial location and aims to define the structure of the organizational dynamic in the five centers, in terms of the general characteristics of the firms, interaction and relations and "rules of the game". The study also analyzes the sector's relations with the non-industrial environment. The information and data were obtained through existing statistics and two surveys, one of a more quantitative nature and the other, designed with the large contractors in mind, of a more qualitative nature.

Public policy institutions (regional, county and local government, development agencies, etc.), para-public institutions (Chambers of Commerce) and research centers involved in aeronautical activities or in formation centers are also discussed. Exhaustive interviews with key institutional actors were held in order to understand the principle characteristics of public policies and their application and deflections at the local level.

The study emphasizes the capability of local actors (firms and institutions) to produce specific local resources while perpetuating territorial attraction. Institutional aspects are considered essential to the concept of territorial governance which designs institutional dynamics (rules of the ga-

me, local value systems, collective representations) based on the technical-economic dynamics of the territory.

3 The Aeronautical Sector: Recent Tendencies

Aviation first appears as the First World War is coming to an end. As with other productive sectors, the strategic needs of nations will set the pace of development in the aeronautical sector. Born as an adventure of pioneering dreamers, aviation became a strategic industrial sector as a consequence of the First, and particularly, the Second World Wars when the sector is essential to the nations' armed force defense needs This fact has been the principle singularity of the sector until only recently. That is, the aeronautical industrial sector was strongly conditioned by governments and had become a public good as a strategic defense sector.

Although this tendency is still latent, at present the institutional framework of the sector is undergoing changes. The original impetus as a public sector in its beginnings still persists, but decisive steps are being taken to slowly move aeronautics away from its historical path. This change began to come about in the 1980s but the dynamic transition toward a new governance structure has not yet been completed. This evolution will be one of the concerns of this study.

3.1 The Organizational Model in the Industry

Five characteristics may define the aeronautical sector since its beginnings in the first third of the 20th century. The first is that it arose within the framework of nations' strategic defense needs and therefore shares the characteristics of a public good. The second involves the legal format within which most of the leading firms in the sector have operated, whether closer to private ownership or public property. Related to this characteristic are the relations between firms and the largest monopsonistic client: the State. Third, the peculiarities of the sector's industrial organization distinguish it from other productive sectors. The convulsion taking place in industry in general since the 1980s has occurred with particular strength in the aeronautical sector. Fourth, the importance of science and technology in the sector is crucial and, finally, the territories and their

agents play an important role in the creation, consolidation or restructuring of the aeronautical industry.

3.1.1 Defense and the Aeronautical Sector as Public Goods

Economic literature in the field of Public Finance refers to non-rival goods as those whose demand cannot be excluded and designates them as "public goods". The most systematic example is national defense. It is clearly a non-rival good which means that one specific demand for the good does not reduce the quantity available to another demand, and, at the same time, if the good is available, other consumers cannot be excluded from its consumption.

For defense to be a public good, resources must be made available so that defense is more than mere rhetoric. Men and weapons must be available to the armed forces in order to defend the country from outside intervention. For this reason, the history of nations has not only been concerned with the contributions of men, but also in great measure with the history of the equipping of its armed forces. In fact, weapons factories have generally been created or supported by governments who consider them strategic industries of the country.

Also rivalry among nations has been common since the creation of nation-states, which explains the priority that governments assign to endowing its armed forces with the best defensive and offensive weapons to properly safeguard "national sovereignty". A country's weapons, then, are closely related to the concept of a public good as described in the literature.

Along with the technical grounds for determining if a good is more or less "public", political and financial aspects accompanying the good should be considered. The financial impact that defense requirements have had on public budgets has historically been understated. Defense industries have normally generated many jobs which has justified those who support the sector.

The rhetorical use of "public good" has often concealed investment decisions hardly justifiable to be in the best interest of the country. Public goods for defense were identical to national interest and, therefore, no other justification was needed.

After the 1950s, the sector has increasingly developed civil aviation while progressively freeing itself from the ties with military industry. This is not to say that government opinion has not been a determining factor in the evolution of the aeronautical product, from financial support, design and development to having the last word as to who the products will be sold to and, indirectly, how the aircraft will be sold. Government interven-

tion has been the norm in the history of aviation. At any rate, this question of the sector as a public good will be further discussed in the final evaluation of the aeronautical sector.

3.1.2 Forms of Ownership and Regulation

As a consequence of the sector's public nature, the aeronautics industry has historically proved to be dependent on the respective governments. This is due to the fact that aeronautical policy was and, in fact, still is, state policy. Proof of this is that the firms in the sector have either been publicly owned (created and launched by governments) or they have been strongly regulated by the executive branch of each country. Both of these forms of ownership are a far cry from what is understood as economic freedom and market behavior.

In Europe, public enterprise was the rule although private ownership did exist: Dasault in France, Massersmitt in Germany or Fokker in Holland. In the USA, on the other hand, almost all the firms were privately owned. Government control was obvious in public firms normally as a consequence of economic and political circumstances after the Second World War. However, economic efficiency was not so evident. Of course governments themselves were the principle client. Thus the few public suppliers in the territory tended to match up with the few public demanders in the same territory. The result was a close relationship between firms, ministries that controlled the technology and government clientele.

As will be seen below, one of the most substantial changes occurring in this sector, and in most industrial sectors, was the wave of privatizations basically motivated by the need to remedy the severe inefficiency in the sector.

The almost complete lack of interest in price and cost, so necessary for a firm to survive in normal market conditions, was perhaps justified by the years of political and military tension existing after the Second World War. But when "peace dividends" arrived in the 1990s, maintaining military industries with insufficient economic rationality became more and more untenable. This situation could only be solved by a combination of privatization, restructuring and deregulation.

The fall of the Wall of Berlin most likely represented the lowest point in self-esteem within the defense industries. It was thought that the arms race to obtain the most advanced weapons would eventually disappear along with the political and military tension. This argument was instrumental in facing the unavoidable reconversion of the military industry and, in turn, the aeronautical sector.

3.1.3 Organization of the Aeronautical Sector

The application of avionics to flight, understood as the challenge to the Law of Gravity, was initially in the hands of entrepreneurs for whom everything was "home-made". The incipient industry was essentially based on craftsmanship where the inventiveness of creators was accompanied by relative intensity in the use of labor due to the level of knowledge at the time and, particularly, the difficulty of automating production. The automobile industry had initially found itself in the same situation. In fact, although the aeronautical industry now shows a high level of applied knowledge in production processes, it still tends to use the labor factor, usually qualified labor, with relative intensity.

On the other hand, in-house manufacturing in the various productive stages has changed substantially. The Coasian concept of enterprise is fully represented in the aeronautical industry. In the decision to make the various parts in-house or rely on the market to supply them throughout the manufacturing process, it is evident that title firms increasingly depend on the market (external suppliers) for most of their manufactured parts.

Moreover, the aviation industry is an example of collaboration of a broad network of interconnected firms, and particularly of the title firm with suppliers through contracts including all aspects in the building of an aircraft. From screws to motors, sophisticated air conditioning systems, pressurizing and electronic systems or the contribution of new materials - everything is manufactured by contracted suppliers outside the title firm. Of course, there are hierarchies among suppliers depending on the amount of participation in the project. In fact, one of the keys to understanding modern industrial organization in the aeronautical sector is decoding the salient points in relations among firms and analyzing the power hierarchy within the aeronautical complex.

As opposed to the trajectory followed since the 1980s, the role of market in the network of aeronautical industries is evident in two recent tendencies. First, given the volume of resources necessary for the launching of a new plane, many manufacturers of important components and, particularly, suppliers of integrated systems are playing a much more active role in the adventure of building and marketing a plane. Financial participation in the success or failure of the common project (whether desired or not) has led suppliers to share in the financial risk involved in the project. They have begun, in fact, to behave like an active partner who, as such, assumes the results of the business.

Secondly, production in modern aviation is increasingly international. The overflowing of national borders is a fact and the days in which the aeronautical industry was seen as a national endeavor are long past. As

will be seen in the discussion of industrial organization in Airbus, the main components of these aircraft are made in at least four countries before they are finally assembled.

3.1.4 The Aeronautical Industry and Technology

The sector has consistently depended on high level technology which has effectively limited access of firms to aeronautical manufacturing in the world. Though admission to the sector with a final product of renown brand name not only depends on the technological level; technological barriers to admission are decisive in aircraft construction. The industry is densely concentrated in firms from only some ten countries who possess the capability of participating in the sector.

High technology, *a priori*, does not necessarily depend on the market. It can be independent of the market as long as it has political and financial support for both the productive processes and purchase of the product, as has occurred in the countries where aviation was developed. Market concerns were practically absent from the great decisions of the industry during the entire 20th century. An emblematic and extreme case of the absence of market in an industry of very high technological level is that of the former Soviet Union's participation in the industry where the planes built were and still are of great quality and high technical content.

The quest for industrial secrets within the aeronautical sector has been a constant throughout the history of the industry in Europe, the USA and the Soviet Union, above and beyond the economic system of each country. The economic cost involved in building aircraft, of course, is another question, and although all of the manufacturers and countries were notoriously inefficient, an efficiency index can be applied to the various manufacturers and countries.

High technology does not mean that the sector or the leading firms carried out research tasks. The building of aircraft is a matter of known basic and applied science. Therefore the major contribution of the industry involved innovation in the area of design, industrial development and "learning by doing". The industry, then, is central to a society that accepts and creates technical change. Significant innovative applications are generated and adapted during the construction of a new product and its processes, but there was essentially no formal research nor was science created.

Innovation represents the most dynamic profile of the aviation industry where the total innovation is the sum of the specific innovations of all the participating firms. In turn, these firms, must observe the strictest quality requirements in their processes and products if they wish to participate in

manufacturing programs. The quality requirement itself is at the technological frontier.

It was, in fact, the aeronautical industry that served as the example and model for Arrow's seminal study on the importance of "learning by doing" in which he demonstrates that learning involved in the manufacturing process - the "learning curve" - could dramatically increase production in industry. Moreover, investment in productive processes generates technological gains that spillover into the general economic and social fabric.

As usual, the final product will be defined in terms of the level of incorporated technology in its components, which makes the relationship among the various firms participating in the final product of great importance. Therefore, one cannot really refer to the technological level of the title firm, but rather of all the firms participating in the project.

Although the original design and instructions as to requirements and quality depend on the title firm's specifications, the technical participation of the largest suppliers, particularly those of entire subsystems, is increasingly crucial. Most of the development engineering of the major components of a plane, beyond the basic concept and blue prints, emerges from the joint effort of engineers from both the title company and the main suppliers. Project engineers at the main firm often search for solutions to specific problems through collaboration with engineers from the integrated systems suppliers. When these suppliers compete with others to win a contract, a sort of solutions game comes into play whereby the title firm requests the best technological solution, while potential suppliers attempt not to give over all their knowledge for fear of revealing industrial secrets to their competitors. "Inducing solutions" becomes a game of zero sum for suppliers in the short term, but a positive sum for the title firm and for clients in general once the product is developed and marketed.

3.1.5 Product Design, Comparative Advantages and Reliability

Dependence of the majority of aeronautical firms on the State still conditions both the manufacturing process and the creation of knowledge and innovation in the sector. Therefore, despite the influence that the onset of commercial aircraft and final consumers had on aircraft demand, supply still controls market conditions. Today supply, including civil planes, is the inheritor of the state industry of the past and that situation is not unrelated to the creation of knowledge and innovation.

Since the consortium EADS, and therefore Airbus, arose from an agreement among states, with their respective contributions of physical and human assets, the activities of each of the various national headquarters be-

fore aggregation were to determine the capabilities of each one in the final product. The consortium reckoned with the fact that each of the national headquarters would specialize to some extent. Although learning and new specializations could and can appear in each one of the firm's factories, there is no doubt that EADS had to take into account the inertia in the production and technological trajectories of each production unit.

The various national firms coming together to form EADS were both similar and different. One common aspect was the existence of strong state ties and, consequently, a certain remoteness from the market along with advanced technology and quality requirements in their products. The national firms were characterized by various strengths and weaknesses, the technological and competitive advantages of each unit and, of course, their human resources, capital and financing.

When EADS (or Airbus) conceives a new commercial or military plane, helicopter or any other product, the consortium's research center is responsible for designing the basic characteristics of the prototype and, therefore, of the future product which, in this case, will be assumed to be a civil aircraft. It is a matter of obtaining the best possible product with the level of knowledge existing on the frontier. Moreover, the capabilities and specializations of each productive unit in the consortium are known. It is therefore logical to suppose that optimization of the productive process and costs will lead to the assigning of the aircraft's integrated systems to those units with the greatest competitive advantage. Given the ambit and complexity of the various components of a plane, the decision as to what factories will produce what and how much, should be based on criteria of efficiency, that is to say economic efficiency, at a given technological level required for the entire product.

In the aeronautical sector the technological requirement is closely linked to quality and reliability tests of materials and parts obtained with available technology. Quality control of aircraft parts and components has always been the most demanding in the industrial world. Therefore, innovation in the sector is not only determined by the product itself but also the product's reliability, strength and resistance.

We have, then, the origin of embedded knowledge in a product called civil aircraft: an engineered design with incremental innovation and with the most advanced level of pure and embedded knowledge possible so that, once the plane is conceived and tested, it can be built and replicated by assigning the construction of the various parts to those productive units within the consortium with the most competitive advantage for each component. Implicit in this statement is the exacting of maximum uniform technology in the various components and factories and this requires exhaus-

tive quality control for each and every part, from the most sophisticated motor down to the most basic screw.

There is an extremely important factor to take into account when dealing with the aeronautical sector. The entire productive system of the sector is pre-determined by and designed for the title company, Airbus in this case, owner of the final product (the aircraft) and trademark, and therefore, of all the tangible and intangible assets. The various components of the plane may be mainly produced by the title company itself, as occurred for many years, or they may be contracted or subcontracted to other firms as is increasingly taking place at present. In the end, however, all of the components are at the service of the final product, a fact which leads to a relationship of considerable dependency of the supplying sub-contractors on the final client.

The foregoing is simply a concrete example of how an original idea is applied to a specific product at the service of the Airbus consortium. We now look into how this origin of knowledge combines with that of other agents and, in turn, flows to yet others.

3.1.6 Aeronautical Firm and Production Costs

From "In-House" to "Spin Off" and "Outsourcing"

The aeronautical sector, as discussed above, emerged within the European public sector. Its remoteness from the market and from economic efficiency, obviated the high costs of the sector. Unacceptable production costs under the protective wing of the state led to structural adjustment to adapt the productive system to market conditions. In the civil aeronautics, this meant privatization and reconversion.

When an entrepreneurial response to a crisis in production costs and adjustment to the market is required, a double strategy is employed. On the one hand, the firm focuses on improving productivity of its main activity, that activity with which it is identified. On the other hand, the restructured firm should approach the market to obtain factors and products that it formerly produced "in-house". Conceptually, this is Coah's (1939) classic definition of a firm and of the basic criteria for the definition of markets and hierarchies.

The result of restructuring in the sector was the appearance of new firms, most either emerging from former public firms, often constituted *ex novo* by the personnel of expiring public firms (with technological levels similar to those of the former public firm but with much lower production

costs), or as spin offs of former public firms which controlled a majority of the capital but chose to externalize those activities of high technological value not central to the firm's main activity. The resulting spin offs will not be only a lucrative source of profit for the title company as a shareholder but they also had greater access to clients as a "nominally" independent firm. The process brought about the creation of more firms and more market in the aeronautical sector.

3.1.7 From Production Costs to Transaction Costs

The breakdown of the "in-house" productive model, where firms disregarded market conditions to manufacture a greater number of aircraft components within the firm with the consequent high production costs, led to the emergence of a group of subcontracting firms at various levels of the productive process usually depending on specialization and technological capability. The disintegration of the in-house model led the productive fabric (really the market), to assign tasks to the firms according to their capabilities and knowledge.

In addition to change in the productive system, globalization, which began to take place in the 1970s, increased business opportunities and access to more information and, therefore, more enterprises involved.

However, this solution to high production costs had an undesired result, that is, high transaction costs between the title firm (Airbus) and subcontracting firms. High transaction costs are only structural to the sector because of the proliferation of subcontracting firms. Not only is the sector subject to the complexity of normal contractual relations between firms, but also to the complex manufacturing protocol and quality certifications required from all aeronautical parts suppliers and, hence, endemic to the sector.

When manufacturing is mainly done in-house, production costs are higher, but transaction costs are lower since costs involved in certification from one department to another were considered direct manufacturing costs. However, with the increase in outsourcing, transaction costs arose. Coase (1960) provides a theoretical basis for this circumstance in his observations on transaction costs and economic efficiency. Many difficulties arise within the administration of the title firm due to the complexity of managing relations with a large number of firms by means of complicated legal contracts.

To simplify this situation, Airbus management is attempting to reduce the number of subcontracting firms in the production chain of its line of products in order to better manage relations with outside firms and reduce

costs. However, this decrease in the number of subcontractors to Airbus does not mean that outsourcing of production will decrease but rather that less subcontracting firms will take charge of a greater number of tasks and work loads. This will directly influence the number and size of auxiliary firms located in the clusters of each territory. The corollary is that firms within the auxiliary industry must grow, particularly in human resources, financial strength and in innovation.

It is quite possible that increased transaction costs in Airbus, and therefore in EADS-CASA, represents the greatest threat to independent SMEs in the aeronautical fabric, particularly for those firms lacking adequate financial basis and innovation.

3.1.8 Knowledge Flow in the Sector

Once the aircraft is designed and tested in the laboratory, the next challenge is the manufacturing process which makes use of resources existing both inside and outside the title firm.

External resources will depend on the firms operating directly within the sector or that providing complementary products or services in the manufacture of an aircraft. If firms belong to the aeronautical sector and do not produce other products for different markets, their dependence on Airbus (or Boeing, say) will be greater since the alternatives are fewer. This dependence and vulnerability is highly restrictive for the auxiliary firm in the aeronautical sector who has, in fact, only one client and often depends on the title firm for technology and indispensable quality certifications. If, on the other hand, the firm operates in a sector that is *a priori* not aeronautical but whose products are complementary to the sector, its feasibility is greater since it depends less on the title firm and has greater independence as to knowledge and technology.

In this last case, there will be some functional dependence depending on subcontracting firm's location in the supply chain for the final product. But there will be less technological dependence since the level of knowledge of these firms will likely be equivalent to that of its own industrial sector. These firms are leaders in their specialty and participate in certain Airbus models as suppliers of integrated systems and basic aircraft units such as cabin pressurizing, motors, auxiliary motors, avionics, etc. In their specialization, these firms are at the cutting edge of knowledge in the sector.

Airbus is definitely enriched by pure knowledge emanating from its own highly qualified human resources as well as from tacit knowledge accumulated throughout the trajectory of its managers and employees, all of which place the firm at the global technological frontier in the sector. To this, one

must add the external knowledge, also cutting-edge, contributed by a relatively small number of multinational firms operating in the global market who are usually not the final assemblers of the aircraft.

These complementary firms - "equipementiers" or large systems manufacturers - have special relations with the title firm ranging from the predisposition to assume risks in the production of their products to the knowledge strategies they display for the title firm.

In addition to the horizontal knowledge flows described above, Airbus projects flows of vertical knowledge toward firms located at inferior technological levels. There are varying degrees of knowledge in which firms with relatively advanced knowledge levels, for example, large systems manufacturers capable of outsourcing part of their production, can be distinguished from those firms with lower technological and entrepreneurial capability whose possibilities of acting independently of the title firm or systems manufacturers are limited.

These small firms, often family-owned, are the most numerous and the most vulnerable in the system. Normally they work from blue prints submitted to them by the title or large systems firms and show an inferior level of capabilities and hence, innovation. Recently some of these firms have evolved from being mere receivers of blue prints, to participating in the design of parts required by the contracting firms. It is a qualitative change and marks a quality path to be imitated by the rest of the SMEs in the sector.

3.1.9 The Organizational Model and its Consequences

The central headquarters of Airbus in Toulouse is, of course, ultimately responsible for development of the firm composed of all the subheadquarters located in various European countries with different entrepreneurial cultures. This task was not easy and Airbus' major competitor, Boeing, launched adverse predictions, later shown to be mistaken, as to the possibilities for success of the European consortium. The relevant question, then, is how the firm is managed and, of even greater interest, how its entrepreneurial model has evolved.

Hence, the organizational model of Airbus encourages the various production headquarters in the company to introduce and consolidate competition and outsourcing and leads managers of the various headquarters to compete for quotas of the final product according to the offers they have presented. The control variable, measured in work load (hours/year), that Airbus will use as a performance tool in its productive process emerges from this sort of "auction" held among the sub-headquarters. Work load in

hours/year becomes the basic physical and budgetary restriction for each one of the consortium's production units. With this procedure, each one of the sub-headquarters knows *a priori* its potential for production and, in turn, for billing and income.

As for subcontracting, Airbus has adopted a policy of increasing externalization, already described above, of more and more manufactured parts as a measure to cut historically high production costs. This policy of outsourcing or spin off, depending on the case, has generated a new productive structure in the sector based on firm networks in which each firm jockeys for position according to its financial or knowledge capabilities. This is a sort of "Extended Firm" in which local aeronautical firms existing in the territory are at the service of and depend on the sole final producer either technologically or functionally. It will therefore be necessary to analyze the organizational model of each one of the production strata existing within the general conglomerate of externalization of the aeronautical sector in the territory under study.

This organizational model, essentially based on competition among the production units and on subcontracting, is obviously a far cry from the model of the past when firms operated with disregard for the market and maintained a production organization that maximized in-house manufacturing and showed little interest in production costs.

3.2 New Concept of the Product

A Reorganization of Subcontracting

In a global view of international competition (particularly with Boeing) the production cycle of an Airbus or an ATR is within a framework divided into four work areas:

- A European and international division of work between the partners (country-firms) that participate in EADS (France, Germany, England, Spain);
- A national distribution of the work of Airbus France between the different production centres (Toulouse, Nantes, Méaulte, Saint-Nazaire);
- A distribution of the tasks between the different plants within the same production centre. For the centres in Toulouse, for example, among the four locations (Blagnac, Colomiers, Santo-Martin del Touch and Saint-Eloi).

- A division of work between Airbus and the subcontracting network. The large contractors are then the manufacturers or their first hand subcontractors.

Added to this "atomized" industrial organization are difficulties having both to do with the nature of the processes: technologies, applications (advanced technologies, new materials, quality requirements…) as well as with the national, international and institutional difficulties of the sector.

Thus, an important problem arises in productive and cognitive coordination of a complex technical object: to coordinate the conception and realization of subsets and coordinate the integration of the subsets to the final product. In what follows the outstanding features of the relations between firms in the aeronautics sector of Toulouse through the subcontracting relations between the main contractor, Airbus, and its major industrial partners, will be studied.

3.2.1 Cascade Organization of Subcontracting

Rationalization and Hierarchic Organization

Two main facts characterize the evolution of subcontracting in the aeronautics sector in recent years: The reduction in the number of subcontractors and the hierarchic organization of the subcontracting network in 1st, 2nd and 3rd categories or those integrated in modules; as subsystem integrators or equipment goods manufacturers, specialized subcontractors and production subcontractors. Both the reduction in the number of members with direct relations with Airbus, and the hierarchical organization begins in the late 80's[1], in a process of technical and organizational transformations, process known as systemic rationalization.

A Systemic Conception of Production

The step from an integrated conception of product to a modular conception leads to a definition of new functions for subcontracting. The organization

[1] In 1987 the Aerospace Aircraft Division inaugurates its new "industrial view" that stresses the specialization of the production centres and a reorganization of subcontracting. See F. Larré. "Mechanisms and forms of coordination between firms." PhD thesis. University of Toulouse 1. 1994., Allard and Pouget (1992) Industrial change and Management of production. CEJEE. University of Toulouse1.

of subcontracting lies within the logic of decomposing of the aircraft in subsets or technically homogenous sets. Once the sets and subsets are defined, the set of phases of the study, development, industrialization and implementation of an important aircraft component are entrusted to the same firm.

The decomposing of technical objects into individualized subsets leads to a strong densification of the necessary interactions for the recomposing and for the assembly of the aircraft. In fact, a large part of the coordination work was integrated into the SPIDER ("System of Informatics Production of Grouped Elements") as a result of the application to the entire activity of the TGAO (Group Assisted Technology by Computer)[2].

Subcontracting Hierarchy

Based on the systemic rationalization of production just described, the subcontracting network of Airbus has a pyramidal organization with four levels:

- The systémiers or sub-system integrators are firms that participate in the creation of an idea and in the carrying out of a technical subset under its own responsibility. A sub-system integrator can be an industrial firm (Latécoère, Ratero, Rockwell…) or services firm (Thalés, Clairis, Honeywell). During the phase of conceiving and defining the technical profiles, it sends teams of engineers and technicians to Airbus (team work). A sub-system integrator shares the financial risk with the aeronautics constructor financing his R+D and the industrialization costs. The relation with the contractor is an old relation based on the cooperation within the previous programs.
- The equipment goods manufacturers: make available either an "autonomous" technical module or a module that should become a part of a more complicated technical system. Its supply is based on a written set

[2] In principle, this automated informational system is easy. The basic idea is that many problems are similar but that they receive different technical solutions. Thus, grouping problems that are similar we can give them the best single solutions. SPIDER permits rationalize and order the production of parts from different families, from its conception to its manufacture. It organizes the work of the consultant and of production with the help of the concept of Technology of the group, and which thanks to a code number on each part, permits standardization and automatization of the process of drafting, preparation and management of the production by family of parts, independently of the products that have produced them (F.Allard and M. Pouget op cit.).

of precise stipulations or under petition of both the study as well as the realization to the manufacturer.

- Specialized subcontractors: are firms that have specific assets (not easily transferable) in a particular field of endeavour. They are usually mechanical firms or services firms in informatics. They are 2nd level subcontractors.
- The production or capacity subcontractors: are generally smaller firms selected on the basis of its financial offer. They produce production parts or widely standardized generic services that depend on highly competitive markets.

The higher level subcontractors (1st and 2nd) are the contractors of the lower level subcontractors. In most cases, the 2nd and 3rd levels group together SME positioned in relatively low technology activities. They are implicated by more traditional subcontracting contracts.

The association between Airbus and the 1st level subcontractors is important during the general conceiving phase of the aircraft and in research and development for updating the technical solutions adopted. Only during these two phases are the integrated teams called together. Each subcontractor sends from 5 to 10 engineers to Airbus to work on the initial ideas of the aircraft. A work team (made up of integrated teams) established for 6 months, 18 months or 2 years, may need as many as 400 people. It is, however, necessary keep in mind that only 1st level subcontractors participate in this collaboration. The risks for this work in common are shared equally by all of the partners.

3.2.3 Subcontracting Relations

Between Competition and Cooperation

The complexity of the process and the security requirements make it necessary for the firms include competences that are real specific investments that are not economically profitable unless they are made with the idea of a long-term investment, which thus defines them as characteristic of a true association. On the other hand, the size of these investments permit the firms introduce themselves in an international forum of competition.

Airbus's Selection of Subcontractors: A Growing Demand

All contractors agree that the pressure on costs is a constant fact in the negotiation with Airbus. The programme "Route 06" is the clearest example.

It is an extensive programme of rationalization of the manufacturer's activity that, among other things, foresees a 15% cost reduction for 2006. Naturally, this reduction in costs is reflected on the whole set of firms of the subcontracting network. Though important, the financial offer is not crucial in the final choice of contractor. Various firms have been selected despite offering a worse financial offer than its competitors. In fact, the main selection criteria of the suppliers are a set of technical and organizational competences, relations of trust, financial conditions and risk analysis.

Financial risk management becomes a factor in the elimination of the small subcontractors. In fact, the fall in the subcontracting with exclusive capacity and the rise of ever more global subcontracting, increases the duration of the production cycle of the subcontractor and thus, increases his need for operation funds. Industrial evolutions thus increase the demands for financial capacity on behalf of the subcontractors. Thus, all of the firms interviewed[3] of sub-system integrator type or manufacturers of equipment are 100 % industrial groups or affiliates of international groups. Among them we find:

- A French Group, Latécoère.
- Three subsidiaries 100% from the French groups Clairis (Sogeclair), Thales Avionics (Thalès) and Labinal (Snecma). Four subsidiaries 100% from the American groups Ratero Figeac (UTC Hamilton), Honeywell Aerospace (Honeywell), Goodrich Aerospace (Goodrich), Rockwell-Collins France (Rockwell); and a subsidiary 100% from the Swiss group Liebherr Aerospace Toulouse (Liebherr).

With respect to the volume of sales made, they are important size firms, as we can see in the table 3.1.

Further ahead we will see that these two criteria (size and the statute of either the group or a subsidiary of a group) are two basic elements in the relation with Airbus.

Another characteristic of the firms surveyed is that they have strong specific assets in the aeronautics sector. They all sell an important or very important part of their production in civilian or military aeronautics.

[3] In the questionaire Q2, besides Airbus, ten important associates were also seen.

Table 3.1. Sales volume in 2003 (In millions of €)

Firms	Sales
LATECOERE	196
RATIER-FIGEAC	130
THALES	1 000
ROCKWELL-COLLINS FRANCE	105
LIEBHERR AEROSPACE	145
GOODRICH FRANCE	60
SOGECLAIR-CLAIRIS	16
LABINAL	176

Source: Data from Q2 Survey

Table 3.2. Breakdown of business volume in the aerospace sector (in %)

Firms	Civil Aerospace	Military Aerospace	Others
LATECOERE	97	3	0
RATIER-FIGEAC	70	23	7
THALES	70	30	0
ROCKWELL-COLLINS FRANCE	40	40	20
LIEBHERR AEROSPACE	88	12	0
GOODRICH FRANCE	100	0	0
SOGECLAIR-CLAIRIS	65	15	20
LABINAL	68	15	17

Source: Data from Q2 Survey

The presence of these firms in Toulouse is the result of one of the two following paths:

1. A long historical path, begun at the beginning of the last century by the French groups or French subsidiaries of international groups. This historical presence imbedded in the productive fabric of Toulouse is the result of development also largely based on internal growth. Thus, Latécoère was created in 1917, Ratier-Figeac in 1904, Labinal in 1920 and Thalès is the result of an industrial adventure that begun in 1893 with the French company Houston-Thomson (Thomson CSF in 1919). A relatively recent implantation is the group Sogeclair-Clairis, whose creation goes back to 1972.
2. The implantation is the result of successive external growth begun during the 70's or at the beginning of the 80's (Honeywell). The most typical case is Liebherr Aerospace:

- 1945: Creation of the SEMCA;
- 1971: Merger of SEMCA with ABG;
- 1984: Liebherr takes a 40% of the capital shares of ABG SECMA;
- 1989: With a 66% of capital Liebherr becomes major shareholder;
- 1995: Control of 100% and change of denomination (Liebherr Aerospace).

Systémiers (Sub-System Integrator) and Equipment Goods Manufacturers: Global Actors

All of the firms interviewed are in touch with other important protagonists in aeronautics, be they manufacturers, equipment goods manufacturers, systémiers or motor manufacturers.

Table 3.3. Matrix of relations between firms between 2003 & 2004

	AIRBUS	EMBRAER	DASSAULT	SNECMA	EUROCOPTER	GODRICH	HUREL	BOMBARDIER	BOEING
LATECOEE	X	X	X	X				X	X
RATIER	X			X	X	X	X		X
THALES	X	X			X			X	X
HONEYWELL	X		X	X	X				X
ROCKWELL	X	X	X		X				X
LIEBHERR	X	X	X					X	X
GOODRICH	X								X
CLAIRIS	X							X	
LABINAL	X		X		X				

The many ties between aeronautical constructors, manufacturers of equipment goods and international systémiers shows us the degree of internationalization of the sector. It draws the boundaries of a worldwide industrial sector grouped around a small number of manufacturers, but also a small number of first rate suppliers: all of the subcontractors interviewed, major partners in the relation, also work for Boeing, Embraer or Bombadier. The systémiers or the equipment goods manufacturers often find themselves in situations of bilateral oligopolies with the manufacturers (moulds, motors, boarding systems…).

Type of Work Accomplished: A Great Diversity

The work trusted to subcontractors refers to the totality of the elements that enter in the conception and realization of an aircraft. It may be a complete module (fuselage, doors, moulds, motors, landing gear, control systems), equipment goods for the construction of a module (cabin equipment, air conditioning systems…) or somewhat standardized equipment goods (video systems, mobiles, avionics…). Globally, the work entrusted to subcontractors represents, on average, a 30% of the total aircraft.

In the case of the engine manufacturers it is different given that the burden of the distributed subcontract depends on the kind of motorization and on the programme. The A330-340 is 100% American when the aircraft is equipped with Pratt and Whitney motors, or 90% when the engines are General Electric or also 100% British when we speak of the A340-600 equipped with Rolls-Royce. In the case of CFM motorization, the costs are distributed evenly among Snecma and General Electric. The International Aero Motors consortium (IAE) that equips 30% of the A318-19-20 and 21, distributes the costs between its members: Pratt and Whitney (30%), Rolls Royce (30%), MTU Aero Engines (20%), Fiat (10%) and Japanese Aero Engines Corp (10%).

Table 3.4. Type of work done in 2003 – 2004

FIRMS	WORK CARRIED OUT IN 2003 & 2004
Ratier Figeac	Cockpit equipment, Triggers, round screws
Thalès Avionics	Calculators and automatic pilot & visualization systems
Honeywell	Avionics (calculators, screens) & APU (auxiliary groups of potencial)
Latécoère	Fuselage parts, passenger doors, electric closets, video systems
Liebherr	Air conditioning systems
Goodrich	Reactor wherry, cable systems, landing gear
Rockwell-Collins	Computer programmes for routes, Data transmission programmes
Clairis	New ideas, Electronic engineering
Labinal	Electrical harness, ideas and manufacture, avionic furniture, electrical centre

Source: Data from Survey

The statute of systémier or of manufacturer of equipment goods is not acquired for ever. It varies according to the programmes and the selection run by Airbus in face of the context. Specifically one can be systémier on the A330-340 programme and manufacturer of equipment goods on the A380 and the other way around. In the same way, and for a similar mod-

ule, one can be a manufacturer of equipment goods for Bombardier and systémier for Airbus or Embraer.

In fact, Airbus spreads the principles of rationalization and organization that prevail internally to its subcontracting network. Three basic dimensions describe this network:

- A **technical-cognitive dimension**. The technical layout of the network of subcontractors introduces new types of relations based on the globalization of the tasks to be subcontracted, but also in the nature of the knowledge required. The systemic rationalization undertaken in the late 80's and based on the logic of the decomposition of the aircraft in subsets permitted define an architecture of the subcontracting network based on blocks of knowledge and technical knowledge. Keeping the specificity of the technological processes applied to aeronautics in mind, and the growing importance of information and knowledge in the idea and realization of complex products, the organization of subcontracting points out the path from a technical division of labour to a cognitive division of labour.
- A **hierarchical dimension** that seeks the double objective of reducing the number of direct subcontractors and the creation of a webbed network built around a 4 level hierarchy. This hierarchy is based on the amount of control of the technological competences, in the manner of the Japanese model, where "as you descend the hierarchy of the subcontracting group, the technological competences of the lower rank subcontractors are less and less specialized." The fact that their production can be easily substituted by those of the competitors gives them very little power for negotiation for participating in the "quasi-rent" (Aoki). The power to negotiate and to have clear objectives in these groups is due to the critical and decisive character of its resources and to the amplitude of its cooperation relations.
- A **territorial proximity** dimension with most subcontractors near and/or around the contractors' production centres. This proximity is often necessary, even by the fact of the relation itself. The division of technical objects in individual subsets induces a strong densification of the necessary interactions for recomposing and assembly of the aircraft.

The presence of the large systémiers, old partners of Aeroespacial and of Airbus later on, is a strong instrument for controlling the sector and a link for the diffusion of the "Airbus culture" towards the smaller firms. This diffusion can take the form of a seminar organization in the framework of meetings between firms within each local productive system.

3.3 EADS: Its Increasing Importance in the World

3.3.1 Structure in the Global Aeronautical Market

At the international level, the aeronautical sector is organized into poles of technical competence around the main actors and is very dense in that aeronautical activity is structured around only four main industrial actors[4]:

- Commercial or business aircraft and helicopter manufacturers;
- Systems manufacturers that supply entire technical systems and share industrial and financial risk;
- Large equipment manufacturers (équipementiers);
- Other subcontractors that supply specific or generic parts.

The three main actors of the sector on a global scale form oligopolies or duopolies. In civil aviation of more than 100 seats, Airbus and Boeing are a duopoly as also occurs in the market of regionalflights (Embraer/Bombardier) and regional turbo-propelled planes (ATR/Bombardier).

Table 3.5. Market structure

Segments	Market	Main actors
Jets	Duopoly	Airbus,/Boeing
Regional airplanes	Duopoly	Embraer/Bombardier
Regional Turbo jet planes	Duopoly	ATR/Bombardier
Business aircraft	Oligopoly	Dassault/Bombardier/Gulfstream
Helicopters	Oligopoly	Eurocoptère, Sikorsky, AugustaWestland, Bell
Systems manufacturers	Oligopoly (Depending on the system)	Goodrich, Hamilton, Liebher, Zodiac, Snecma, Latécoère, BAE Systems, Smiths group, Finnemeccanica, Honeywell

Sources: Authors.

These market structures do not seem likely to change in the near future. Although there is a Russian manufacturer, the present dominance of Airbus and Boeing in the segment of jets is likely to continue. This duopoly runs some risk, however, in aircraft of more than 100 seats from projects by Bombardier (190/195) and Embraer (C-Series).

In the regional aircraft market, attempts to concentrate the industry and reorient the basic trades led to the progressive withdrawal of other manufacturers: BAE Systems, Saab, Fokker et Dornier. Competition from new

[4] If not otherwise indicated, the following data is taken from "The Civil Aerospace Sector in the World", Les Echos Études (2004).

aircraft manufacturers such as the RRJ (Sukhoï, Russia) and the ARJ21 (AVIC 1, China) does not seem likely to modify this situation over the next few years.

The structure of systems suppliers and motor manufacturers is very concentrated in an oligopoly. Concentration and specialization affects an entire group of competencies; hydraulic systems, aviation and embedded electronics, cable installations, aerial structures, landing systems, interior installations, etc. Influenced by market globalization and steadily rising production costs, concentration of firms within segments will continue, particularly through regroupings to supply new markets in Asia and Latin America. The sharing of industrial and financial risks in increasingly exacting programs lead the various actors to look for strong partners or those associated with large groups that provide the necessary financial and technical resources. The distribution of production volume seems to have become one of the bases in agreements to concentrate or cooperate. An example is the Dassault Manera 7X produced by 27 partners from seven different countries. Due to the participation of Asian industries, it is estimated that 50% of Boeing's 7E7 was produced internationally. Similarly, the Chinese regional airplane ARJ-21 was produced in association with 11 international firms. For European actors, the decreasing effects of fluctuations in the dollar has been a significant factor in the search for partners in the dollar zone.

Whether due to strategic reasons and/or current cooperative relations, the situation in the motors segment also appears to be long term. Thus GE and SNECMA cannot cooperate more than they actually do because of very likely opposition from French authorities. The fusion between Sagem and SNECMA is more of a reinforcement of the two participants at the national level. However cooperation between Rolls-Royce and Pratt & Whitney could increase, particularly in the supply of motors for the Airbus series.

In the final stages of the activity, maintenance and repair firms (MRO for Maintenance, Repair and Overhaul) are important players in post-sales operations. This sector should register an increase of about 2.5% over the next 10 years which represents a global growth of 32%[5]. Business volume could reach $49.1 billion in 2014 as opposed to $34.2 billion in 2003. The most optimistic prediction from ÍDEM Aéro foresees business activity for $60 billion in 2013. This growth will take place in all maintenance segments although general maintenance and motors will see a more significant progression. Maintenance activities vary depending on the labor factor. As to market share, motor and structures maintenance represent about

[5] Air et Cosmos, 1 Oct 2004.

30% each while maintenance of other aircraft equipment, 18%, and routine maintenance, 22%. Participants in these markets are either independent firms, affiliates of large groups or specialized firms within the large airlines.

In sum, firms are very concentrated industrially and so is aeronautical activity within global economic geography. At present Airbus and Boeing in Europe and the United States respectively are the two main actors of the global aeronautical market, in particular, the civil market. In terms of sales volume, the European aeronautical industry - without distinction of activity segments - has become first in the global market in recent years.

Table 3.6. Sales volume of the top four countries in civil aeronautics (Billions of €)

	1999	2000	2001	2002	2003
U.S. Industry	61.3	63.4	70.0	52.4	36.5
Variation (%)	-	*3*	*10*	*-25*	*-30*
European Industry	46.7	51.9	56.5	51.2	47.6
Variation (%)	-	*11*	*9*	*-9*	*-7*
Canadian Industry	8.3	10.9	14.3	12.9	12.5
Variation (%)	-	*31*	*32*	*-10*	*-3*
Japanese Industry	7.2	7.1	7.7	6.5	5
Variation (%)	-	*-1*	*8*	*-15*	*-23*

Sources: AECMA and ASD.

The dynamism of the Canadian aeronautical industry due to the results of Bombardier in business aircraft and regional transportation deserves mention here. The number of planes supplied by the Canadian manufacturer increased steadily over the entire period with an average percentage of 25%, that is, 214 deliveries in 2003 as opposed to 87 for its main competitor Embraer. Japanese firms, however, are strongly linked to the American aeronautical industry and thus suffer from the repercussions of Boeing's first regression in the aeronautical market in 2001.

In fact, the market for jets decreased about 36% between 1999 and 2003 mainly due to reduced deliveries of about -55% in Boeing over the period. The difficulties in Boeing are essentially due to less demand, a stronger second-hand market and Boeing's policy of non-renovation of series initiated in the 1990s with the elimination of the B737 Classic in 1999, the MD90 and MD91 in 2000 and 2001. Moreover, the Seattle firm has abandoned its new generation B747 project and its Sonic Cruiser program and is concentrating all its efforts on the launching of the 7E7, a long-distance plane with 200 to 250 seats which is expected to be profitable. On the other hand, deliveries of the new models (B767 and B777) were not as efficient as hoped. The group still depends on military contracts to compen-

sate poor results in its civil activity. 2004 and 2005 appear to show more favorable results, particularly due to a perceptible recuperation of growth in the US and continued growth in Asia.

Improvement in the American and Asian markets benefited Airbus more than it did Boeing. With no need to renovate its series, Airbus continued with its strategy of conquering international markets through good behavior in the area of delivery and orders of most of its models and the successful extension of its A330-340 series with the A340-500 and 600 models. The latest creation of Airbus, the A380, closes the series in close competition with Boeing in all market segments.

Although Boeing clearly dominates the market with 15,554 planes in service in the world as opposed to Airbus' 3,320, the competitive positions of the two world leaders have been inverted in recent years. Airbus is progressively gaining positions on its competitor by investing in complete aircraft series. In 1989, the European manufacturer had only 15% of market share measured by deliveries, but by the end of the first semester of 2004, it had already made 185 deliveries as opposed to Boeing's 171. The year 2003 marks the turning point when the position of market leader seems to have been taken over by Airbus, at least for the next few years. The European aeronautical builder foresees delivery of a total of 400 planes in 2006 as opposed to Boeing's 350.

Table 3.7. Sales volume of the principle world builders (Billions of $)

Builder	Country	Type	VN 2002	VN2003	Variation
Boeing	United States	Commercial planes of more than 100 seats	24 095	22 408	- 7
Airbus	Europe	Commercial planes of more than 100 seats	22 138	21 695	-2
Bombardier	Canada	Regional airplanes	7 194	8 071	12
Gulfstream	United States	Business planes	3 273	2 946	-10
Cessna	United States	Business planes	3 193	2 299	-28
Embrear	Brazil	Regional planes	2 526	2 143	-28
Raytheon	United States	Business	2 047	2 088	2

Sources: Flight International

With these forecasts of demand for 17,300 planes of all types for some 1,900 billion dollars[6] over the next 20 years, Airbus should consolidate and reinforce its position. It is estimated that the demand for new passenger

[6] Global Market Forecast Study by Airbus.

aircraft of more than 100 seats will be 16,600, which represents an average of 830 yearly deliveries over 20 years, the result of tripling passenger traffic over this period, (an average annual growth of 5.3%) and of the substitution of 9,200 gas-guzzling planes by 2023. Essentially, this tendency originates in Europe (32%), the Asian-Pacific region (31%) and North America (26%).

3.3.2 The Creation of EADS in 2000

It is in this context that EADS is created as a result of a process of consolidation of the French, Spanish and German aerospace industries. The European firm is the product of multiple European cooperations, at first bilateral in the 1950s and 60s, but multilateral after the 1970s with the Airbus program. In this way joint companies are created for each type of program: Airbus for planes with more than 100 seats, ATR for regional aviation, Eurocopter for helicopters, Euromissiles for missiles and Ariane Espace for space launchers. Each large firm in the European sector is involved in a variety of cooperation agreements that bring together other industrial firms, competitors in other projects, for specific tasks. European states preferred this complicated system of competition and cooperation which intensified in the 1980s and 1990s when governments perceived that, with this strategy, industrialists could share risks and increase production, particularly military production, despite increasing budgetary difficulties. These many cases of European cooperation and the resulting specialization of production centers paved the way to integration of the European aeronautical industry.

The French firm Lagadère, the German firm DaimlerChrysler, both linked by an agreement until 2006, and the French state are the main stockholders in the new entity (see Fig. 3.2.). The presence of the latter is due to the fact that Aerospatiale was a public firm until its privatization as a result of the fusion with Matra Hautes Technologies which, in turn, integrated into EADS in 2000. Thus a public actor could still participate in the strategic definition of the European group. On the other hand, the French government has also kept control of the EADS units responsible for the building of ballistic missiles which constitutes the main French nuclear dissuasion force. Similarly, the creation of EADS was conditioned by an agreement among the heads of government of France, Germany and Spain that the presidency of the group would be bicephalous, directed simultaneously by French and German CEOs.

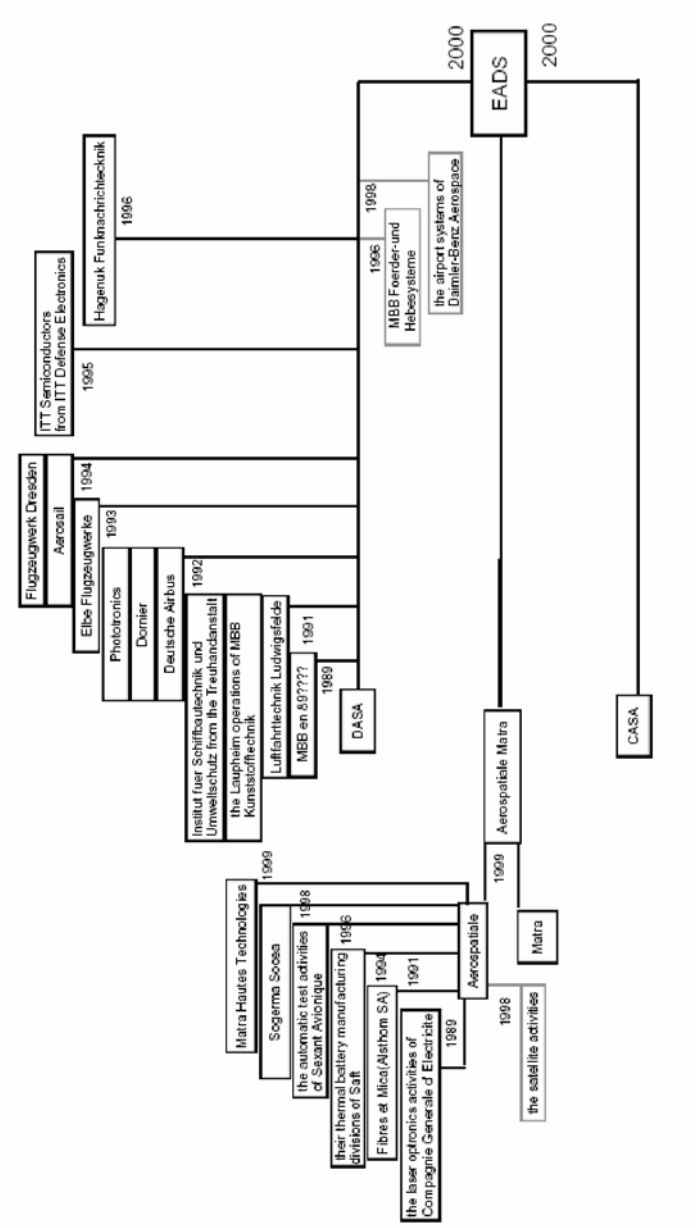

Fig. 3.1. Process of consolidation of EADS (before the DASA-CASA-Aerospatiale fusion)

Source: S. Cancel, Information Center, GRES-LEREPS, 31 December 2002

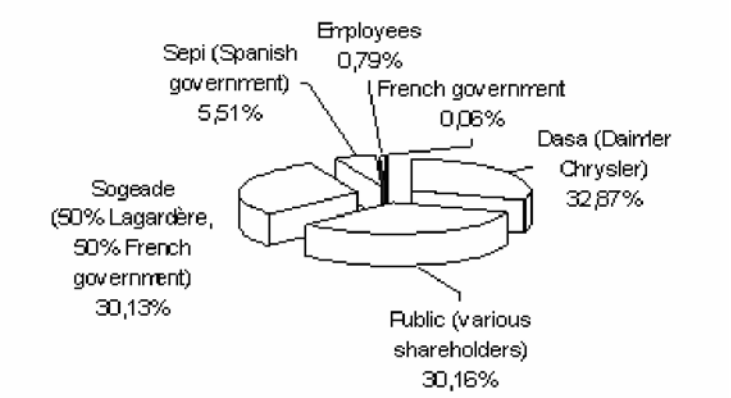

Fig. 3.2. Shareholders in EADS in 2004

Source. Reference document EADS, 2004

3.3.3 The Group and its Five Divisions

EADS was created in July, 2000 and accumulated activities formerly carried out by the following companies:

- *Aerospatiale Matra*: commercial aeronautical manufacturing (Airbus, Socata), military and commercial helicopters (Eurocopter), maintenance and modification of planes (Sogerma), space systems (Arianespace, Astrium), missiles and telecommunications;
- *DASA*: commercial aeronautical manufacturing (Airbus), military and commercial helicopters (Eurocopter), military aircraft (Eurofighter), maintenance and modification of military and commercial planes, space systems (Arianespace, Astrium), missiles and missile systems, telecommuncations and defense systems;
- *CASA*: commercial aeronautical manufacturing (Airbus), military planes (Eurofighter), military transport planes, maintenance and modification of military and commercial aircraft, space systems (Arianespace).

The group is organized into five divisions as shown in the following organigram (see figure 3.3.). Without intervening directly in aeronautical, defense and space activities, EADS N.V. coordinates all of them by defining and controlling objectives and approving the important decisions of EADS. The social headquarters offers services to all the group. The Divisions are in charge of establishing client needs and defining solutions.

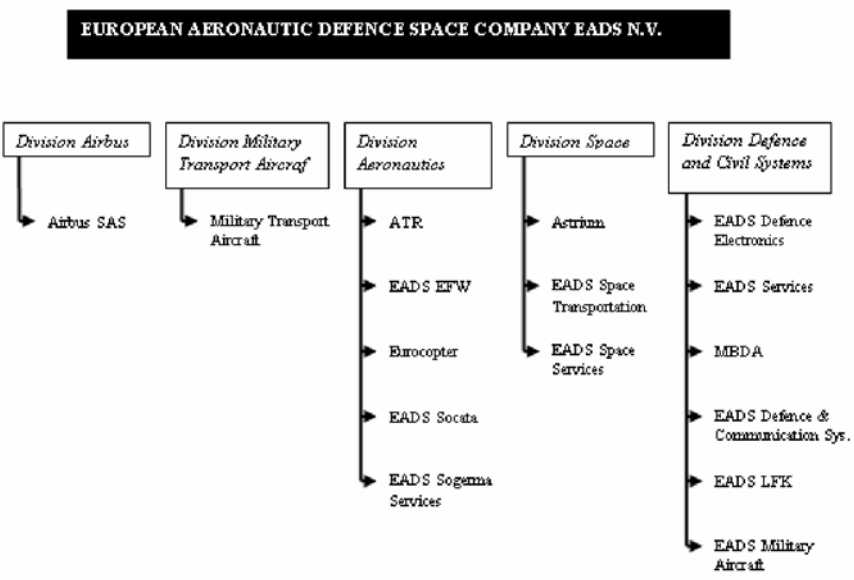

Fig. 3.3. Simplified Organigram of EADS in 2003

Source: authors from EADS reference documents, 2004

- The *Airbus Division*: In June 2000, the GIE Airbus format is abandoned in favor of an integrated structure in which all design, engineering and manufacturing installations at Airbus Industry are integrated into a group led by a legal firm called Airbus SAS (80% EADS, 20% BAE), which is also responsible for marketing activities and customer service.
- The *Military Transport Aircraft Division* produces and markets military aircraft built from existing transport plane platforms used for specific military tasks (maritime vigilance, in-flight refueling, etc.). This market is made up of three segments: light military transport (C212), medium military transport (CN-235 and C-295) and heavy military transport (A400M). The development of the A400M program brought about the creation of Airbus Military, a Spanish firm dedicated to the development, construction and marketing of the A400M which includes the firms of participating countries. Airbus SAS owns 69.44% of the capital and EADS CASA is a significant participant at 20.56%. Airbus Military delegates to Airbus the control and design of the A400M. This Division is also active in the segment of aerostructures, supplying systems equipment to builders world-wide.
- The *Aeronautics Division* brings together civil and military activities including helicopters (Eurocopter), regional aviation (ATR), light avia-

tion (Socata) and aircraft reconversion and maintenance (EFW and EADS SOGERMA Services).

- The *Space Division* designs, develops and builds satellites and provides orbital infrastructure for launchers and space-related services. It includes three main companies: Astrium, EADS Space Transportation (formerly called EADS Launch Vehicles) and EADS Space Services. The Division also renders launching services through companies in which it participates: Arianespace, Starsem and Eurockot. The Space Division has had to confront the market crisis in telecommunications satellites with negative financial results which has led European actors to come together to reduce jobs and restructure around its three main entities: Astrium (with 100%), EADS-ST and EADS Space Services.
- The *Defense and Civil Systems Division* intervenes in the sector of integrated systems, missile systems, combat airplanes, defense electronics, military communications and services.

EADS in all had 110,700 employees in 2004 distributed in more than 80 production centers, mainly in Germany, Spain, France and Great Britain. Ninety-seven per cent of personnel is European even though about half of business is carried out in Europe and a third in the United States. Asia, particularly China and India, represent excellent growth opportunities for the group which expects to do 30% of its business there in 2015.

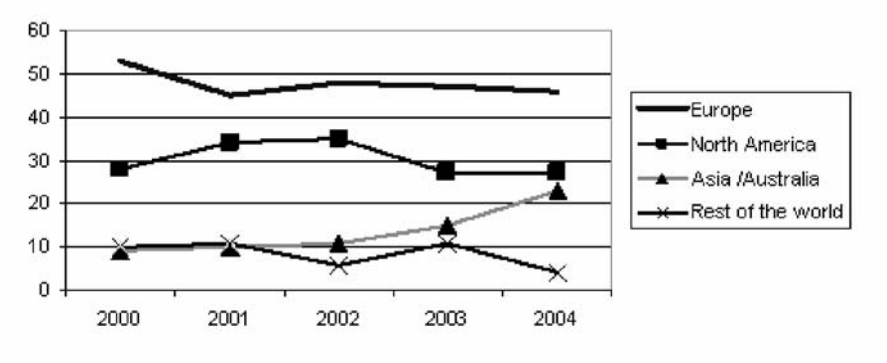

Fig. 3.4. Geographic distribution of EADS business volume in % from 2000 to 2004

Sources: EADS 2000-2004 reference documents

3.3.4 EADS' Dependence on an Airbus Division

It was logical that EADS would be structured around the ex GIE Airbus for various reasons. GIE was the most advanced model of industrial and commercial cooperation in Europe. Aerospatiale, DASA and CASA have learned to work together over 30 years within the Airbus programs although integration was not easy. Moreover, the success of the fusion was helped along by the fact that the Spanish, German and French states contributed civil assets (more easily transferred than military assets) to the European company. The French government maintained strict control when some of the more sensitive defense activities, such as those of nuclear dissuasion (see the case of the M51 missile made by EADS ST in the center of Bordeaux), were integrated.

In fact, by whatever angle analyzed, Airbus programs are predominant in the EADS group. In 2004, 48% of personnel belonged to the Airbus Division (see Fig. 3.5.) which also made 60% of total business, received 57% of all orders and is the main source of profit (see Figs. 3.6 and 3.7).

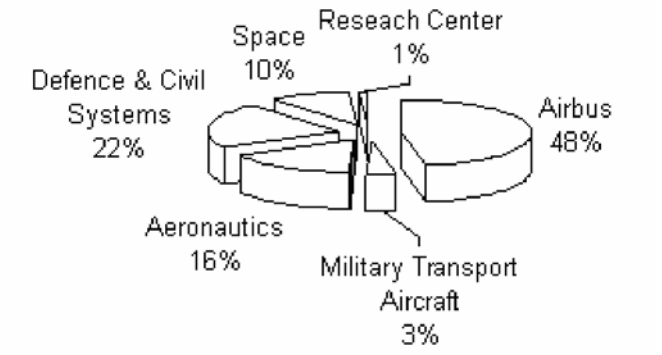

Fig. 3.5. Distribution of EADS employees by Division in 2004

Source: EADS reference document 2004

Airbus' increased business and profits between 2000 and 2001 resulted from the consolidation of the company after its creation. Moreover, business in Astrium was consolidated 100% in 2003 and 75% in 2002 and 2001. 1.612 billion euros were invested in R&D in 2004 (TBM Aero 10/03) which represented 5% of sales.

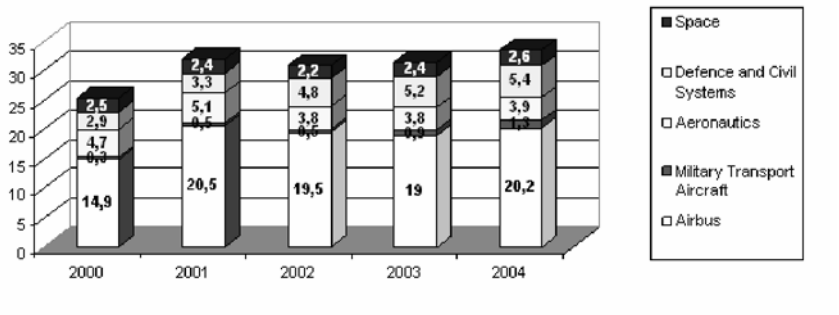

Fig. 3.6. Evolution of business volume by Divisions in billions of € from 2000 to 2004

Source: EADS reference documents 2000-2004

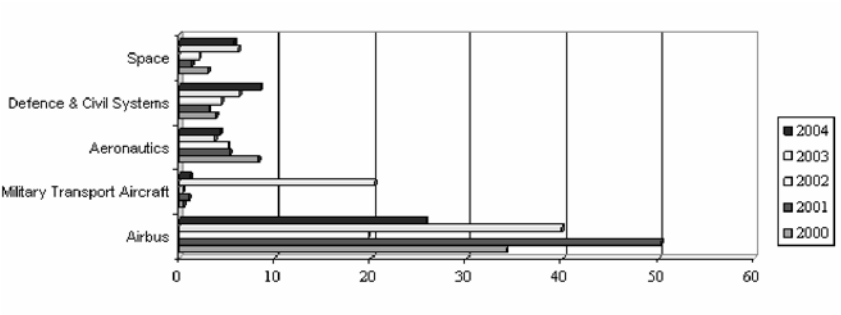

Fig. 3.7. EADS orders in billions of € from 2000 to 2004

Sources: EADS reference documents 2000-2004

The group's dependence on civil aircraft construction is even more conspicuous if orders are analyzed since they indicate EADS' future activity. With the launching of the A400M program in 2003 and rapid growth in the Military Aircraft Division, dependence on the civil sector was reduced considerably and a development strategy in defense activities was revealed. However, this tendency in the Military Division has not yet improved group profits which are still based on commercial success in the various Airbus programs (except the A380 program currently under development). (See fig. 3.8)

This predominance of Airbus activities along with those of ATR (regional aviation), EADS Socata (light aviation), EADS Sogerma (maintenance and services) and a part of Astrium and EADS ST, defines EADS as a civil aviation oriented firm.

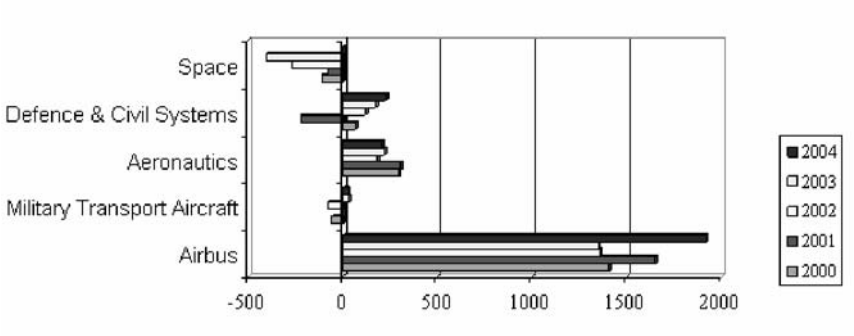

Fig. 3.8. EBIT (profits before interest and taxes) by Divisions in millions of € from 2000 to 2004

Sources: EADS reference documents 2000-2004

EADS expects to increase defense activities to 30% of total business by 2010 and reach sales of 10b euros in 2006, due to the Eurofighter, the NH90 and Tigre helicopters, the military transport plane A400M, the future in-flight refueling plane, the Aster and Meteor missiles as well as safe telecommunications networks. This rebalancing in favor of defense activities should reduce the consequences of cyclical activity in the commercial aviation market due to government orders.

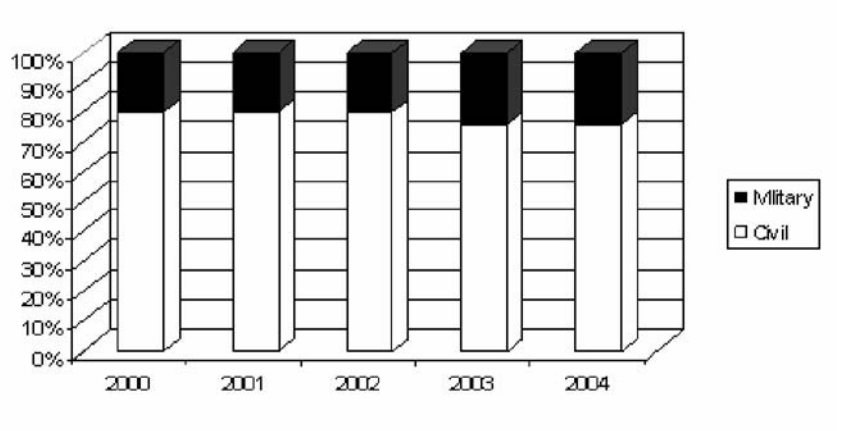

Fig. 3.9. Distribution of business volume between EADS civil and military activities from 2000 to 2004

Sources: EADS reference documents 2000-2004

3.3.5 Guaranteeing Coherence Among the Groups

The Joint Research Center

R&D programs in EADS are currently being integrated. These activities are based on three principles: 1) to grant each Division the responsibility of developing its products in order to closely monitor client customer needs while simultaneously allowing extensive autonomy in research program design; 2) to coordinate investigation within the group through a network of research and technology (the "R&T network") facilitating the flow of information and research results and, finally, 3) to promote the sharing of knowledge, competition and research resources through the creation of a joint research center (the CCR) distributed among three production centers in Suresnes, Ottobrunn and Getafe. The goal is to encourage the various entities of EADS to participate in CCR programs. For this reason the "R&T Network" was designed to cover about twenty technological fields of knowledge. In each field, groups of experts from the personnel of interested entities are constituted to assure transversal coordination will take place. This promotes the development of synergies, reduces costs while simultaneously improving internal and external exchanges.

One of the aims of this organization is to encourage cross fertilizations among units recently integrated into EADS as demonstrated by the example of fiber placement technology developed by EADS CASA for space applications and applied to the construction of the A380 rear cone. In 2003, 120 research and technology programs led to the start-up of various "business units" and one of the two research centers (CCR based in Suresnes and Ottobrun, each with 300 employees). Moreover two "proximity" centers were established for Airbus in Toulouse and Hamburg. Preliminary research is carried out jointly which counteracts the large amount of autonomy of the activities.

This partial integration of research activities (centripetal force) is compensated by the openness of EADS to its local environment (centrifugal force).

3.3.6 Airbus SAS: A Group Open to Cooperation and Alliances

As noted above, the industrial actors of European aeronautics resort to various forms of cooperation and alliances. Thus a significant part of EADS' sales volume comes from consortiums, joint ventures and shareholding. For each program (Airbus for aircraft of more than 100 seats, ATR for re-

gional aviation, Eurocopter for helicopters, MBDA and LFK for missiles, Ariane Espace for space launchers in the case of EADS) the participants constitute a firm according to various legal formulas. Similarly, EADS and Thalès establish various alliances particularly in the military sector (see figure 3.10). An alliance with Northrop Grumman is foreseen allowing entry into the American market.

It is clear that cooperation between EADS and BAE Systems formalized by Airbus SAS is the most important of those mentioned as shown by the predominance of the Airbus Division in the European group (see below figure 3.11). At the beginning of 2001, GIE Airbus becomes a corporation (Simplified Shares Company or SAS), according to French law. All industrial and human assets were transferred to the new SAS and the manufacturing plants in Toulouse, Nantes, Saint-Nazaire, Hamburg, Bremen and Chester became the direct property of Airbus. EADS holds 80% through its Airbus Division.

Airbus SAS maintains a total of 16 development and production centers in Europe grouped in four affiliates (subsidiaries): Airbus France, Airbus Deutschland, Airbus España and Airbus UK.

The Role of Airbus

Task organization and development methods of the various programs were rationalized as projects advanced. Thus, management has evolved from an atomized decision-making structure to increasingly centralized decision making on technical definitions. The creation of the integrated company Airbus SAS, is the logical result of this process.

Activities attributed to Airbus SAS are defined in the statutes: research, conception, design, development, engineering, supply, manufacturing, assembly, ground and in-flight testing, certification, adaptation to customer specification, sales, marketing, financing, rental or leasing, post-sales services, parts supply and other auxiliary services for civil airplanes.

Formerly, the partners sold production to GIE which did not have access to the real cost of these products. However, since integration, one level of profit taking has been suppressed. Supply management controls the quality of suppliers and purchasing and will have the right to inspection of supplies coming from Airbus plants. From now on, Airbus assumes all the classical attributes of a firm, from conception of the product to marketing.

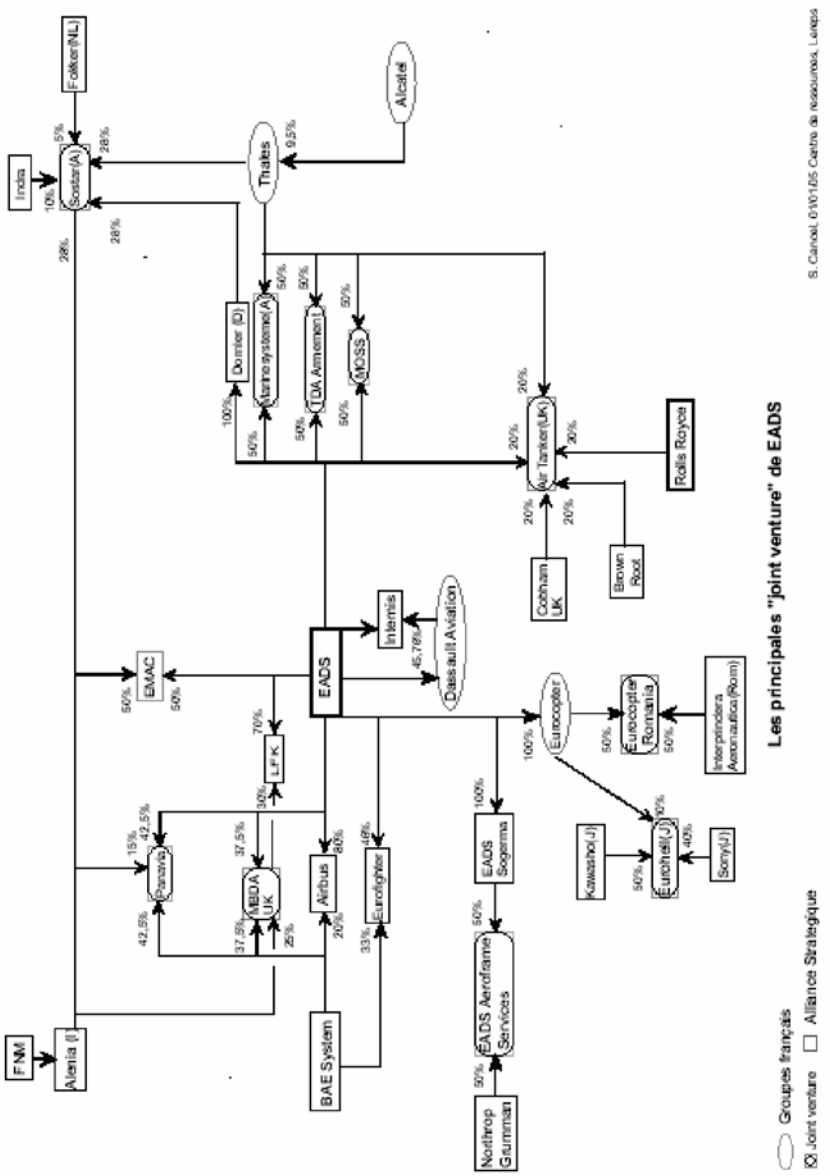

Fig. 3.10. The principle joint ventures of EADS from 2000 to 2004

Sources: S. Cancel, Centre de ressources, Lereps, Jan 2005

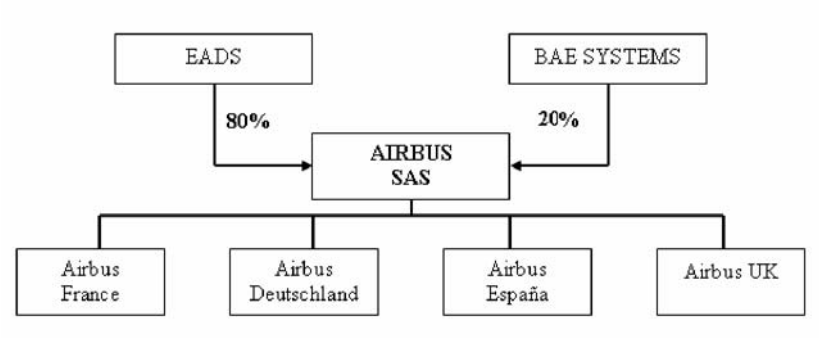

Fig. 3.11. Airbus SAS simplified organigram in 2004

Source: Authors from Airbus SAS website

Fig. 3.12. Main Airbus SAS production centers

Source: www.airbus.com

Increasing Specialization of Production Centers

The principle of specialization is not inherent to the creation of EADS. Initiated by the former GIE Airbus, specialization increased in the 1980s influenced by the French model. By 1988 each firm in the Aerospatiale group had been assigned a homogeneous part of the elements assigned to the French aeronautical manufacturer by GIE. Specialization of the centers is developed at two levels, organizational and technical: specialization by sub-systems (elements in the pilot cabin, doors, reactor anchorage, central

cabin, etc.) based on technical product uniformity and sectorial specialization according to their competencies (chemical manufacturing, large boilers, electricity, formatting, etc.) (Kechidi, 1996). This double specialization avoids duplication of industrial resources, rationalizes machine efficiency and specific competencies (ladder effect) and decreases displacements from one factory to another.

Specialization in the production centers has become even more eminent (Jalabert and AL, 2002). Integrated Airbus teams are assigned to oversee entire systems (airplane structure, section, control mechanisms on board, reactor anchorage, nose, etc.), when formerly, various teams around Europe could be in charge of these areas. That was the case of airplane structure in which responsibility was simultaneously assigned to BAE Systems for wings, DASA for spoilers, ailerons and blinds and Aerospatiale for wing systems. At present, BAE is in charge of all wing functions. At the same time, the regrouping of competencies among these integrated teams is jointly organized at the production center in Toulouse. In the 1990s this organizational method is inaugurated for the A340 programs. Engineering teams meet to deal with specific topics in the program in the stages of conception and launching. These task forces are made up of Airbus personnel and the manufacturers responsible for the conception of externalized sub-systems.

Table 3.8. Specialization of the principle production centers of Airbus SAS

Airbus Deutschland	
Bremen	Rear body elements
Dresde	Floor production and assembly
Hambourg	Pressure systems; air cinditioning; rear body assembly; final assembly of A318, A319, A321
Laupheim et Buxtehude	Customisation
Nordenham	Manufacture of large mechanical parts
Stade	Production of derivates and vertical stabilizers
Varel	Treatment of high precision body parts
Airbus Spain	
Getafe	Panel production in compound element materials
Illescas	Production of panels in brute in carbon fiber for horizontal stabilizers
Puerto Real	Manufacture and assembly of carbon fiber or akuminum components for horizontal stabilizers
Airbus France	
Méaulte	Manufacture of mechanical parts Nose cone
Nantes	Assembly of mechanical parts and compound elements Central box
Saint-Nazaire	Sections assembly Central body
Toulouse	Avionics conception

Source: website Airbus SAS, authors

As can be seen in Table 3.8. each firm in Airbus SAS is, then, the contractor of one or several specific areas for the Division and is competent in the technology relative to these areas.

However, this specialization is not perfectly transversal to all programs. Depending on the type of aircraft in production, the distribution of tasks among production centers may vary. Thus, wings produced in Chester for the A300, A310, A330 and A340 are first taken to Bremen to receive equipment before being forwarded to Toulouse to be installed, while the wings for the A380 do not travel to Germany. The A320 is assembled in Toulouse but the rest of the planes in the series (A318, A319, A321) are assembled in Hamburg. In figure 2.13. an example of task distribution and transportation of elements for the A380 can be seen.

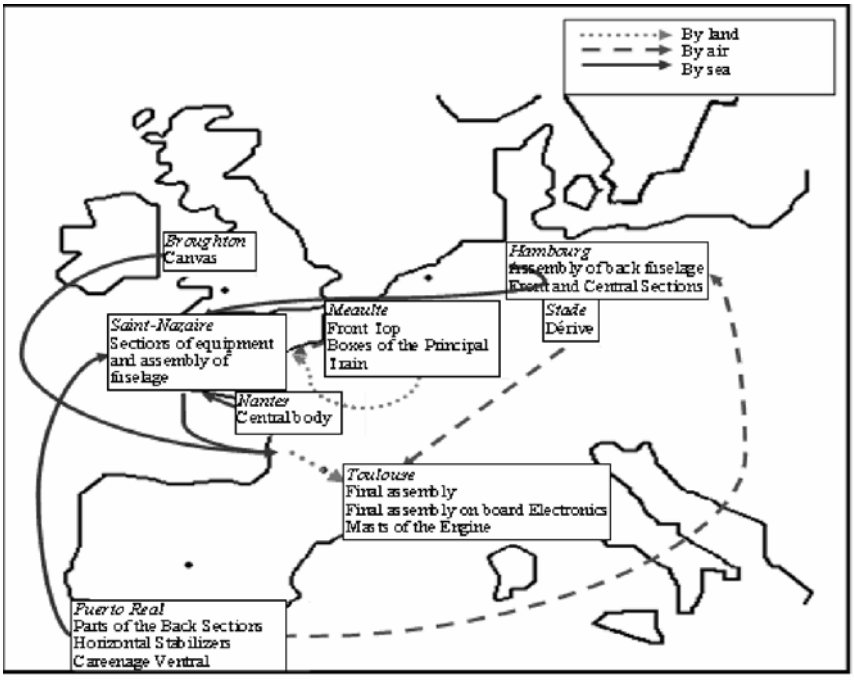

Fig. 3.13. Transport (simplified) of A380 elements by land, sea and air

Sources: press, Airbus web page.

3.4 The A380: Its Significance

3.4.1 The A380 Program: Its Significance

The A380 program, developed by EADS' Airbus Industrie, was launched 23rd June 2000 and officially presented at the end of that year after verifying its technical and financial viability. It was designed in cooperation with large airlines, airports and authorities in the so-called "Customer Focus Groups". The project was initiated 15 years ago[7] to compete with Boeing´s Super Jumbo 747 created in 1969.

This passenger plane, called the "whale of the skies", made its inaugural flight 27th April 2005 and is expected to begin regular service in 2006, at the latest, with Singapore Airlines. The A380 was conceived as a solution to air traffic and airport congestion through rationalization of flight space. Moreover, its aerodynamic design, reduced weight due to innovations in compound materials and the incorporation of new-generation motors reduced fuel consumption, pollution and noise, resulting in a more environmentally friendly and modern aircraft.

In all, compound materials represent up to 22% of the weight of the A380. Sixty-one percent is aluminum, 3% is glare (aluminum and glass), 10% is titanium and the rest is surface protection materials and others. This composite has improved aspects in the area of weight limitations, size, time and costs.

With a wing span of 79.8 meters and a wide body divided into three cabin areas, the A380 will be able to seat approximately 555 passengers in three classes, with greater space per passenger and, therefore, more comfort. Increased flight efficiency, over distances up to 14,825 km, and economical running will connect the major hubs of Europe, North America and Asia as well as inter-Asian connections.

The cargo version has a capacity for 150 tons and flight autonomy of 10,410 km which will reduce operation costs per ton/mile, a comparative

[7] From the beginning of the 1990s, Airbus had attempted to develop a prototype aircraft that could compete with the B747, initially with Boeing in the so-called VLTI project. In 1995, Boeing decided to leave the project due to the crisis affecting the sector and justified this decision with the poor future market perspectives in the segment of high capacity, high autonomy planes. From that point on, Airbus Industrie proposed to meet the goal of competing with the B747 through the A380 Project based on totally new technology and great comfort. The basic design for the new airship, finished in 1999, showed operating costs from 15 to 20% lower (2.9 liters of kerosene consumption per 100km/passenger), greater autonomy, more seats and less time on the ground per round trip than its rival B747 (EADS, 2004).

advantage over Boeing's cargo plane. Data comparing the new A380 and Boeing 747/400 can be seen through the following data:

With 250 aircraft manufactured at a catalog price of $250m, the A380 project is estimated to reach financial balance in 2008. In May 2005, Airbus had received 144 confirmed orders from major world passenger airlines (127), and cargo and delivery carriers (17). Over the next 20 years, the firm foresees sales of 750 aircraft.

Graph 3.14 shows the distribution of A380 orders by customer for passenger airplanes with 62% of demand coming from Asian and Pacific countries.

The cargo planes were ordered by Federal Express (10), UPS (10), ILFC (5) and Emiratos (2).

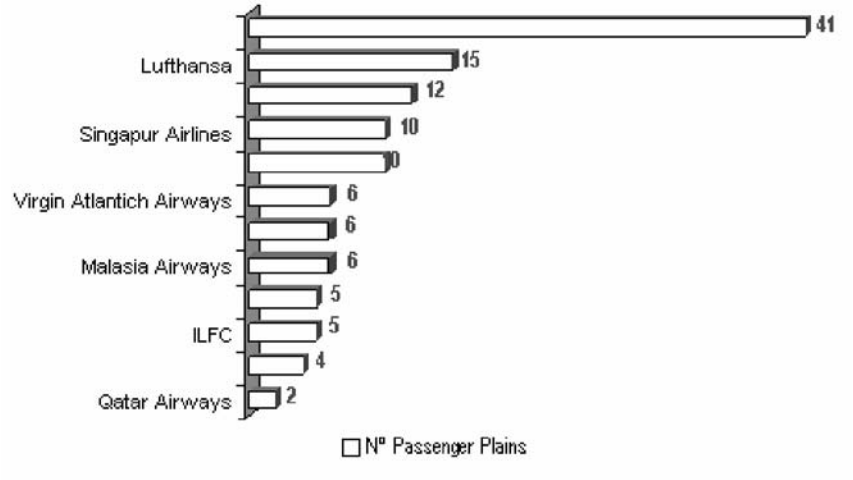

Fig. 3.14. A380 passenger aircraft orders by client

Source: www.airbus.com

These A380 customers plan for 130 weekly flights to China by the year 2010. According to the Global Market Forecast by Airbus, 75% of the large passenger aircraft fleet will be used for flights from only 20 of the world's largest airports and 12 of these will be located in Pacific Asia.[8]

[8] According to JP Morgan analysts, the fact that there has not yet been an avalanche of orders for the A380 is due to various reasons. Among them are financial reasons (poor financial situation of American aviation companies), price (the strength of the Euro) and market segment. A plane like the A380 makes sense on long routes stopping in large airport hubs (traffic distribution centers). Airlines and manufacturers coincide on the future growth of air passengers, be-

At present more than 6000 engineers work in Airbus centers around the world, connected through the so-called "Airbus Concurrent Engineering" (ACE) intranet system[9]. As with the rest of Airbus aircraft, the components of the A380 are produced in several specialized factories in Europe. Martorell, through the German group, Rücker, designs interior fitting out and their Hamburg plant adapts craft to specific uses. Airbus produces body sections in the same central plants in France and Germany as other Airbus planes. Facilities in the UK build wings while plants in Spain produce the horizontal stabilizer and other parts (see figure 3.15.).

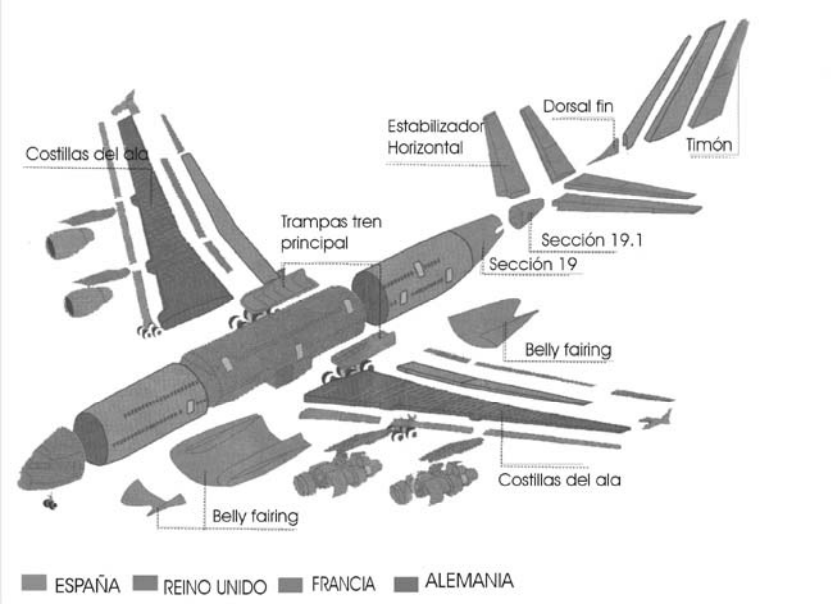

Fig. 3.15. Distribution of A380 project work load by participating countries

Source: www.airbus.com

Later, some of these components are sent by plane - Belunga - from the original competence center to the final assembly line in Toulouse. Due to the size of the A380, many section parts of the plane are transported by sea

tween 4 and 6% by 2023. The question is how this growth will be distributed. While Boeing foresees a rise in low cost companies which will promote traffic from one point to another over short and medium distances, a segment which will be served by its new model 7E7 Dreamliner, Airbus believes there will be sufficient demand for the A380 over long-distance routes.

9 This system is based primarily on information technology and proposes to reduce the time employed in the development cycle, optimize production, avoid many initial problems and save on non-recurrent costs.

or by land to Toulouse for final assembly and final equipping, including the installation of engines, and flight tests. Finally, the plane is transferred to Hamburg for cabin finishing and adaptations to customer specification.

The transition from three assembly stations, in the case of the A320, or from two with the A340-600, to only one in the case of the A380 has reduced the surface required for construction, saving about 18m euros. I has also saved about 8m euros on tools and cut in half the stocked materials and equipment needed for production and improvement in security.

3.4.2 The A-380 Program in Spain

Current participation of *Airbus España* involves the construction of the horizontal stabilizer, the vertical rudder, belly fairing, the main landing gear flaps, wing ribbing and the dorsal fin which joins the stabilizer to sections 19 and 19.1 of the rear body. The latter is made of carbon fiber, the first aircraft body made from this material in planes of over 100 seats and is the result of innovative processes such as fiber placement, developed in the *Centro de Composites Avanzados* in Illescas (Toledo). With carbon fiber technology and ATL and RTM (resin transfer molding) methods, panels of great curvature can be manufactured placing Airbus in the global lead since this is the first time a material of this type has been used in body sections of large commercial airplanes.

Spanish participation in the A380 project has increased to 10.7%[10], well over the initial 4.2%. But the challenge is to occupy third place in the European aeronautical race after France and Germany. Spain's participation in engineering development and the sector is successfully pioneering the development of carbon fiber applications.

The A380 project has brought about an unprecedented quantitative and qualitative advance in the Spanish aeronautical industry. For the first time in the history of commercial aviation, body sections have been designed, developed and manufactured of carbon fiber for airplanes of more than 100 seats.

The technology for the horizontal stabilizer of the A380 was developed within the framework of the government *Technological Plans* I and II, which shows significant support on the part of the Spanish Central Administration. The prototypes were built to scale in *Technological Plan II*.

In normal production conditions, the A380 will bring in sales equivalent to the total sale of components manufactured in Spain for all other models of *Airbus* which implies a substantial increase in the work load subcon-

10 Since June 2004.

tracted to the rest of the national aeronautical industry and a change in traditional subcontracting models. The work load is given to "collaborating firms" who are responsible for management of the entire work package (Mata Verdejo, E. 2004). These firms, fully integrated into the development of the plane, take full charge of design and production of subassembly. 37% of the total manufacturing of structural components and 97% of tools needed to build them is being subcontracted to Spanish firms (ATECMA, 2005).

From 2001 to 2004, the A380 project in Spain has generated about 900 jobs. With assembly-line production of the plane, that is, one plane a week, it is estimated that there will be 6000 people working on the A380 in Spain of which 2000 will be direct jobs.

In November, 2003, the government committed 376m euros over ten years (until 2013) to the development of the A380 project in Spain. As of that date, the Ministry had contributed 92.5m euros. The total amount represents 33% of development costs of Spanish participation in the project while the other two-thirds proceed from private initiative. The Junta de Andalucía committed 17.5m euros and the central government more than 13m euros to the expansion of the Puerto Real Factory and its competence center for automated structural assembly.

Spanish participation in this project is generating an increasing network of firms collaborating with Airbus including firms in almost all of the "Autonomous Communities", some of which belong primarily to the automotive or metal mechanics sectors. Tasks are carried out according to *Airbus España* specifications which means that design and construction are developed jointly through "concurrent engineering".

The following firms are the some of the most important:

- *Internacional de Composites, SA (ICSA)* developed the horizontal stabilizer rims and rear body parts.
- *Composystem* designed and built the dorsal fin and the horizontal stabilizer fairings as well as other parts of the wing ribs and rear body. It was in charge of the entire process of industrial designing, estimates and development. This firm manufactured all air and exhaust pipes for the Auxiliary Power Unit (APU) of section 19.1 of the A380 with engineering support from ITD.
- *Aires Complex* participated in design, development, manufacturing and product support for the rudder and elevator.
- *Mecanizaciones Aeronauticas, SA* (MASA) is in charge of development, design and manufacturing of tools and initial parts such as box joints and exit rims on the horizontal stabilizer.

- *ITD, SA* (within the ITP group) participated in the horizontal stabilizer and rear body systems and in the design and supply of subsystems within the auxiliary energy system of the aircraft. It also designs and supplies instruments for flight tests (FTI) of the belly fairings, rear body and horizontal stabilizer. *ITP* is in charge of design, manufacturing and assembly of the low pressure turbine and the turbine bearing housing (TBH) of the Trent 900 motor which will be installed in the A380.
- *Gamesa Aeronáutica* is in charge of design, development, qualification, production and delivery of the metal structure of section 19 of the rear body. Since the beginning of the program this firm has delivered 12 units to Airbus España. Redesign of part of the structure has led to significant weight reduction.
- *CESA* has produced the first assembly-line units of the front landing gear retraction action lever for the firm Messier-Dowty in charge of the A380 front landing gear. The action lever made by CESA is the first developed in Spain with a nominal work pressure of 5,000 PSIG (pounds per square inch gage) and the first to eliminate hard chrome skin on the pistons by substituting it with carbon wolfram applied by H.V.O.F. (High Velocity Oxygen Fuel Thermal Spray Process). It also made 20 units of hydraulic tanks for Airbus and carried out the certification tests for fatigue, vibration and duration. The firm SPASA was in charge of metal shaping, commercial management, installation of the various sub-systems, joint assembly and design of the testing and trial bank.
- *Sener* used a compound material to design the front and rear parts of the belly fairings which are manufactured by *SACESA*. It also perfected the design of belly fairing systems - Emergency Ram Air, Low Pressure Ground Connector and the Supplemental Cooling System - and the air intake levers (AGU NACA) whose design was tendered to *CT Ingenieros* who modified the design of sections 1, 2 and 5 of the belly fairings and inaugural flight documentation. *CT* also elaborated the first edition of elements plans and of the final plans for various parts they have been collaborating on for years.
- *SK10* is responsible for the manufacturing of various belly fairing elements and elemental metal parts for the rear body.
- *SACESA* is in charge of the design and manufacturing of belly fairing panels.
- EADS-CASA is in charge of the design, manufacturing and support of the belly fairing metal structure and manufacturing of all the metal components of the main landing gear flap.

- *El Grupo TAM* manufactures various components for section 19, particularly the shield and the titanium and aluminum, press-folded rubber reinforcements. It also completed tuning by making changes required by the final assembly line of body section 19 and worked with Airbus España on the design of the horizontal stabilizer with a team of their engineers integrated into Airbus España's design team.

Firms like *CADTECH Ingenieros, Fosterwheeler, MTAD, Tegrafingeniería (TGA group)* and others operating in specific fields are also important in the development of technology. They constitute a higher level in subcontracting since they take on risk. At this level, tasks are distributed through orders with specification trees in which the hierarchy is highly integrated. An entire second level supply fabric of small subcontractors who do not share in risk is located in Andalucia.

3.4.3 A380 Program Impact in Aquitaine and Midi-Pyrénées

It is unquestionable that firms in the Midi-Pyrénées region capitalized on the A380 program more than their colleagues in Aquitaine. In 2002, the Regional Council of Aquitaine estimated the repercussions of the program in the region at about 1,000 jobs as opposed to 7,000 in the Midi-Pyrénées. There are at least four reasons for this.

First, the consulting firms that conceived the A380 project and the assembly line locations were both in Toulouse and the program was the objective of years of work on their part.

Second, various large international systems manufacturers had recently set up in Toulouse near Airbus SAS. At present, only these "equipmentiers" are able to respond to international tenders (see Chapter 3 for a detailed analysis of the new reports on subcontracting) and they logically have first priority in selection. In Aquitaine there are fewer industries at this level and the region is less skilled at taking advantage of the new subcontracting norms.

Third is the presence in Toulouse of the agglomeration S*SII Informaticas* specialized in the creation of computer programs for space satellites. A delegation from this firm is in charge of conception of the program and *SSII* offers its knowledge of computer technology in the design of computer programs and development of the aircraft.

Finally, the small and medium size firms (SMEs) in the Midi-Pyrénées better adapted to the new subcontracting norms as is obvious from the successful regroupings that have taken place.

The A380 Program: Aquitaine Firms Decrease in Suppliers

To be selected by Airbus as a first row subcontracting firm for the A380, one must show sufficient capability to conceive and produce an entire system or subsystem and be willing to share risk[11], a clear application of market logic. Except in the case of SOGERMA which received some compensation (see territorial strategies of Aquitaine in the corresponding chapter) and Thalès Avionics and Messier-Dowty, global systems manufacturers, only eight SMEs in the region directly participate in the A380 program with Airbus (see table 3.9.)

Table 3.9. Aquitaine firms contributing to the A380 program in Level 1

Firms	Activities contributed	Type of relation	Type of subcontracted element
Thalès Avionics (Le Haillan)	Integrated modular avionics, cockpit visualization, flight control unit, radio-altimeter	Conception and production	Entire system
Messier Dowty	Front landing gear	Conception and production	Entire system
EADS Sogerma	Floor in alloy, pilot seating, interior arrangement	Conception and production	Entire systems and subsystems
Composites Aquitaine	Internal cabin elements in composites	Conception and production	Subsystems
Potez Aéronautique	Structural elements and lower forward body	Conception and production	Subsystems
Creuzet Aéronautique	Structural body elements, under-wing soles, "lisses de barque" for front nose structure	Conception and production	Subsystems and elementary parts
Asquini MGP	Central body parts	Conception and produc-	Elementary parts

[11] Thus, funding guaranteed by partners with risks is $3.1b, that is, a third of the cost of the A380, while Airbus invests $5.1b in refundable subsidies established in $2.5b. In early 2005, Airbus confirmed higher costs of around $1.5b.

		tion	
MAP	Central body structure parts and rear landing gear housing	Conception and production	Elementary parts
CEMA (ALEMA Group)	Assembly tools, airplane structure chains	Conception and production	Tools
Globaq (five SMEs)	Research in testing methods	Conception	-
Altea	Conception of front nose parts	Conception	-
CTEI	Conception of perforating and manufacturing tools	Conception	

Sources: Periodical information of the Regional Council of Aquitaine, 2004, Press, authors.

Despite these new markets, Aquitaine is still orientated toward military aeronautics and its strategies are generally aimed at adapting to the crisis. In this region the poles were gradually weakened by decreased weapons spending in the 1990s. In spite of the diversity of poles in the region, dependence of large local entrepreneurs on military programs (see table 3.10.) determined their internal work load which had a cascade effect on subcontracting firms.

Although the large firms in Aquitaine could, at least in theory, carry out a broad spectrum of aeronautics/aerospace activities, they are in fact anchored in defense programs. This limitation is explained by the fact that in recent decades not only did armed forces equipment budgets increase, but budget arbitration favored programs developed by local firms. However, with "peace dividends" reduced budgets questioned programs in which local firms were participating (the problem of GIAT industries and the Tarbes arsenal was mentioned in the INTERREG II C contract cited above).

Decreasing Aerospace and Defense (ASD) orders for the large firms of Aquitaine brought about a reduction in work plans which led to job losses (see table 3.11).

Table 3.10. Dependence in 1990 of main industrial entrepreneurs in Aquitaine on military programs

Firms	Facilities	%
Sogerma-Socea	Mérignac	44.3
EADS-ST	Saint Médard/Jalles	5.3
Dassault	Biarritz	65.8
	Martignas	87.3
	Mérignac	45.6
	Cazaux	95.4
Turbomeca	Tarnos	58.9
	Bordes	59.5
Messier-Dowty	Oloron	54.4
Thales Avionics	Le Haillan	0.1
SME	Saint Médard/Jalles	97.2
	Bergerac (lié à propulsion)	61.3
SNECMA-PS	Le Haillan	67.3
Thales Airbone	Pesca	100.0

Source: authors' estimates from DGA data

Table 3.11. Employees in main Aquitaine ASD contracting firms, 1990-1995

	1990	1995	2000
EADS-ST	1 675	1 314	1 213
EADS-Sogerma	1 096	1 110	1 210
Roxel	-	95	292
Dassault (Aquitaine)	3 385	2 868	2 829
Turbomeca	3 715	3 611	3 283
Thales Avionics	617	615	880

Sources: DGA, firms, press

A second consideration, perhaps more important, is the rising uncertainty as to the consequences of progressive industrial "privatization". The absence of State involvement in preliminary research stages makes anticipating future production cycles increasingly difficult. Not only did this change have direct repercussions on the quantity of job loss in subcontracting firms as a result of fewer work plans in the large firms, but also a perceptible evolution in the relationship between large groups and their subcontracting firms was taking place.

Although the significance of the crisis is manifested in job statistics, the second part of the 1990s showed a recuperation that Aquitaine firms did profit from, depending on the strategic location of the groups and on the productive specialization of local firms (Dupuy, Gilly, 1995). In this way, three economic trajectories were emerging in Aquitaine (Jullien et al, 2002): some firms, specialized in military activities, continue in the military sector, others such as Dassault launched on a quest for diversification with business planes (Falcon) while still others continued with a dual mission.

The A380 Program: A Slack in the Number of Suppliers is Taken Up by Firms in the Midi-Pyrénées

A380 assembly and flight testing is done in Toulouse and subcontracting firms in Midi-Pyrénées have obtained large markets. Among the most significant examples is the case of the aeronautical group Latécoère in Toulouse. This major supplier of aerostructures for Airbus won three contracts for the A380: the lower part of the front nose, the doors of the upper bridge and four electrical cupboards. Latécoère was also selected by Airbus to develop and produce the ETACS (External and Taxi Aid Camera System) for the A380. This contract confirms Latécoère's capability in videos systems on board and their installation and interfacing with the aircraft structure and, based on the synergy of their competency in aerostructure and wiring on board, Latécoère Systems is the world leader in the sector. Therefore, Latécoère obtained a new contract which complements the three preceding ones described above. The firm Hurel-Hispano located in Colomiers near its main client, Airbus, had just finished a new expansion of their facilities from 5,500 m^2 to 13,500 m^2. The dimensions of the new workshop that employs 190 workers were calculated to be able to preassemble the A380 engine gondolas.

For the first time, Thalès entered the electrical sector of Airbus with a contract for the electrical generation at variable frequency for the A380 through the joint firm Aerolec constituted by Thalès Electrical System and Goodrich. It also received orders for doors and slides with Diehl. In 2000, Thalès Avionics had already moved its computer and avionic systems analysis programs for civil aircraft to Toulouse for the A380 tenders. The firm will propose the same platform and integrated modular avionics for the A400M as the one it has just produced for the A380. The production center in Bordeaux is more involved in production activities while the Toulouse headquarters is more oriented toward marketing. When Airbus installed its teams in Toulouse, Thalès Avionics obtained most of the A380 avionics contracts (an increase over its share in the A320 program), except the flight plan management system obtained by Honeywell. Its integrated

modular avionics platform represents "a technological breakthrough which will equip future Airbus craft". The A380 will be the first plane to have only one central control for the various functions in order to decrease weight. Thalès Electronics obtained this contract with the German firm Diehl of which Thalès acquired 49% of the capital. With this same partner Thalès also acquired the AFDX high production Ethernet communications bus of the A380 calculators (which will be assembled in the A400M), the interactive visualization systems in the pilot cabin (LCD screens and computer programs that allow staff to produce flight images with a mouse), the control panel and also the nose calculators and the ailerons.

Goodrich won supply of the A380 main landing gear and the evacuation slides. The 130 workers in the Saint-Martin-de-Touch production center are able to assemble 24 engines at the same time. Two regroupings of firms took place to adapt to the new subcontracting rules and participate in the tenders. Sogeclair, the automobile, space and aeronautical engineering group located in Blagnac (Haute-Garonne), formed an affiliate with Mécachrome, the French manufacturer of aeronautical and automobile equipment, to meet a contract of more than 10m€ for the A380 front nose floor. Sogeclair will do the research and Mécachrome will build the floor and the group is called SAS Alliance for mechanical development, in which Mécachrome holds 65% and Sogeclair 35%. ST3D, a consulting and estimation firm in Toulouse with 45 employees associated with Macahers to obtain the contract for the A380 pylon structure from conception to production.

Table 3.12. Firms in Midi-Pyrénées contributing to the A380 program at Level 1

Firm	Activities contributed	Type of relation	Type of element subcontracted
Latécoère	Inferior front nose part, upper bridge doors and four electrical cupboards, embedded video system	Conception and production	Entire systems
Thalès Avionics (Toulouse)	Integrated modular avionics, cockpit visualization, integrated Flight Control Unit, redio-altimeter, upper head collimeters. Emergency instrumentation	Conception and production	Entire systems
Hurel Hispano	Pre-assembly of motor gondolas	Conception and	Entire systems

(Groupe Snecma)		production	
Aerolec (joint venture Thalès/Goodrich)	Electrical generation with variable frequency	Conception and production	Entire systems
Honeywell	Flight plan management system	Conception and production	Entire system
Rockwell Collins	Data connection (AFDX network)	Conception and production	Entire systems
Goodrich	Main landing gear and evacuation slides in front fuselage	Conception and production	Entire systems
Comecad (Snecma Group)	Electrical wiring	Conception and production	Subsystems
Liebre Aero	Air conditioning system	Conception and production	Subsystems
Technofan (Snecma Group)	Air distribution	Conception and production	Subsystems
Ratier Figeac (Hamilton Sundstrand group)	Flight controls, horizontal compensation bearing	Conception and production	Subsystems
Serin	Metal structure for assembly	Conception and production	Tools
Dedienne Aerospace	Assembly tools	Conception and production	Tools
Socoa	Tools for mounting structure	Conception and production	Tools
Sogeclair	Floor conception	Conception	-
Assystem	Conception case for exter-	Conception	

	nal landing gear and nose fairing		
IGE+XAO	Computer programs for electrical wiring	Conception	
ST3D and Mecahers	Conception (ST3D) y production (Mécahers) of forward pylon	Conception and production	Subsystems
Garrigues	Assembly Hall	Conception and production	

Sources: Press, authors

4 From Specialization to Specification

From Bordeaux to Toulouse

The French aeronautical industry has experienced important changes over the last forty years. Its historical leader, the State, retires from its role as organizer of the sector and contributes, at the same time, both to the appearance of a civil aeronautical manufacturer, Airbus, leader today in its market, and to the integration of a part of the large European groups within aeronautics and space travel through EADS. Over a period of decades, though formed for nationalistic reasons, an integrated European industry was built. EADS is now capable of competing with the American firms in both civil and military markets and sell products that are competitive technologically at acceptable prices, while at the same time covering the R+D expenditures and the important deadlines of the investment results.

After presenting the changes in the basic data of the sector, the consequences of the interactions between sellers and buyers and the strategies of the institutional actors within the territories of Bordeaux and Toulouse will be analyzed.

4.1 Basic Data of the Aerospace Sector

4.1.1 The Ill-Defined Boundaries

According to the INSEE, the Aeronautics and Aerospace Industry (IAS) groups together the set of activities defined by the E13 code divided into three branches, as shown by the table 4.1.

This definition, focused at the heart of the activity, does not value one of the basic changes of recent years sufficiently, that is the part of the electric and electronic systems in the construction of a plane or of a satellite[1]. It reduces, therefore, the growing importance of the suppliers of the newly embodied electrical and electronic systems.

[1] Corresponds to sector 332A (navegation aid instruments) of the APE code.

Table 4.1. Aeronautics and aerospace construction: Main results in 2003

	Sectors	Number of firms	Cash in 2003	Volume of business Tax free (Mill. €)	Exports (Mill. €)
353A	Aircraft motor construction	21	23.862	5.346	3.019
353B	Aircraft cell construction	84	49.919	12.222	7.717
353C	Launching pad and spaceship construction	6	7.071	2.091	1.021
E13	Aeronautics and aerospace construction	111	80.852	19.659	11.757

Source: SESSI

For the French Aeronautics and Spatial Industries Group (GIFAS), the boundaries of this industry are wider. They involve all firms specialized in the study, development, implementation, marketing and maintenance of the civilian and military aeronautics and space programs and materials including the equipment goods, the subsets and the associated computer programs.

Table 4.2. Aeronautics and aerospace construction in 2003

Number of firms		Paid Workers		Volume of sales (millions of €)	
INSEE	GIFAS	INSEE	GIFAS	INSEE	GIFAS
111	221	80.852	101 500	19.659	24.911

Source: SESSI and GIFAS (Activity Report, 2004)

On the other hand, due to the imperatives of national sovereignty and more generally, the history of the appearance and development of this industry, to the "aeronautics and aerospace industry" (IAS) is often added the qualifier "of defence" in order to designate the strong dual character of this activity between both the civilian and the military sectors (Carrincazeaux and Frigant 2004 and C. Serfati 1996).

In 2003, the IAS registered a volume of sales (tax free) of around 25 billion Euros, which represents an increase of 55% in 10 years.

Table 4.3. Volume of sales evolution of the IAS from 1994 to 2003 (in millions of €)

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
16.068	15.415	16.623	20.108	21.353	21.886	23.716	25.024	24.606	24.911

Source: GIFAS (Activity report, 2004)

Constantly increasing during the decade of the 90s, the sales volume of the IAS diminishes or stagnates in recent years. This evolution is characterized by the cyclical feature of the activity[2] as well as by the civilian and military nature of its products.

4.1.2 A Dual Industry: Between the Civilian and the Military

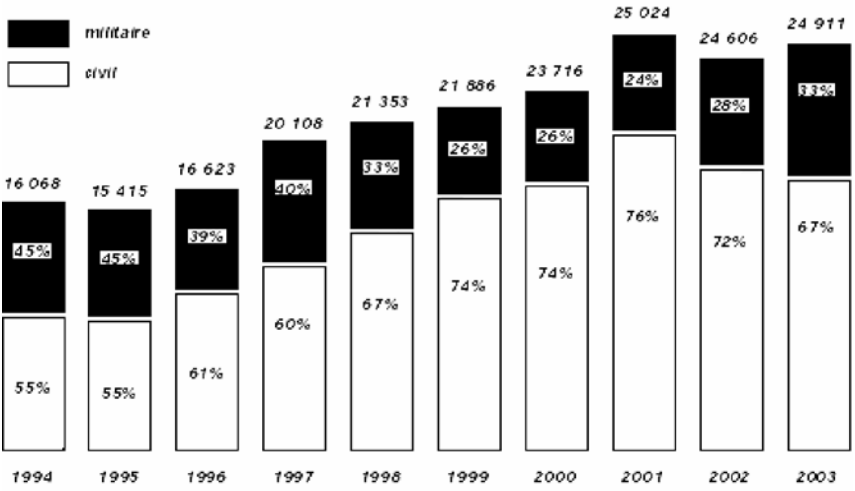

Fig. 4.1. Evolution of the civil and military sales volume (in millions of €)

Source: GIFAS (Activity Report, 2004)

The appearance and development of IAS in the world is characterized by the structural role of the public authorities. Public intervention in particular, through the power that the military purchasing orders confer – but not exclusively – was the privileged instrument for the building of a national industrial base. In France, the entire process that fulfils today's industrial

[2] In 1996, 400 planes were supplied throughout the World, 900 in 1999 and 600 in 2003.

landscape was carried out either under direct public intervention (see arsenal logic) or, indirectly, through the impulse of the regrouping of firms and the organization of a European industry with the creation of EADS since 2000.

Traditionally linked to the defence industry, the IAS devotes an important part of its activity to the States armament needs. Although a strong decline was felt between 1996 and 2002, because of the reduction of the military equipment programs, the military sales, on average, are between a forth and a third of the total volume of sales.

The dependence on the expenditure of the Defence Ministries helps in part to explain the fluctuations in the volume of sales. Thus, in France the increase in sales in 2003 with respect to 2002 is entirely the result of the military purchase orders that amounts to 8.3 thousand million Euros (an increase of 22%), whereas the civilian sector's volume of sales felt a fall of 7%, with 16.6 thousand million Euros. This tendency should be confirmed with the effects of the new military program law (2003-2008).

Table 4.4. Breakdown of sales by client

Consolidated sales volume (in Millons of €)	2002		2003	
	Value	%	Value	%
French government	4.809	24,04	3.893	19,08
Other French clients	1.374	6,86	1.162	5,69
Exports	13.821	69,09	15.348	75,22
TOTAL	**20.004**	**100**	**20.403**	**100**

Source: GIFAS (Activity Report, 2004)

Producer of important foreign trade surpluses, the French aeronautics industry depends largely on foreign markets. This dependence has increased this past year: exports within the volume of sales went from 54% in 1995 to 75% in 2003.

4.1.3 A High Technology Industry

The IAS firms are traditionally characterized by high investments in research and development, typical of a strongly technological activity that requires the control of a large variety of trades. Even more than in other industrial sectors in the field of high technology, the research and development expenditures are an essential investment, and important for reasons of competition. These expenses, without financial distinctions, increased a

21% between 2000 and 2003 and represent a growing part of the industry's volume of sales.

The sources of finance are mainly the public budget, self financing, co-operation with research institutions and cooperation between firms. If, in the field of civil aeronautics, private financing is clearly dominant (65%), public funds represent over three fourths of the total R+D space program or are linked to defence. With the development of the PCRDT (Fragment Programme on R+D) in recent years, European financing is ever more important. Thus, the sixth PCRDT (2002-2006) moves 17.5 thousand million Euros of which, more than 1.5 is specifically assigned to the aeronautics and space activity.

Table 4.5. Share of R+D within the volume of sales (in millons of €)

Years	2000	2001	2002	2003
Sales Total	23.716	25.024	24.606	24.911
R+D total	3.609	3.979	4.083	4.367
Part of R+D in Total Sales	**15,80%**	**15,90%**	**16,60%**	**17,50%**

Source: GIFAS (Activity Report, 2004)

An industry with a high technological content, the IAS is a qualified worker industry.

Table 4.6. Breakdown of personnel by professional category in 2003

Engineers –Managers		Intermediate professions[24]		Blue collar workers		Total
Nº	%	Nº		Nº	%	
32 500	32%	43 600	43%	25 400	25%	101 500

Source: GIFAS (Activity Report, 2004)

With respect to the activity, 27% of the personnel, that is, 27,400 people are devoted to research and development activities, 20.5% to trade and 52.5% to production activities.

4.1.4 A Location Based on the Effects of Concentration

The French aeronautics and aerospace industry employs around 100,000 salaried workers. Employment experienced an important cut back in recent years. Between 1982 and 2002, it is estimated that 10,000 IAS jobs have been lost (Lejeune and Nosmas, 2004). This reduction in personnel emphasized its geographic concentration even more: with a 70% of total em-

ployment, the regions of Ile de France (36%), Midi-Pyrénées (22%) and Aquitaine (12%) are the main aeronautics poles.

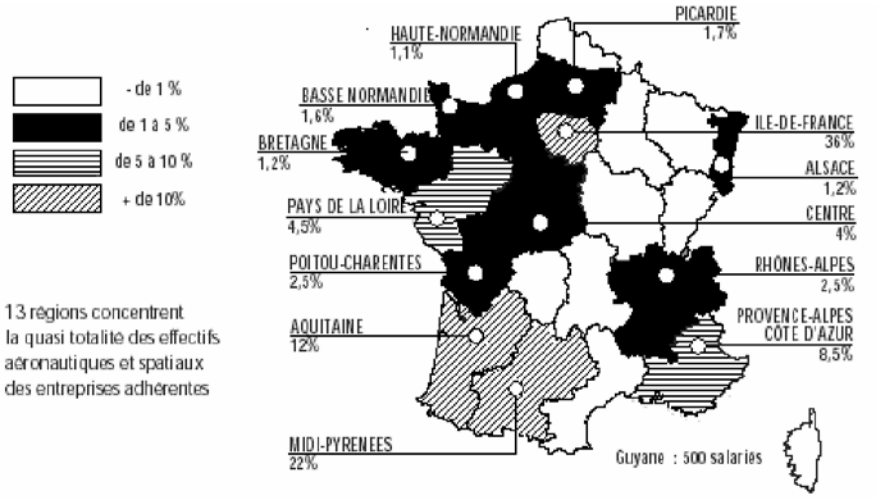

Fig. 4.2. National distribution of the IAS by professional category

Key: - than 1%; from 1 to 5%; from 5 to 10%; + than 10%

4.2 Basic Data in Aquitaine and Midi-Pyrénées

The Aquitaine and Midi-Pyrénées regions include the whole variety of aeronautical activities, both civilian as well as military. In this whole, the role of EADS and more specifically Airbus is more consolidated every day.

4.2.1 The Aerospace Sector as a Whole

This Southwest region of France is far from being a single industry region, but the aeronautical and aerospace sector occupies an important place. According to the INSEE statistics, the contractors in the aeronautics and aerospace sector have 26 firms in Aquitaine and employed, in 2003, close to 18,200 workers (INSEE 2004). The numbers represent 27 firms with 20,400 workers as of Dec. 31, 2002 in the Midi-Pyrénées. The importance of these two industries is therefore similar. The importance of the industrial personnel is slightly higher in Midi-Pyrénées (20,400/146,500 = 13.9%) than in Aquitaine (18,200/161,500 = 11.3%).

Whereas in Aquitaine two main poles (one pole in Bordeaux, and the other in Pau) and the Adour valley[3] are taken into account, in Midi-Pyrénées, the concentration around Toulouse is very strong. The agglomeration of Toulouse focuses the main part of the region's activity: close to 75% of the firms entailed are located here and they employ ¾ of the workers. During the past fifteen years, the area of the Haute-Garonne is the only industrial pole that has increased personnel and its influence in the sector. This tendency should be confirmed by the strengthening of the Airbus A380 programme.

Paradoxically, the importance of the ASD sector in the Aquitaine region was long ignored by the majority of the people in the region, and it is in the early nineties, when the sector feels its first serious crisis, that they discover the region's industrial specialization. This "discovery" can be explained by the very nature of the local activities present, which for years were devoted to military programs.

The situation is different in Midi-Pyrénées, where for forty years the presence of the aerospace pole has become an important political tool which the different local groups pretend appropriate. An example can be found in the advertising campaign that the municipal government of Toulouse launched for the first A380 flight: Bravo Toulouse.

Nevertheless, and pointing out another difference with Midi-Pyrénées, the aerospace industry in Aquitaine has an advantage: its diversification. Aquitaine seems more dependent on the aerospace sector, and it covers a wide range of fields and appears less focused on a single firm as is the case of Toulouse, where EADS is the focal point of the regional aerospace sector.

1. The Situation in Aquitaine

In the region of Bordeaux the aeronautics industry first appears in the period between wars, with the installation of Edmond de Marçay, Dyle and Bacalan, Blériot, L'ARMA, UCA or the first installations of Marcel Bloch (future Marcel Dassault)(Garros, 1992). It is nevertheless after World War II that the aerospace industry is truly established in Aquitaine.

The Gironde region makes good use of its triple advantage: geographical (unoccupied space, flat lands and mild climate), political (the same person was mayor of Bordeaux for over 40 years and was noteworthy on the

[3] See the Interreg II C report: The development of the territories: Comparative Analysis of the re-conversion policies in SE Europe. Universidad Autónoma de Madrid, University of Toulouse I, Sept. 2001 and the Thesis by L. Baméche (1995): Industrial logic and the territories: The example of the aeronautics industries in the Pays de l'Adour.

national level), and historical (the end of colonization in Algeria and development of the nuclear programme), and turns its industrial vocation towards the aerospace industry in defence during the period 1945-1970. It takes full advantage of the decentralization agreement. In the South of Aquitaine, as in the Midi-Pyrénées on the other hand, the contractor locations are older and go back to the time between the wars, primarily for strategic reasons: the German threat provokes the decentralization of the arms production centres[4] (Jalabert, 1974). These military origins are going to last, and despite the change in direction of the nineties, the region continues with its "rather military" vocation. The industry ASD in Aquitaine has five specialized clusters that group large leading firms and the subcontracting SME[5].

- THE BALISTIC POLE

In the Gironde region is located the French Strategic Nuclear Force Centre, which employed over 6,100 people in 1990 in three production centres – established in the western agglomeration of Bordeaux during the sixties – associated with the trial test pole, and has almost all of the necessary competences for making the ballistic missiles MSBS and SSBS.

The location close to the in-flight testing centre (particularly, tactical) supports the coherence of the ballistic pole.

- POLE FOR THE CONTRUCTION OF COMBAT AND COMMERCIAL PLANES

Dassault Aviation, practically the exclusive supplier of military airplanes for the French armed forces, has four production centres in Aquitaine. In 1990 there were 3,572 employees, approximately a fourth of its personnel. At the same time as the combat planes, it is also in Aquitaine where the core of business plane activity for the group is carried out.

This pole is less complete than the previous one in so far as research and development are carried out in Paris, and the flights for the prototypes in Istres. Furthermore, SNECMA makes the motors in the region of Paris. Nevertheless, we should add that SAFT manufactures the special batteries destined for the aerospace programs in Bordeaux, be they civilian or military, and a part of the installed electronics is carried out within the agglomeration of Bordeaux.

[4] Messier is established towards 1937 in Bidos and in 1940 in Arudy, the Anglet (Dassault today, the origin of SMA and Bréguet) production centre.

[5] A pole is made up of a significant goup of firms of Aquitaine of the ASD indstry, defined according to a specific composition trade/product.

- THE AVIONICS AND ELECTRONICS POLE

The Thales group activity is articulated around three fields, which are defence (62.4% of sales in 2004), aeronautics (16.9%), informatics and systems technologies (19.5%), Thales Avionics in Bordeaux is focused around a single aeronautical pole, evenly distributed between military and civilian. The firm employs about 1,700 people distributed between the installations in Haillan (for aviation) and Pessac (for radar and the embarked mission systems). Its activities of "systems integration" has just been relocated from Paris to these installations, which represents 350 supplementary employees.

The Thales Air transports Systems (exthomson CSF) of Pessac has a complementary activity. The objective of the re-location carried out in 1974 was to bring it closer to Dassault.

Aquitaine has two other important aeronautical poles, whose development was less directly linked to the military vocation of the region. Even so, they contribute in structuring the whole region.

- THE AERONAUTICS MAINTENANCE POLE

This maintenance pole, as previously seen, is widely articulated around Eads-Sogerma. Nevertheless, another important firm works within the region, and more specifically very close to Bordeaux. The Aeronautical Industrial Workshop (AIA) depends, in fact, on the General Directorate of Armament. It guarantees the maintenance of aircraft and helicopter motors that depend on National Defence.

- THE CONSTRUCTION AND MAINTENANCE OF HELICOPTER TURBINES POLE

The Aquitaine region undoubtedly constitutes the world centre for production and maintenance of helicopter motors thanks to the location there of the world leader in the market: Turbomeca (subsidiary of SNECMA). This affirmation is maintained thanks to the presence of two installations in the South of the region. A Tarnos (South of Landes region), Turbomeca guarantees the general maintenance and repair of its helicopter turbines. In Bordes in the Atlantic Pyrenees region, the other firm of the group, designs, produces and sells helicopter turbines and turbo reactors.

2. The Situation in the Midi-Pyrénées Region

The industrial activity of the Midi-Pyrénées region placed, in value added terms, in the thirteenth level in France, was greatly renovated in the second half of the XX century. While important traditional activities – coal extraction, textile industry, garments and leather- declined, other high technology industries took over.

With a 22% of the French aeronautics and aerospace personnel, the Midi-Pyrénées region is placed at the second level nationwide, immediately after that of the Ile-de-France region. In 2003, this sector employed slightly over 20,000 workers, which represents close to a 14% of total employment of the industry. The first industrial employer in the Midi-Pyrénées, following the agro alimentary sector, it focuses around the manufacture of civilian airplanes and satellites. This sector alone contributes over 13% to the value added in industry, which represents four times as much as the rest of France. Its presence alone explains the regional industry's export capacity and its power to attract some foreign firms in Midi-Pyrénées. Aeronautics and aerospace products represent a 51.5% of the region's imports and a 73.3% of its exports. Thanks to the strong presence of the aeronautics/aerospace sector, the Haute-Garronne region is an attractive location for foreign firms, particularly American (19 corporations with a majority of American capital) and British (11 corporations).

Of the 27 aeronautics and aerospace construction firms, 19 are aeronautics firms (13,200 employees) and 8 aerospace firms (7,200 jobs). In this group, the aeronautics pole formed around EADS is very important. It employs over 10,000 workers, basically near the Blagnac airport. The sector also has two important units in the aerospace field, Astrium and Alcatel Space Industries. Outside the agglomeration of Toulouse, two important firms are located, one in the Haute Pyrenees region (SOCATA in Tarbes) and another in the region of Lot (Ratier-Figeac).

In 1999, the ten largest manufacturers of the Midi-Pyrénées sector were: Eads Airbus SA (8,430 employees), Alcatel Space Industries (2,080 employees), Astrium SAS (1,800 employees), Airbus-Industria (1,210 employees), Ratier-Figeac (1,030 employees), Eads-Socata (920 employees), Silat-Latécoere (600 employees), Liebherr Aerospace Toulouse SA (520 employees), Eads-Atr (450 employees), Microturbo SA (400 employees).

Networking is the organization system most characteristic of the industrial sectors in Midi-Pyrénées. Furthermore, this industry plays an important role within the regional economy, and goes beyond the limits of its own field. Aeronautics and aerospace construction, in particular, is the motor force of activity of approximately three hundred fifty industrial plants and two hundred services firms established in the Midi-Pyrénées. The existence of these firms, particularly of consulting corporations, and informatics services corporations, so close to the industrial firms, represent an important regional asset.

The industrial units group together close to 60% of the firms and of employment. The majority work in the metallurgy, metal transformation or mechanical sectors. Almost 2/3 of employment in metallurgy and metal transformation, and over half of the employment in mechanics, is directed

towards aeronautics. The Haute-Garonne region alone gathers together 420 of these firms (23,300 jobs). From construction to maintenance, the entire sector is present within the region.

In recent years, due to an especially favourable period (in ten years, the aeronautics personnel increased a 50% in Midi-Pyrénées), the aeronautics and aerospace vocation of the Midi-Pyrénées region reaffirms itself. It surpasses that of Aquitaine, more focused towards military aeronautics.

The aerospace industry is structured around three main competence poles.

- THE AEROSPACE POLE

The appearance of aerospace activities in France began in 1961, with the creation of the CNES whose tasks were the following: definition of a national space policy, creation of technological and organizational capabilities in aerospace matters, and their progressive transfer towards the industry in general.

Since 1968, within the framework of the State's regional and territorial policy, the core activities carried out in Paris in the CNES are progressively relocated in Toulouse.

The presence in Toulouse of the CNES, of an emerging industrial capacity in certain aerospace technologies (automatisms, system activities, informatics, engineering …) and of a set of training and formation centres attract the spatial divisions of the two large industrial groups, Matra and Thomson-CSF (future Alcatel Espace)[6] to Toulouse in 1978 and 1982. In the early 80's a strong growth in the activities of the aerospace pole of Toulouse was taking place and employment passes from 1500 to 5000 workers. Hence, a collective process of innovation, around design and satellite control technologies, born on multiple links and connecting associations between Matra-Espacio, the CNES, SME subcontractors, informatics services corporations and research laboratories was developed.

The 90's are characterized by important changes, both on the economic as well as on the macro institutional level. In the field of telecommunications, competition grows between European and American groups with a transformation in the demand towards "aerospace systems with complete services" (including launching platforms, satellites, floor segments, maintenance…). At the end of this development, the aerospace pole of em-

[6] After nationalizing, in 1982, the groups Thomson and CGE-compagie generale dÉlectricité, the aerospace communications activity is transferred from Thomson to CGE (who in future becomes ALCATEL). After various reorganizations and denationalization, appears ALCATEL SPACE through the merger of Alcatel Space, Aérospaciale, Thomson-CSF and CEGELEC. It is a world leader in the field of aerospace systems and has an installation in Toulouse.

ployment in Toulouse represents over 9,000 jobs: 2,400 for the CNES and subsidiaries; 4,400 for Astrium (ex Matra) and Alcatel Space; 1,100 for the SME; 650 for services corporations, essentially informatics; and 450 jobs in research labs.

- THE AERONAUTICAL CONSTRUCTION POLE

Its creation begins with the entrepreneurs, who, since WWI built the first airplanes: Latécoère and Morane-Saulnier (today SOCATA), De Woitine (who at the end of various nationalizing processes and concentrations will successively become Sud-Aviation, Aerosapatiale and finally Airbus France). Since the late 80's, the closing of the Bréguet-Dassault installations in the outskirts of Toulouse marked the disappearance of the military activity. The specific competence lies in previous phases of the production process: in the design and development of the airplanes, in the management of the exchange that allows establish the final assembly, and in the organization of post-purchase maintenance. These competences are based on particular knowledge in so far as materials, systems, etc. are concerned.

- THE EQUIPMENT SYSTEMS POLE (avionics, navigation and flight management systems, air systems, hydraulic systems, electrical systems, flight control and flight guidance systems…).

This pole depends on great international firms as Goodrich, Hamilton Sundstrand (UTC group), Honeywell, Liebherr, Rockwell Collins, Thales, Zodiac. Similar to the two previous poles, but also supplies the automobile industry. This pole is inter-sector given that it unites the firms' knowledge of the electrical and the electronics industry and of the informatics services firms. IERSET, a research laboratory, facilitates the access of firms, particularly of the SME, to expert technical assistance, indispensable in order to innovate. Its members vary greatly, among who are entrepreneurs, service firms, institutional actors, training centres and/or research centres.

For the whole of the region, the existence of three contracting categories (aerospace, civil aeronautics, military aeronautics) has repercussions on the occasional economic adjustments. Without mentioning the cycle itself, given that there is no true regularity in the succession of the expansion and contraction phases, the amount of work of the subcontractors is the result of the combination of the following three occasional economic movements.

Activity in civil aeronautics is naturally linked to air transport, that includes both transportation of people as well as of commodities. This sector is on the rise throughout the world. There is bitter competition between the traditionally established airlines and budget airlines. The restructuring of

companies can have an effect on the manufacturers and create competition among them. If, for example, Ryan Air takes business away from Air France, this could benefit Boeing more than Airbus. The rising trend of air transport can be affected by accidental international incidents: The Gulf War in 1990-91, The World Trade Centre terrorist attack in 2001. The consequences of these short term fluctuations in the general business are clear in the Midi-Pyrénées.

Military aeronautics supplies the French army as well as a number of armies throughout the world. Its activity is thus linked to the armament programs of different countries. The sale of arms does not obey competitive criteria only. It is linked to the strategic location of the countries who sell and who buy, and consequently to the foreign policy of these countries. During the 80's-90's, with the fall of the Berlin wall we see a diminution in the armament programs of large countries, even though numerous conflicts still exist. The consequences of this downward trend can be seen in Aquitaine.

Last of all, the conquest of space obeys even more complex criteria. There is, undoubtedly, an industrialization of space and the launching of satellites linked to the strong development of telecommunications and multimedia (telephone, TV, walkie talkie…). Along with this industrial utilization, we find military uses (spy satellites and star wars). Finally, it is necessary recognize the purely scientific programmes of exploration of the universe. These uses are articulated more or less between them. There existed, for example, evident relations between the SPOT Programme of Earth watch for civilian purposes (agriculture, oceanic water levels…) and the HELIOS programme of observation for military purposes. The duration of the phases of the different aspects of the aerospace industry is not identical. Often they are based on supranational decisions. An example is when the Hermes space plane project was abandoned in 1992 after 10 years of study and having spent close to 2 thousand million Euros.

The effect this has on the subcontractors of these three occasional movements is carried out without foresight as to the possible combination of their phases. It can be gathered that the subcontractors should combine flexibility and reactivity[7] (capacity to react to both occasional reductions and rapid renewal of activity).

[7] "ON THE FLEXIBILITY OF SUBCONTRACTING TO INDUSTRIAL REACTION" under the direction of Françoise Larre, and with the participation of Françoise Dauty, Yves Dupuy, Sylvie Ferries, Joachim Haas, Marie Laure Morin, Toulouse, LIRHE, 2003.

4.2.2 EADS Installations in Aquitaine and Midi-Pyrénées

1. The Peripheral Position of EADS Aquitaine Installations within the Group

In general, the EADS group encourages the division of labour between its different firms. It follows the specialization movement of the production centres begun some time ago by GIE Airbus. This concerns the set of firms of the group, particularly, those in the Bordeaux sector.

Thus, at the present time, Eads-Sogerma rationalizes its activities between the different production centres: the heavier maintenance tasks that have a higher value added content, converge towards specialized areas, as occurs with Bordeaux, that should receive the industrial activities of the installations in Toulouse (with 278 employees) and only maintain personnel devoted to sales and research there and transfer the rest of the personnel to Airbus. With respect to EADS-ST, the difficulties of aerospace activities are the result of both a diminished demand for satellites and as a result of launching, an excessive European capacity for production (satellites and launching pads), and cost reductions required by the DGA. They reinforce competition between the installations that are more and more specialized. In fact, this general movement is based on units that are devoted to activities (maintenance, ballistic missile) that are not the main activities of a group that obtains its profitability today in activities as a civil aeronautics constructor; and it should be remembered that this represents no less than 60% of its volume of business in 2003. From this point of view, firms in the Gironde region are situated at the periphery of the group. Nevertheless, due to the divergent development paths, this peripheral situation covers different realities between Eads-Sogerma and EADS-ST.

2. The Central Position of the EADS Midi-Pyrénées Installations within the Group

The set of EADS firms located in the agglomeration of Toulouse are part of the Division of Airbus. With respect to this, they occupy a central place within the group, and as previously seen, its activities were geared, first, towards civil aeronautics with the range of Airbus. This main feature is emphasized by the fact that the firms in Toulouse (assembly, research, decision-making) are essential to Airbus SAS.

Until 2000, the installations in Toulouse are distributed between Aerospatiale and GIE Airbus Industries. Airbus Industries was born in 1970 to sell the airplanes manufactured by firms of the partners countries (mainly Germany, Spain, Netherlands, United Kingdom, France) and assembled in Toulouse in a plant of the firm Aerospatiale. In the early 80's the Toulouse

firm became the essential pole of the planes division of the firm "Aerospatiale", whose management continues to be in Paris. Since the mid 80's the internal organizational changes for dealing with how to develop the relations between plants. An organization by function is established for the purpose of guaranteeing a better coordination between the industrial centres and better work tools harmonization. The Aircraft Division operation unit was located in the production centre of Toulouse (thus consolidating its importance) under operative management in charge of production. Production management supervises quality control, industrial management, foreign manufacturing and manufacturing. In 1999, these production centres incorporate Aerospatiale Matra to the group, before becoming part of the Airbus Division of EADS.

As of 2000, The Toulouse production centres were integrated in Airbus SAS and in Airbus France. For historical reasons, we find various Airbus SAS entities in the agglomeration of Toulouse: Airbus SAS headquarters, that has 4,000 people and is located in Blagnac, and the headquarters of Airbus France, located in the same place as the installations of Toulouse of Airbus France, the whole group has around 11,000 employees.[8]

4.3 The Industria Surrounding the Large Contractors

Today's productive fabric structure can be explained partly by the local history of the sector's evolution.

4.3.1 Recent Evolutions

The temporary quality of defence aeronautics related to the evolution of the geo-strategic policies is not the same as that of civil aeronautical construction that depends on the evolution of air traffic.

1. A Decade of Recomposing the Subcontracting Fabric in the Aquitaine Region

A cut back in the military purchase orders during the decade of the 90's after the fall of the Berlin wall puts the entire chain of subcontractors in danger. The fabric of the subcontractors in the Aquitaine region is faced with a "double crisis." The crisis caused by a lack of orders in the early 90's, after the reduction made in the budget for military equipment goods

[8] Airbus France has around 16,000 employees of which 11,000 are in Toulouse, 2,000 in Nantes, 2,000 in Saint-Nazaire and 1,000 in Méaulte.

in the region is re-transmitted in mid decade thanks to a transformation in the purchasing methods on behalf of its contractors. In this respect, some researchers see during this period the possibility of a de-structuring of the territorial ties established since the between-war period in the South of Aquitaine and since the sixties in the Bordeaux pole (Frigant, Jullien, 1997).

Throughout the decade, the SME will realize that the way to accede to the markets change, and that the very nature of their work evolves differently. Thus, with the support of the contractors and the local institutions, and seeing what could happen in other European regions (Frigant, Moura, 2004), it is possible specify the adaptation strategies undertaken by the subcontractors in the Aquitaine region.

A study made by the CRCI in 1997 permits update four development paths foreseen by the 103 subcontractors that answered the survey. The client's need to diversify clearly wins out in the SME. The need to reduce its dependence towards the contractors of the Aquitaine region, armament in particular, is clearly seen given that over 70% of the subcontractors decide reinforce their commercial strategy and intend diversify their markets. For 38.8% of them, this strategy seems based on the update of new products and more specifically, of their own products that are seen as an opportunity of gaining in independence from the contractors. Last of all, translating the structural weaknesses of the SME in Aquitaine, 43.8% of the subcontractors foresee or have already foreseen, a regrouping strategy for the purpose of increasing its technical, financial and organizational means so as to face the new demands of the contractors.

The effort made to achieve sectoral or geographical diversification is not without consequences, as can be seen by the very different trajectories, depending on the firm. Furthermore, some subcontractors, hurt by the inertia when faced with these changes, will only survive as producers integrated in larger, often local, firms.

2. Growing Externalization in the Midi-Pyrénées Subcontracting Activities

In thirty years, the industrial organization of the aeronautical sector in Toulouse and its region has changed completely. In the early 70's the aeronautics constructors were very integrated firms, carrying out most of the process of aircraft construction internally and not open to the milieu, either industrial or institutional. In 2000, the aeronautics constructors are open to the outside and subcontract a large part of its production. They establish a variety of relations within their milieu and create associations with them.

In Midi-Pyrénées, the evolution of the network fabric of the subcontractors is closely linked to the hegemony of the firm Aeroespacial and later to Airbus as the final contractor.

Since the 80's, an important increase in the externalization of production and services activities can be observed. In the decades of the 80's and 90's the part devoted to purchases in the sales volume passes from 40 to 70% world wide (in the Aeroespacial accounts subcontracting passes from 18% in 1986 to 32% in 1995).

The regional subcontracting fabric is restructured around a small number of 1st level subcontractors (systémiers and equipment goods manufacturers) that will in future control the cascade of subcontracts.

- The increase in subcontracts throughout the world confirms the wish to externalize activities: in future there are more jobs in the firms that are linked than those in aeronautics and aerospace construction.

Table 4.7. Employment evolution in the subsidiaries AS

	1982	1992	1999	2002
Employment in the sector	12.692	16.841	17.500	20.400
Employment in the related firms	7.632	14.245	28.440	29.284
"dedicated"[31] employment in related firms	3.758	4.202	10.665	13.822

Source: INSEE Midi Pyrénées; Survey on aeronautic and aerospace subcontracts and TEMP

- The subcontractors focus in the urban area of Toulouse. In the Midi-Pyrénées region we notice a strong concentration of the firms in Toulouse and its surrounding areas. This tendency is not exclusive of the aeronautics sector, given that the population and jobs generally focus round Toulouse. This concentration points out that despite the development of transport and communications, the advantages of geographical proximity continue to be important in localization strategies.

Of the 553 firms that answered the INSEE survey of 2003, 380 are located in the agglomeration of Toulouse. It focuses close to three fourths of the employees, two thirds of the purchase orders in aeronautics and the majority of the aerospace orders. Most of the services firms and practically all of the informatics firms are placed around Toulouse. 80% of the firms that work for the aerospace sector settle within the agglomeration area of Toulouse, whereas less than 70% work for the aeronautics sector. (INSEE, 2003).

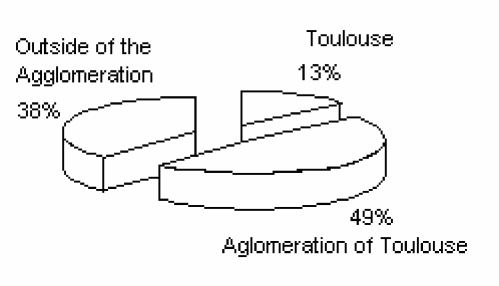

Fig. 4.3. Location of Firms

Source: Data from Survey

This concentration does not mean relocation of jobs but rather a greater increase within the agglomeration of Toulouse than in the rest of the region. This evolution is linked to the changes in the content of the subcontracts: the increased role of the services rendered increases the demand for proximity.

- The average size of subcontractors increase. Between 1992 and 2002, the percentage of firms with over 100 employees goes from 53.8% to 68.7% of the set of firms involved. This increase shows the new demands of subcontracting: the contractor keeps asking for more participation in risk, that can only be done by firms with a sufficient financial capacity and consequently of certain size. It can be noted, on the other hand, that these subcontractors associate more and more with regional or non regional groups.
- With time, the composition by branch of activity of the firms involved, evolve. Within this process, the aeronautics construction branch recurs less and less to the mechanical construction firms and more to the projects and services firms. In this way, tertiary activities pass from less than 20% of the total of jobs involved in 1982 to close to 45% in 1999 and to a 55% in 2002. This movement is related at the same time to changes in the content of the product (there is more electronics and informatics every day) and in manufacturing methods.

The transformations mentioned above show two sets of crucial questions for the development and perpetuity of the local subcontracting fabric.

The first refers to the diversification of the markets. Diversification permits "ride" the waves of the different short term cycles. This requirement is easy to formulate theoretically, though more difficult to carry out because of the specificity of the assets that must be put into practice so as to be present in specific markets. On the other hand, even if the clientele is very focused at a particular moment in time this does not mean that it is

impossible to reach another market. On the contrary, it may be the signal to take advantage of the opportunities offered by the development of new markets. Whatever the difficulties of interpretation, it is clear that the concentration or the diversification of the markets is important: it may lead to a geographic or to a sectoral level.

The second refers to the modifications in the procedures for contract adjudication. It may be said that the internationalization of production, the rationalization of subcontracting, and the centralization of buyers' services requires the existence of very formal competition and/or contest protocols. Formal adjudication of contracts makes for fewer personal relations. On the other hand, the globalization of proposed markets imposes that firms have a sufficient critical mass with respect to technology or financial capacity. The formal adjudication procedures poses the classic problem of information (Akerlof).

With respect to these two questions, the results of our observations will be organized and used in a complimentary manner to that of the yearly INSEE survey and our own research. Before touching on these, we should ask about the composition of the subsidiary in order to take inventory of its activities.

1. A Subsidiary Firm of the Mechanical Industries in Aquitaine with Services that Emerge Mostly in the Midi-Pyrénées.

The INSEE survey in the regions of Aquitaine and Midi-Pyrénées of firms susceptible of working for the aeronautical and aerospace sector shows, in 2003, 537 firms in Aquitaine and 549 in Midi-Pyrénées. This view is rather broad given that it includes firms that are mere suppliers of generic goods such as administrative services or other normal products.

The table 4.8 selects only what the INSEE calls the firms closely involved. It is lower in number.

When we focus on the industrial activities or tertiary activities, the more significantly dependent on aeronautics and aerospace, they represent 7,425 jobs distributed among 261 firms in Aquitaine (385 firms with 22,094 jobs in Midi-Pyrénées). The impulse effect is clearly higher in Midi-Pyrénées than in Aquitaine. Not surprisingly, the firm fabric is formed basically by the mechanical and by research and development activities; activities with a high consumption rate in the aerospace industry.

Table 4.8. Brealdow by activities in Aquitaine and Midi-Pyrénées

	AQUITAINE		MIDI-PYRENEES	
	% of firms	% of employees	% of firms	% of employees
Mechanical equipment industries	18,01%	17,21%	12,47%	15,64%
Electric and electronic equipments	11,88%	19,64%	10,39%	10,97%
Metallurgy and transformation of metals	8,81%	9,62%	12,21%	13,34%
General mechanics	35,25%	22,26%	20,26%	8,57%
Informatics	7,66%	7,65%	15,06%	22,30%
Services to firms	0,00%	0,00%	29,61%	29,18%
Research – studies	18,39%	23,62%	0,00%	0,00%
	100,00%	100,00%	100,00%	100,00%
Numbers	261	7425	385	22094

Source: Data from INSEE Survey

The burden of tertiary activities (informatics and services) is lower in Aquitaine (26% of the total) than in Midi-Pyrénées (51% of the total). This implies that, for these industries, proximity is still important. It also means that the industrial organization is not the same in the civilian sector than in the military. The secrecy linked to the defence sector stop the externalization of the activities except for the superfluous ones. It is also necessary see that the financing difficulties are not the same in the two activities. In the military sector the State has a much stronger commitment and control.

In Aquitaine, general mechanics concerns close to a third of the firms, but, due to the small size of the firms, only occupies a 22% of total employment and tends decline in relative and absolute value. A sign of its strong sectoral specialization (60.7% of its business volume is in aeronautics and aerospace), mechanics generates a 28% of the jobs.

Table 4.9. Part of aerospace in the volume of tax free sales and number "dedicated"

	AQUITAINE		MIDI-PYRENEES	
	AS/CA	Ed	AS/CA	Ed
Mechanical equipment	0,336	429	0,249	860
Electric electronic equipment	0,288	420	0,667	1617
Metalurgy-metal transformatión	0,638	456	0,606	1786
General mechanicsl	0,607	1003	0,687	1300
Informatics	0,447	254	0,492	2424
Services to firms	0,395	1001	0,677	4365
TOTAL		3563		12352

Source: Data from INSEE Survey

Note AS/CA: part of the aerospace business volume in total business volume; Ed: number dedicated.

For the activities mentioned, the firms in Aquitaine appear to depend less on its sales to aeronautics than the firms in Midi-Pyrénées (48% against 56%).This dependence reinforces the impulse of the aeronautics industry and varies from one branch to another. The most significant differences are seen in general mechanics that occupies a more important part of jobs devoted to it in Aquitaine than in Midi-Pyrénées, and contrary to the activities in informatics, or cybernetics which are greater in Midi-Pyrénées with close to a 20% of employees against a 7% in Aquitaine. Given that there is no reason to think that the nature of the techniques differ from the military to civilian sectors, this difference can only be explained by the difference in externalization policy in the two sectors, for the reasons mentioned above.

More generally, the sector composition of firms involved in aeronautics and aerospace construction presents the problem of the sector's boundaries. In a broad definition, a large set of activities that contribute to the manufacturing of the product can be considered: they may or may not be closely involved in the production process (from the elaboration of meals for personnel to the supplier of paper for the invoices or material for the PCs). It is possible have a narrower view using the concept of specific asset: a production factor that can be used only once. Naturally, all intermediate situations are possible.

2. Insufficiently Diversified Markets

This refers both to the clients sector as well as to the geographical distribution of sales.

- The clients sector: The distribution of the business volume by sector of clients reflects the different specialization of the regions of Aquitaine and Midi-Pyrénées and the smaller dependence of the firms in that territory. In Midi-Pyrénées, close to a half of the firms answered Q1 (1/3 of the total sample) that they are over 80% dependent on the aeronautics sector. In the INSEE survey, the aeronautics and aerospace sector represents over 90% of the business volume for a 20% of the firms. This implies that the subcontracting activity is quite concentrated: in 2002, the 69 firms that answered the INSEE survey do a 65% of the work in aeronautics and aerospace. This information means two things:

On one hand, this dependence on behalf of the firms has an evident cyclical aspect. At a time when the economic situation is good, the large contractors first recur to their usual partners. By the fact of recurring to the

subcontractor, the business volume of the subcontractor increases, and also the business volume destined to aeronautics.

On the other hand, we know that the contractors wish to reduce the number of subcontractors. One of the methods of cost reduction in suppliers is the reduction in transaction costs, this requires a cut in the number of contracts that must be negotiated and concluded. The reduction in the number of partners and the termination of long term contracts creates monopolistic situations and presents the classic problems of appropriating the income devoted to organization. In order to avoid this kind of problem, we see that some contractors wished to limit the dependence of their subcontractors by assuring that the business volume given in subcontracts not go over a certain percentage of the subcontractors´ activity. Contrarily, in the period of low economic activity, the contractor pretends continue giving work to some subcontractors so they can maintain their productive capacity.

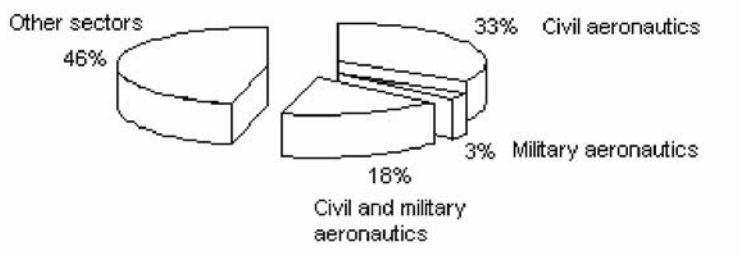

Fig. 4.4. Breakdown of firms by clients in Midi-Pyrénées

Source: Data from Survey

Fig. 4.4 interpretation: 33% of the firms do over 80% of their work with civil aeronautics.

Thus, we observe a strong predominance of aeronautics as a whole with 54% of the firms that do more than 80% of their business volume with this sector, and the preponderance of civil aeronautics. This is due to the almost total absence of military aeronautics in the region, at least in the final assembly phase.

Table 4.10. Importance of the military programmes in the business volume of aeronautics and aerospace according to firm activity

		Importance of military programmes in the BV		
Activities	Exclusively civilian	Less than 30%	[30, 60]	[60, 100]
Mechanical equipment industries	47,8%	41,3%	8,7%	2,2%
Electric and electronic equipment industries	36,7%	53,3%	3,3%	6,7%
Metallurgy and metal transformation	30,4%	65,2%	4,4%	0,0%
General mechanics	52,9%	33,3%	11,5%	2,3%
Other industrial activities	51,4%	35,1%	8,1%	5,4%
Research – projects/studies	34,0%	48,9%	8,5%	8,5%
Informatics	55,0%	25,0%	10,0%	10,0%

Source: INSEE Data -Aquitaine (2004a)

In Aquitaine, the local industrial fabric of the subcontractors does much of their work in aeronautics activities. Aerospace activities alone generate a meagre business volume for the local firms. Thus, 42.1% (41.1% in 2002) of the local firms business volume is done with aeronautics, 3.4% (2.2% in 2002) with aerospace industry. On the other hand, the restructuring process previously mentioned affected the distribution of the firms that work on military programmes. Despite annual fluctuations, subcontracting firms appear reduce their dependency throughout the world in this type of market. Thus, participation in military programmes is being reduced and a large part of the firms do less than 30% of their aerospace business volume on this type of programme. In our survey, without distinction of sectors of the subcontractor ASD, less than 40% of the firms declare devote over 20% of their activities in the civilian sector, this percentage is reduced to less than 18% in the military. In sum, joining the civilian and military, less than a third carry out more than 50% of their activity. We find here two phenomena that are practically contradictory. On the one hand, since the nineties, the contractors demand that their subcontractors have various clients. This criteria helps justify that the types of dependence towards military programmes are mechanically reduced. On the other hand, the conditions required for the work on military programmes imply heavy investment costs (in terms of security, in particular) that justify that firms specialize in defence.

The geographic distribution of sales. In Aquitaine as in Midi-Pyrénées, the market area is mainly regional, as can be seen in the following table:

Table 4.11. Business volume by geographic origin of orders (in %)

	The región	The other	The rest of France	The rest of the EU	Rest of the world
Aquitaine	53,1	15,8	18,5	7,3	5,3
Midi-Pyrénées	56	5	16,7	11,9	10,4

Source: INSEE Survey 2004

In Aquitaine, the effort of diversification, when it exists, is mainly directed towards the Midi-Pyrénées region. This fact also reflects the dynamism of the aeronautical economy of Toulouse, and more specifically, the launching of great programmes that require many project services: the A400M and A380.

In comparison, the Midi-Pyrénées region appears more open, since on average only 56% of the business volume comes from the Midi-Pyrénées firms. This percentage varies widely according to branch. Activities devoted to cybernetics and/or informatics are most sensitive to proximity given that a 90.4% of the purchase orders come from the same region. For the rest, the weight of the large firms is more important in Midi-Pyrénées, which explains the international opening of the markets.

Close to 55% of the firms surveyed declare carry out more than half of their activity in the Aquitaine region, and 16% their entire business volume. Less than 10% does not have any market in the region. The geographical location of the contractors thus confirms this form of "regionalization" of the activity[9], especially with a 40% of the firms of our sample that declare have all of the contractors inside Aquitaine and an 85% more than half.

In Midi-Pyrénées, the industrial sectors appear to be more open to the outside. With only a 5% of the purchase orders, the customers in Aquitaine are a relative minority. The volume of orders destined abroad represents a 22% of the business volume of aeronautics and aerospace, of which half are carried out in the European Union. The firms that work with the aerospace sector turn towards the region more than those that work with aeronautics, who focus more towards foreign markets. It is clear that in this tendency the Airbus effect is in play. The centralization of purchasing in Airbus opens the doors of other countries of the European Union to the subcontractors with good references. This can also play against, that is subcontractors from other countries of the Union will compete with the re-

[9] The differences may subsist between the influence of the Aquitaine region in total activity of the firms and the geographical location of the contractors explained by the fact that its activity is not only the result of subcontracting.

gional subcontractors. The weakness of the contacts with the contractors in Aquitaine may be explained by two elements that reinforce: the military specialization in Aquitaine and the weakness of the military economic situation.

Nevertheless, the image that these statistics reflect is that of firms too centred in their region of origin and for whom internationalization is difficult to be achieved. A weakness of the subcontractors in Aquitaine is the slight inclusion of the Midi-Pyrénées region during the period under study. It should be kept in mind that this period is a very dynamic one for the aerospace sector of Toulouse where points of congestion appear. Some subcontractors declare that this period has allowed them get involved in the Toulouse market, taking advantage of the saturation of the local production capacity, but they continue sceptical as to the possibilities of continuing when the tendency changes. The weakness of the firms with 50 to 99 employees to be present in this market is, in our opinion, disquieting (11.2% of their business volume, against a 19.4% for those over 100 employees and 15,4% for those with 10 to 49 employees).

3. An Industrial Fabric That has not yet Reached its Critical Mass

The question of critical size is always difficult to answer. It can only be answered afterwards based on the characteristics of the firms that were unable to attain the expected volume of sales. There is an assumption in what follows, that if a firm only subcontracts production it is because it cannot get more respected activities.

As shown in the two following tables, many firms continue to play a role of subcontracting production (60% in Aquitaine and 45%% in Midi-Pyrénées). Based on this plan, the Midi-Pyrénées firm results are a bit better since 14.8% get a global pluri-annual contract. It is due to the presence in Midi-Pyrénées of the large systémiers that are the true partners of Airbus.

Table 4.12. Relations with the aeronautics and aerospace sector

	Aquitaine	Midi-Pyrénées
Production subcontractor	60	45,5
Technical associations/corporations	19	16,5
Innovation group	7	14,5
Progress contract	3	3
Pluriannual global contract	5	14,8
Others	6	5,7
	100	100

Source: INSEE Survey on aeronautic and aerospace subcontracts

A majority of firms thus find themselves limited to the role of subcontractor from which it will be difficult to release itself and move on to other activities, keeping in mind that they are small firms with limited organizational means.

Various reasons may explain the difficulty of reaching the critical size and respond to the criteria of obtaining markets:

Problems of size and cash structure

The problems of size and personnel structure: On average, the personnel in the firms is scarce, offering a profile of small firms with little resources in management (see table below).

Table 4.13. Average number of firms and percentage of managers by activities

Activities	2002		2003	
	Average number	Executives %	Average number	Executives %
Mechanical equipment	30,4	10,2	27,2	14,0
Electric and electrónicos equipment	41,4	21,1	47,0	14,9
Metallurgy and metal transformation	61,4	6,0	31,0	8,5
General mechanics	20,3	11,8	18,0	13,3
Other industrial activities	58,7	8,1	64,3	7,4
Research- projects/studies	26,4	31,8	3,5	32,5
Whole	-	12,7	-	14,2

Source: INSEE, 2003 & 2004a

The situation is somewhat better in Midi-Pyrénées where a 56% of the firms employ over 50 workers.

The firms that answered our survey are more numerous than those that answered the INSEE survey (a 56% of our sample have over 50 employees faced with only 23% for the INSEE). Whatever the number decided upon, it is, on average, above the regional average where only a 1% of firms with over 50 employees is counted. The INSEE survey gives complementary information: in 2002, the larger firms concentrated the most activity, the 69 firms that answered with over 100 employees carry out 65% of the aeronautics and aerospace work.

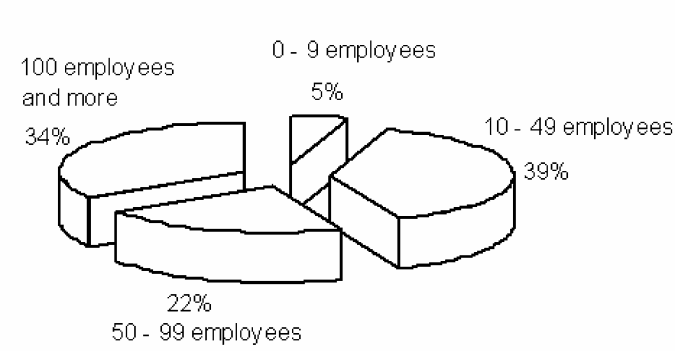

Fig. 4.5. Breakdown of firms by number of employees

Source: Data from INSEE Survey

Executives and managers (directors of firms, professionals, managers) represent a 14.9% of the active population on average in the regional industry, in aeronautics construction they represent a 34.6% and a 24.8% in related firms (1999 census). This high technical level is related to two elements:

The change in the organization of labour on the one hand; the increase in production management tasks with relation to the manufacturing tasks has often been pointed out. This increase in innovation and conception tasks explains the growing presence of managers.

On the other hand, it is also the sign of the relocation of manufacturing tasks and consequently of the lesser skilled jobs to countries with low labour costs.

Search for the means to acquire financial capacity

In 2003, of the firms surveyed by INSEE, 18% in Aquitaine and 24% in Midi-Pyrénées pertain, in over 25%, to other firms (16% in 2002). In Midi-Pyrénées a third of the firms of our survey belong to a group. It can be either a French or foreign group. These groups can or cannot be involved in aeronautics.

Table 4.14. Group membership

	Number of firms	%
Independent	25	56
Entity of group	14	31
Total	39	87
No answer	6	13
Total	45	100

Source: Data from INSEE Survey

This is a general movement within the French economy that enjoys a period of strong financial concentration. This financial concentration refers both to the take-over of small firms by large groups, and to the creation of groups of various SME having often a regional basis. Financial concentration may be the result of SME that during a troubled period seek persons that will take charge of the firm, or SME that associate so as to coordinate its industrial or commercial policies or also of foreign groups that wish to establish themselves in order to get closer to their markets[10]. This concentration can be characterized in a more subtle manner by defining the origin of the groups that take charge of the firm in crisis.

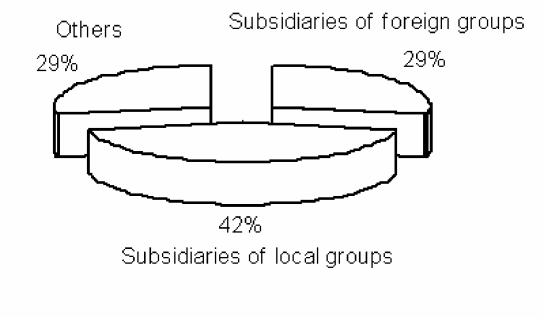

Fig. 4.6. Financial dependence

Source: Data from INSEE Survey

Of the 4 foreign groups, two are groups specialized in informatics for aeronautics. For the subsidiaries of the local groups, we can observe that for two of these firms, there is a relationship between them, this is the case of Latéele and the SIDMI. Latéele belongs to Latécoère that also controls SIDMI.

[10] Insee Première.

An activity insufficient in research and development

Although close to 60% of our sample (56% in Midi-Pyrénées) declare having invested during the last 3 years in technological innovation (without it always being possible to distinguish product innovation from process innovation), spending in R+D continues to be low: in Aquitaine, in close to half of the firms, invested funds are less than 10% in their total investment, whereas in Midi-Pyrénées, only 15.4% of the firms of the survey acknowledge spending more than 10% of its investment in R+D[11]

To this "lesser intensity" in invested funds should be added a limited number of license patents, given that in Midi-Pyrénées close to 65% (12/19) of the firms that innovate declared not having licensed patents. Yet, close to half pointed out having obtained a certification because of these innovations. On a more global level, 97% of the firms in our sample acknowledge not using patents from other firms. These statements would globally confirm a situation in which the firms that subcontract in the region of Aquitaine tend to lean more today on their own competences and knowledge. Innovations are made, and rarely, under a "closed lid", and permits notice cooperation processes between the different protagonists of the sectors to whom these firms belong, not excluding the institutional actors (public or quasi public).

Thus, no less than 70% of the firms in Aquitaine and 55% in Midi-Pyrénées declared having innovated and also point out having signed this cooperation agreements framework. This level is higher in the framework of product innovation than in process innovations. While the institutions intervene in a consequential manner in the product innovation framework and never in production process innovation (except for some financial aid not included in the cooperation statute according to the firms surveyed), it should be pointed out that these collaborations are basically inscribed with firms of the same sector.

The reasons for innovation are numerous but competition is the most generally mentioned factor. Close to 60% of the firms (58%) say they innovate in order to maintain or increase their market quota. The pressure of competition is felt more closely in Midi-Pyrénées where a 93% of firms say they innovate in order to maintain or increase their market quota. It is another way of pointing out the cost pressure imposed by the contractor. Even in long-term contracts, cost reduction clauses exist.

For example, the contractor says that the contract will be renewed only if the costs go down x% over three or four years. He justifies the demands

[11] Various firms have stressed the measure of this expense creates a problem in the accounting nomenclature.

by saying that improvement in the organization of the work (better management of supplies, reduction of the production cycles by eliminating empty time…) should allow obtain cost reductions and increased productivity.

In other words, these innovations have given global results. The effects appear to be significant and allow us see a positive elasticity between innovation and the level of activity. Thus, a 75% of the firms that have innovated, admitted that this had produced a rise in their business volume. This rise continues to be very uneven, from 5% to the duplication of the activity. In a more general manner, institutional measures of support to the development of firm activities (training, aid to exports, inter-firm cooperation), stresses that the existence of cooperation relations in the framework of technological innovation cannot obscure the lack of coincidence between the firms and the institutional world, be it local, national or European. In fact, only 18% of firms admit having benefited from these measures. The most interesting fact is that measures are considered mainly by a specific category of firms of our survey: those that had already cooperated within the frame of technological innovations. It would be necessary to see the reality of a "cooperation culture" for some firms. If yes, the question of easy access to the support measures proposed by the different institutions produced in this field is asked, and in particular for the firms that don't have this "culture". Isn't there technical knowledge to be learned in this field?

This can refer us to another question. It is difficult to know to what extent these measures respond to the firm needs and to the organizational and structural demands of their market. In particular, aren't these aids mostly for firms that are already on their way up? Don't these support measures only consolidate this trajectory?

Our analysis generally shows that through the group of experts on measures, firms usually seek help in training and for outstanding cases, in aid to cooperation development between firms (national or international) and in export aid.

Given the geographical origin of the supplier institutions of the measures used, our survey does not show a firms preference with respect to the local, national or European statute of these institutions, independently of the nature of the aid obtained. Thus, no strong reason for proximity appears in this phase. This would corroborate to an extent, the small coincidence observed between subcontracting firms within our survey, and the institutional fabric of the region.

A certification system not yet established

One can see a reinforcement of the criteria on quality control during the 90's. The certification (RAQ, ISO) becomes an almost indispensable reference in order to work on military and civilian programmes. Here too, the SME position is weakened as a result of the investments that must be made, both for paying the certifying organism as well as for introducing the rules within its organization and equipment. Furthermore, the smaller firms have difficulties in including specific personnel devoted to quality control and some other difficulties, for instance, those related to environment protection. Nevertheless, these organizational elements become a reason for selection on behalf of the contractors.

What is in play behind the development of this quality certification, is a transformation of the contractual procedures. The working logic for vertical relations between firms was, up to now, essentially tacit. The growing "marketization" of relations leads to more impersonal relations and a reinforcement of contractual procedures. Earlier working methods were essentially based on network of relations and tend to slow down for three reasons:

- The turn-over in those responsible for buying during this period
- Greater importance is given to buyers and their functions, to the detriment of direct relations between users/suppliers: buying was a simple exchange before, and now becomes autonomous;
- Growing formality in the contests and/or competitions and reinforcement of contracts.

The importance of norms is always ambiguous. When a long-term relation between partners exists, the common experience is sufficient for the information on the firm's competence and if the people's skill is satisfactory. The demand for norms then appears to be superfluous. Yet, the globalization of the markets makes it necessary since it may be required by the final client. It appears that the regulation movement should continue. Given the variety of rules and norms, the question of what type of regulation should be used must be precise. Over 70% of the firms surveyed say that the contractors demand quality control, of which, a little over half are general norms, the rest are manufacturer norms.

Without choosing between contractors and subcontractors, the INSEE Midi-Pyrénées research states that the ISO 9000 norm is more prevalent, given that there are 80% of certified firms. Next comes the Qualifas norm, with 30% of the firms. The frequency of the norm grows with the size of the firm. Thus, 16% of small firms are certified as opposed to a 90% of

those with over 50 employees. Many firms have at least two certificates, particularly the larger firms.

Table 4.15. Certified firms in Aquitaine & Midi-Pyrénées

	Certified Firms	
Activities	**Aquitaine**	**Midi-Pyrénées**
Mechanical equipment	60,5	60.5
Electric and electronic equipment	72,4	62.9
Metallurgy and transformation of metals	79,0	53.5
General mechanics	56,3	43.6
Other industrial activities	43,8	54.7
Services to firms	55,6	49.2
Whole	58,8	52.8

Source: Data from INSEE Survey

The Midi-Pyrénées region is delayed with respect to certificates of quality control. This delay refers to practically all branches. This is due perhaps, to the "privileged" relations established by the subcontractors some time ago with the local contractors. It is also, perhaps, an indication of the delay in the awareness that in future the subcontracting markets are international.

Collaborations that should be developed

As a general principle, the purpose is to take note of the expansion of the local fabric for establishing forms of collaboration between firms. In spite of its individuality, by the fact of having a similar cultural experience a group can be associated around federal technological and/or commercial projects. As we will see next, these hybrid forms of cooperation, that combine maintenance of a kind of independence from the firms and integration of complementary competences, aim propose to the contractors of "global offers" supply the set of services they require.

Table 4.16. Firms committed in a collaboration network

Activities	Aquitaine	Midi-Pyrénées
Mechanical equipment	38	26
Electric and electronic equipment	45	21
Metallurgy and transformation of metals	39	21
General mechanics	27	32
Other industrial activities	23	23
Research- projects/studies	31	40
Whole	32	28

Source: Data from INSEE Survey

Generally speaking, firms in the Midi-Pyrénées region appear less committed in the cooperation movement than other firms in Aquitaine. Only a 28% of the firms are under contract in an association network (as opposed to 32%). It is the sign, perhaps, that the Midi-Pyrénées firms grew under the protection of the aerospace sector, at a time when relations were more personal and this personalization served as a guarantee. The observation of the branch distribution of the intensity of collaboration leads us to this interpretation. In Aquitaine, the fact that the activities most involved in this scheme are equipment goods industries (a 38% of the mechanics, and a 45% of electrical electronics), metallurgy and metal transformation (39%), is a good example that shows they try to cover the structural deficiencies in these activities where responsibilities are greater. In Midi-Pyrénées, the branches traditionally linked to subcontracts are those that collaborate less. It is the sign, perhaps, of a delay in the perception of change in the manner of adjudication of the markets of subcontracts.

The table 4.17 shows the forms of collaboration when they exist.

Table 4.17. Collaboration structures

	Aquitaine (in %)	Midi-Pyrénées (in %)
Collaboration	68	71,9
Formal juridical structure	17,6	14,6
Comercial programme or project	14,4	12,6
Development product or project	10,9	9,3

Source: Data from INSEE Survey

The relative importance of these features indicates, however, a clear evolution of the local protagonists towards this type of solution. Some years ago, the hostility towards the alliances was clearer. An illustrative fact is that in practically half of the cases of collaboration (a little more in

Aquitaine, somewhat less in Midi-Pyrénées), alliances are based on the basis of a formal juridical structure (Group of Economic Interest (GIE), Joint stock company, simplified joint stock company, or associations also). Established mainly for commercial projects, and so, often sought by the contractors, a 34% (27% the previous year) of the alliances seek to develop a product or their own activity (INSEE, 2004a). The EETSE survey also shows that the majority of firms that have innovated in recent years did so within a context of cooperation.

From a geographical point of view, alliances are established by proximity, and so the Aquitaine region is always first to locate the subcontractors partners within the same region. Yet, and in agreement with the geographical evolution of the client portfolio, Midi-Pyrénées is also significant, although the set of other French regions occupy an important space, and growing in these last two years. This is particularly true when a product or development project is trying to be accomplished and more and more often when a commercial program or project is trying to be established. In this respect, the Aquitaine contractors seem to be seeking simultaneously a sectoral diversification, which, given the importance of the aeronautics and aerospace activities in the two SW regions, it would encourage them find partners outside of the region. Relations with firms outside of the region are developing when the service under contract refers to maintenance activities whereas the relations within Aquitaine are clearly dominant when the purpose is to cooperate on the conception of new ideas or in production.

These cooperation strategies should be judged with caution. On the one hand, they really are a means of reducing the effects of the structural insufficiencies mentioned before. On the other hand, they are not free from problems since:

- It is assumed that the working rules are clearly seen and accepted in the long term by the contractors of the respective partners;
- They cannot pretend change the firm organization structure of a firm that is vertically integrated because responsibility is rather slippery.
- The greater importance of equipment goods manufacturers in the value chains suggest that the alliances between SMEs can only be a means to keep a 2nd or even 3rd position within the supply pyramid.

In conclusion, in Southwest France (regions of Aquitaine and Midi-Pyrénées) are found the two regions where, besides the Paris region, the aeronautics and aerospace activity is most developed. Around this activity has emerged the mechanics and metal production sector and later that of services, and the development of a large number of SMEs to which the ac-

tivity is linked. The start-up of an aircraft or of a satellite requires the collaboration of a multitude of disciplines and trades, which the large manufacturers don't always wish develop internally. Thus, slowly, a complete array of outsourcing firms was built up over time.

It seems as if the development was accomplished in parallel, without synergy between the two regions to the extent that the sectors were built on separate blocks: the military in Aquitaine and the civilian in Midi-Pyrénées. The differences between the large contractors produce different cultures and different rules in industrial organization.

The SME in Aquitaine appear to be faced with a real organizational and cultural challenge, which is to pass from a logic based on agreement with its traditional contractors to a commercial logic where competition is more severe and the cost criteria become a burden. These demands have been imposed for a much longer time to the SME of Midi-Pyrénées given that Airbus entered into commercial competition in the early 80's and is determined to continue a rationalization and organization of the subcontracting fabric.

To enter into an ever more world wide competition, the subcontractors should reach, either alone or grouped to others, a technological and financial critical mass. The technological level should allow them guarantee, not only the manufacturing of the parts, but upgrade in the phases of conceiving new ideas. This improvement would on the other hand, permit them obtain a certain power of negotiation with the contractors. Their financial structure should allow them guarantee finance the increase in the needs for the operation fund, linked to the lengthening of the production cycle caused by the integration of the conception and design phases of the product.

The globalization of the subcontracting markets makes the subcontractors enter into a world of imperfect information and doubtful future. In order to avoid the difficulties born of this situation, they should not only do it well, but also communicate their quality standards well; and in order to do this they should enter into a certification logic that will allow them indicate the quality rules they have achieved.

4.4 Territorial Governance in Midi-Pyrénées and Aquitaine

The analysis of local institutional agents belongs to the larger question of territorial governance (see Chapter 3). At the meso-economic level, territorial governance refers to the way in which the actors interact according to "norms" and make these norms change. Territorial governance in itself

does not play a role, but rather is rooted in national, European or even global (the WTO for example) regulations. Although the spirit of the meta-level should be upheld, in this section we will focus on regional aspects to show that the regions of Midi-Pyrénées and Aquitaine are similar to each other in some points but different in others in the issue of territorial governance. This section will analyze these points.

4.4.1 Governance in the Aeronautical System of Toulouse

Present-day territorial governance in both Aquitaine and the Midi-Pyrénées is, of course, the result of a long historical trajectory. Contemporary configurations should be discussed within a historical perspective sin-ce transformations in global and local regulations and learning on the part of local and other actors determine the governance concepts conceived at any given moment in time.

1. A Brief Historical Perspective[12]

The choice of products to be manufactured and the appointment of management staff in the French aeronautical industry was initially in the hands of the government. Then in the late 1970s aeronautical activities underwent a process of industrial and financial concentration under the auspices of the State which, in 1969, led to a single firm, SNIAS, in civil aeronautics. This process structures the dynamic of the French aeronautical sector dominated by this completely integrated and hierarchical firm. Design, research and R&D were carried out in the Parisian region of Suresnes, while manufacturing and assembly were located in provincial cities as in pure Fordism. All tasks were distributed among the firms integrated into the group leaving little opportunity for externalization.

The structure of the sector, therefore, was vertical for this period to the end of the 1970s. SNIAS was the only integrated firm under government control and carried out all the tasks involved in the construction of an aircraft.

During the transition period (1980-2000) GIE Airbus and SNIAS developed a new marketing strategy, an alternative to the arsenal logic that had prevailed up to the 1970s. This strategy was accompanied by a radical reorganization of production inlcuding externalization of some activities and specialization of production centers, particularly in Toulouse. Relations

[12] The reader can find a more detailed analysis of these historical aspects in Dupuy, Gilly (2005).

with public research centers were still scarce and technological innovation was essentially developed internally.

State intervention progressively receded which paved the way for the privatization of the group. However, the vertical logic remained in place in GIE and SNIAS, the key public and private agents.

In the most recent period, 2000-2004, interviews with the main actors revealed that the most active public institutions in the industrial dynamic of the Toulouse Aeronautical System (SAT) were the regional council, through the Midi-Pyrénées Expansion development agency, and the DRIRE, a decentralized service of the State. Cooperative relations between these institutions characterize local governance and pluridimensional cooperation between EADS and its local environment began to appear. To illustrate this complex play of relationships, four examples of these interactions and network building will be discussed in R&D and formation and two programs, the aeroconstellation program and the ADER plan.

2. Research and Development (R&D)

Innovation engineering in EADS is organized in five transnational centers through which engineers from the various production Airbus centers are networked. This organization also maintians links to public research centers (Cert-Onera, CEAT as well as CNRS, Universities, etc.) This new collaboration between EADS and regional research laboratories illustrates the research potential in Midi-Pyrénées in the aeronautical/aerospace sector.

R&D is distributed between public and private investigation as shown in Table 4.18 where the figures refer to personnel and spending.

Table 4.18. Distribution of R&D between public and private research

	Public in K euros		Private in K euros	
Midi-Pyrenees	783 159	6,46 %	1 057 900	5,09 %
France	12 105 204		20 782 200	

The DIRD (interior spending on R&D) of the private sector in Midi-Pyrénées is mainly dedicated to research in the aeronautical and aerospace industry (45% of the total as opposed to 8% in all of France)[13].

The CNRT plays a central role in the fabric of relations between science and industry. The CNRTs, National Centers for Technological Research,

[13] Research in Midi-Pyrénées, *Les dossiers de l'Insee Midi-Pyrènèes*, 123, Sept 2004.

aim to promote efficient collaboration between public laboratories and those of the large industrial groups to develop technological research activities. From July 2000 to March 2004, 19 CNRTs were created by the Ministry of Investigation and constitute a major axis of the Ministry's policy to promote technological transfer. The National Center for Aeronautical and Space Technology Research (CNRT-AE) in Toulouse proposes to create a competence and excellency pole by concentrating resources and organizing close collaboration between public and industrial research thus consolidating Toulouse as the leader of the sector's national and European aeronautical network.

The objective of the CNRT is to create an association of aeronautical engineers, professional unions, public research and, in general, all those involved in aeronautical/aerospace research in France to work toward a new dynamic of aerospace investigation in Midi-Pyrénées. Eight large-scale research programs are now either being launched or on-going. Each program has brought together a consortium of about ten industrial and research participants on topics such as:

- Surface properties of titanium alloys
- The use of UML in the aeronautical industry
- Certification of embedded computer programs
- Numeric simulation of the certification of aerostructures
- Intelligent toolage in the aerospace industry
- The division of ground and on-board authority
- Noise reduction in airships
- Development of an Open Source computer workshop

Besides the key role played by the CNRT, it is also necessary to take into account other agents in the field of research such as the MIDI (Collective Multimedia Visualization and Distributed Engineering) which was created by four partners (EADS, CNRS, the University of Toulouse III and the Toulouse National Polytecnical Institute) for a period of four years (25/10/2002-24/10/2006). In line with Airbus' development projects on industrial methods, the scientific activities developed in the MIDI are the following:

- Cooperative work and simultaneous engineering environment
- Communication infrastructure in the extended firm
- Multimodality, Multi-user distributed interaction
- Multimedia visualization of multiple sources and cooperative interaction

To support the development of aerospace products in firms dispersed throughout the territory, cooperative methods and tools shared among

teams in various locations (distributed engineering) are being developed to facilitate visualization and interaction with shared numerical models, substituting physical models by using Distributed Virtual Reality technologies and generally facilitate communication. The objective is to reduce costs and time of conception, make optimal decisions and correct errors as soon as possible.

The visual presentation of large volumes of multimedia information coming from several sources on a large format visualization device and the use interactive resources for cooperative work sessions are of specific interest. Besides the MIDI, there are two other joint research laboratories:

- The RIS (Labor Security Engineering Network) founded in 2001 by Astrium, EADS Airbus, LAAS-CNRS, Technicatome and THALES. The structure and statutes of the RIS are regulated by an agreement signed by all the founding members of the Network which defines the participation of the various members. The activity of the RIS is articulated around two main actions: thematic workshops and Work Groups;
- The TESA (Aeronautical and Space Telecommunications). This cooperative laboratory includes nine university laboratories belonging to the Enseeiht, the ENST, the IRIT, Supaero, the ENAC and the ENSICA, two industrialists (Alcatel and Rockwell-Collins), three institutional partners: the General Council, the CNES and the DGAC, and a network of associates, particularly SMEs, also associated with this cooperative laboratory.

Various specialized organisms complete the scenario of aeronautical research potential:

- The *ONERA (National Office for Aeronautical Study and Research)*, a technical-scientific public entity of an industrial and commercial nature was located in Toulouse in 1968 as CERT (Toulouse Study and Research Center) with a budget of nearly 225m Francs. It annually sponsors 300 study contracts and participates in the national research programs of the Ministry of Defense, CNES, and other centers as well as in European programs. Human resources include 420 people among which 280 are permanent research engineers and technicians and 90 are pre-doctoral engineers. It also takes in more than 100 practice students a year.
- The *Toulouse Center for Aeronautical Testing (CEAT)*, the first world testing center for structures and materials. The CEAT's line of work is testing and evaluation on the ground of military and civil aircraft structures, equipment and systems thus guaranteeing results, security and reliability. The center has 450 military and civil clients and maintains

direct and constant relations with the large national industries in the sector (Aerospatiale, Dassault Aviation, Matra, Sextante-Avionique, Thomson, Messier-Bugatti, Liebherr Aérospace Toulouse, etc.).
- The *European Institute for Electronic Transportation Systems Research (IERSET)* was founded in 1996 by firms and research centers who proposed to investigate embedded communication systems for the various means of transportation. To date, more than 12 projects joining large groups, SMEs and research centers have been initiated in the IERSET for the amount of three million euros.

Finally, the dislocation of a regional antenna (35 persons with materials, structures and electromagnetic compatibility) from the EADS center located in Suresnes to Blagnac was significant.

The various public actors and the Regional Council of Midi-Pyrénées actively promoted these networking devices for science and industry in the aeronautical sector:

- In the framework of the State-Region Contract Plan 2000-2006, 68.6m euros were contributed, particularly for the "materials" pole (7.6m euros).
- About 25% of the projects presented to the CCRRDT[14] refer to the aeronautical sector.
- CNRT funding for 82K euros (2000-2006).
- Support for two new ONERA programs: 1.2m euros for polyphase construction and 0.4m euros for electromagnetic compatibility.
- Support for the R&D program on compounds (Microturbo, Technofan, Liebherr Aerospace).

3. Worker Training and Mobility

Training

The organization of professional training is usually coordinated between public and private actors coinciding with the creation of new diplomas and their implementation.

The role of peer-group consulting commissions is essential to the creation of new diplomas. The French educational system has traditionally existed independent of all economic reality. In the mid-1970s, youth unemployment sharply rose and the industrialists explained that they needed la-

[14] The regional consulting committee for technological research and development accepts the projects presented by the research laboratories for funding by the regional council. Participation in local development is an important criteria in selection.

bor specifically trained in each professional sector. They criticized the Ministry of National Education for offering training without considering the local employment offers. The Professional Consulting Commission[15] defines the professional and technological knowledge level and test on general knowledge (French, Math, English, History, etc.) and establishes the Job Profile. Then the Educational Commission of the Ministry of Education translates the job profile into a Formation Profile. This procedure takes several years before the new degree is finally published in the Official Bulletin.

New degrees and diplomas are the result of negotiations between the State and local collectives. In fact, since decentralization laws have been enacted, a part of the resources, particularly the teaching staff, is decided by the central administration while the construction of schools is the responsibility of the Regional Council. In both cases, some of the complementary resources may be furnished by local firms who are particularly interested in the local implantation of certain sections of technical training.

With the 1993 law, the Regional Council acquired a stronger role in the coordination of the actors professional training which involved establishing relations with an increasingly broad range of actors and guaranteeing coordination, regulation and coherence in their interventions. The present Control Committee of the PRDF[16] is made up of the State and its decentralized services (SGAR, Rectorate, local conference of University presidents, DRAF, DRTEFP, DRASS, DRJS)[17], representatives from the Apfa, Carif/Oref[18], trade unions (CRCI, CRM. CRA), from the CESR[19], and social spokespersons from the COPIRE[20].

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[15] This Commission is made up of large groups and to some extent SMEs. Depending on the professional trade, artisans or commercial representatives may be associated. The duties of the Commission are essential. It must define the functions, level of competence (savoir-faire and savoir-être), and the level of profes-sional and technological knowledge required. In each affiliate, the Commission must establish priorities in the task and responsibility content according to the training levels (level V: CAP, BEP, Complementary Mention), the technical level (Level IV: Professional or Technological Baccalaureate) and level of management (Level III: BTS, DUT ...).

[16] PRDF is the Regional Plan for Training Development and was established for the period from 2001 to 2006. Its objective is to assure coherence in the plans of the various actors.

[17] These acronyms represent various regional management personnel in agriculture, forest management, employment, job training, health and social services and sports and youth.

[18] Association for professional training and learning, center of animation and information resources on training, regional employment and training observatory.

Interaction among these actors has created a rather prosperous fabric of training centers with 114,000 students of which 99,100 are in the urban pole of Toulouse, making the Midi-Pyrénées region the second in number of students related to total population (4%). In the 14 engineering schools in Toulouse, Tarbes and Albi 7,850 engineers are in training, without taking into account preparatory classes for the large schools. About one third of the students have a second or third cycle university degree or a degree in engineering as opposed to 27% at the national level. Six percent of the students attend engineering schools as opposed to 3% in all of France. The three largest aeronautical engineering schools in Toulouse train 75% of the engineers in the Group of Aeronautics and Space Schools in France.

- SUPAERO . National Superior School of Aeronautics and Space
- ENSICA - National Superior School of Aeronautical Construction Engineers.
- ENAC - Nation School of Civil Aviation.
- ENSEEIHIT: we might add the entity, the Toulouse National Superior School of Electronics, Electrotechnia, Computer Science and Hydraulics) for computer and electronic components. On the other hand, the ENST (National Superior School of Telecommunications) has an aeronautical and space elective.

The following are other schools that are not within this network but can be considered higher education with advanced training:

- The International School of Toulouse, an affiliate of Airbus UK;
- European Institute of Distribution and Negotiation (IEDN - ESC Group)
- European Center for the Teaching of Aerospace Sciences (Air Business Academy).

Vocational training is also being developed at a lower level of qualification. In all, 23,589 students (15,385 in advanced training) were enrolled in technological vocational training in 2001/2002 which represents a 26% increase over 5 years and a 65% increase in IUT schools (University Technologcal Institutes) in 10 years. A typical example is the recent inauguration in October 2004 of the "Lycée des mètiers" in Blagnac which trains students in aeronautical trades at a pre-Baccalaureate level.

[19] Regional economic and social committee.

[20] Acronym for the Regional Interprofessional Paritory Commission on Employment, a social and professional organism made up of eight organizations, five of them from central workers' unions (CFDT, CGC, FO, CGT, CFTC) and three inter-professional employers organizations (MEDEF, UPA, CGPME).

Mobility

Mobility refers both to job access as well as changes from one firm to another. Various owners' associations have been created:

An Association of Employers (TOP) was founded in 1993 in the Mirail (Western Toulouse)and another is being created on the ZAC Aéro-constellation: AFUL. Neither aims to directly manage employment but rather organize regular exchanges of information and "good practices" among firms and direct some of their common needs and demands toward territorial collectivities. This type of association may lead to more complex initiatives such as employer groups, labor loans, exchanges, etc.

These associations are not the only way to organize exchanges among firms: the DRH of the large aerospace groups have lunch together once a month and employer groups such as the one created through an initiative of the Community of the Southeast Toulouse Agglomeration (SICOVAL) whose aim is to perfect the mobilization of labor in order to counteract fluctuation in the activity. It signed the Syntec collective bargaining agreement which is not particularly favorable to wage earners.

A document composed by the Center for Young Managers (CJD) was published in June 2004 titled *Employer Groups: an innovation to create jobs and develop SMEs.* This paper proposed improving the currect legislation which until now could prevent the formation of more employer groups. These modifications refer particularly to the status of the wage-earners' in these groups; the principle of wage equality and social advantages (including participation in profits and shares), doubling the trial period, the approval of a national collective bargaining agreement, etc.

Labor loaning agreements:

- Motorola and Alcatel Espace signed an agreement to loan labor for non-profit objectives in the face of decreasing work plans in the space sector. There are other operations of this type such as Latécoère and Microturbo.
- CESR Midi-Pyrénées proposed generalizing labor loaning and has asked *the* Regional Council to organize a meeting of aeronautical industrialists as soon as possible in order to study possible conditions of labor-loaning according to the modalities described in law number 73-4 of January 2, 1973. A training period could be necessary to facilitate adaptation of the loaned personnel and could be carried out internally by personnel temporarily in excess, in association with the large schools. This solu-tion is not exclusive of the aeronautical sector. (Minutes, meeting 17 October 2003).

*An entrepreneurial job agreement:*The project for job agreements that the management of Alcatel Espace has brought before the labor unions requests that laws be repealed, increasing the duration of provisional contracts to more than the authorized three months and recurring even more to subcontracting to meet an increase in activity (recent dismissals for financial reasons have led to limits on the right to contract external personnel). A CGT mandatary in the firm proposes that provisional status be considered within this same logic of new management: instead of giving personnel indefinite contracts according to the average between highest and lowest job levels, these contracts should correspond to the lowest point and any others should be temporary.

4. The Aéroconstellation Program

The Aéroconstellation Program is an extensive project to adapt the Western Septentrional part of Toulouse by establishing an industrial platform capable of carrying out the assembly of the A380. The launching of this initiative coincided with the decision to build Airbus' huge new carrier and was significant in the choice of Toulouse as the assembly location of the aircraft. In 1995, making a decision as to location and economic feasibility and finding an extensive area where the testing runways could be connected was essential before starting up the program. For this reason the Gran Toulouse[21], through its designers SETOMIP and SEM Blagnac-Constellation, developed the Aéroconstellation Program, one of the most extensive adaptation programs in Europe. State services were immediately associated to the project and since 1999, the prefect has contributed its support and facilitated the preparation of an agreement protocol[22] associating the General Council, the Regional Council, the district of the Gran Toulouse (the future Gran Toulouse Agglomeration Community) and the SIVOM[23] Blagnac-Constellation. For this protocol, the signing collectivities mainly agreed to:

... create, equip and make available to the development of the aeronautical sector the first section of 220 hectares for an adaptation zone which, in the long term will cover 320 hectares without the possibility of continuing north of the Blagnac airport platform. This zone will benefit from the

[21] The Gran Toulouse Agglomeration Community is composed of 25 cities.

[22] For this protocol agreement, the five undersigners "affirmed their will and determination to act jointly in creating and carrying out an operation "de aménagement à vocation de parc d'activités aéronautiques".

[23] An Intercommunal Union, later the SEM Blagnac-constellation, with various tasks to perform in response to location needs: purchase of land, urbanization and connection to networks, resale to industrialists.

infrastructures (roads and other works, fluids, networks, access and taxiways...) and from the services necessary for its aeronautical vocation (reception, vigilance, prevention and health, fire service, sewer treatment, boilers, compressed, air, etc.)...

... receive in this zone, with advantagous financial conditions, the implantation of aeronautical-related activities. The reception in this zone of net job-creating operations, generators of significant fiscal resources, will be effected in optimal financial conditions according to national, European and international norms.

A Task and Follow-up Force was established to which EADS and the airport CCI managers were associated.

In all, the zone mobilizes nearly a billion euros of public and private investments of which 590m come from Airbus. Local collectives promised 172 m euros[24] to public works.

The interaction of the various main actors can be seen in the following organigram. The private actors, in particular *Air France* and *EADS,* do not appear but have been closely linked to the project since its conception because they are the main "clients" of Aéroconstellation. The circulation plan refers to organization and assembly areas.

The Aéroconstallation Program proposes the adaptation of several areas to the needs of the A380 project. The first is the ZAC Aéroconstellation, essentially an industrial area, with 214 hectares which will mainly be used by Airbus for the A380 assembly hall, by Air France as a maintenance area formerly located elsewhere in Toulouse, and for all the industrial installations needed by these two firms. A second ZAC, a residential and services area, is located nearby and has 240 hectares. This is the ZAC Andromède with the potential for accommodation for 3,700. Finally, a third much smaller area (57 hectares), mainly for housing and public offices, is called the Southern Cross ZAC. In these three areas, building is quite advanced. A fourth mainly industrial area, planned for a township somewhat farther from the center and the airport, is the Cassiopée area. Subcontracted SMEs could be located there and applications have already been presented.

Access roads are being developed by the State through the DDE (Equipment Department Management) and will involve adaptation of present roads to make a special-size highway facilitating terrestrial transportation of the sections of the A380 between Bordeaux (Langon) and Toulouse. The General Council will adapt departmental highways for the program.

[24] Les Echos, 10 May 2004.

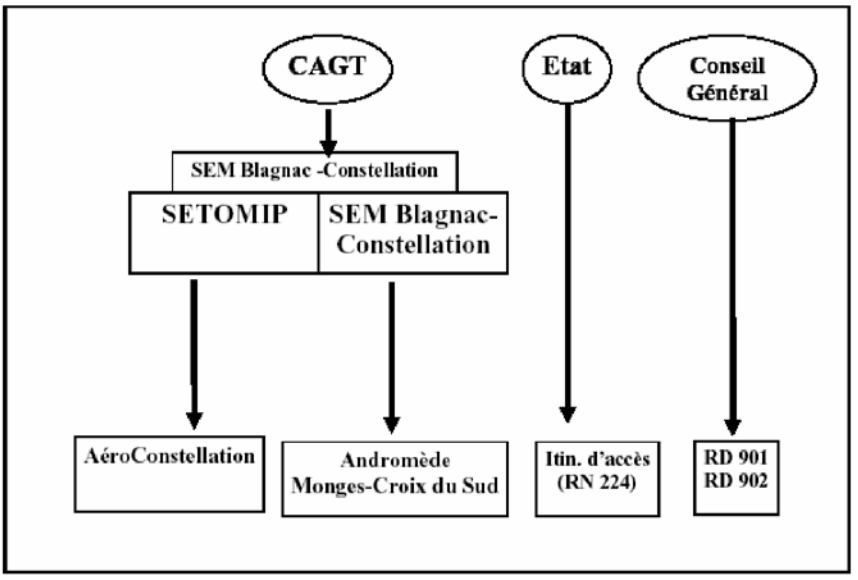


Fig. 4.7. Institutions and the Aeroconstellation zone

This project is therefore the result of the collaboration between public, semi-public and private actors. The legal and financial set-up has required problem solving strategies. Basic installations are funded with the ZAC balance while those of general interest will later be leased to the townships and customer association (AFUL).

5. The ADER Plan: Action Plan for the Development of Regional Outsourcing Firms

Objectives

The ADER plan responds to the need to "modernize" the fabric of industrial subcontracting SMEs (metal workshops, surface treatment, plastidirurgia, electronics, and tool manufacturing) or services (analyses, conception and integration of functional modules, high technology, computer science, telecommunications, etc.).

The aeronautical construction sector must meet significant cost reductions imposed at all levels of the productive chain of subcontractors (an average of 20%) respecting at the same time a higher level of quality and shorter and shorter production deadlines. The contractors systematically make SMEs compete with firms located abroad, particularly through international tenders in electronic market platforms. This international context pushes regional subcontracting SMEs to adapt.

The evolution of production methods within the concept of the extended firm requires subcontracting firms to share the financial risk involved in the development of new programs. The contractor pays orders from subcontracted firms on delivery of the aircraft, that is, several years after the order was placed.

Subcontracted firms must make an effort to increase productivity gains and flexibility, meet shorter deadlines, consolidate contractor-subcontractors relations which require the integration of new technologies, new technical knowledge and new productive processes (e.g. integration of information systems in the control of production), reinforcement of industrial association often leading to regroupings of complementary competencies in order to present joint bids and diversification to meet the needs of future international markets.

For these reasons, at the recommendation of the DRIRE (Regional Direction of the Ministry of Industry), in December of 2000 the State defined the ADER plan for the Development of Regional Subcontracting Firms to accompany the subcontracting SME network within the aeronautical sector in their need to undergo significant change to meet industrial growth.

This action plan, adopted by the Regional Council, requires close coordination of local actors; trade chambers, development agents, professional organizations, etc.

The objectives of the ADER Plan are to:

- Develop Research and Innovation: The Contract between State and Region created the Regional Materials Research and Technology Network (RRRT Materials), while the State, represented by the DRRT (Regional Research and Technology Management) launched a National Technological Research Center in the aeronautical/aerospace sector grouping industrialists and laboratories to synergize their competencies. This Center was established in Toulouse in 2002 with the joint par-ticipation of all laboratories involved and the large industrialists in the sector.
- Intensify the application of simultaneous and convergent innovation technology and engineering in SMEs in order to accelerate industrial change in these firms.
- Promote the regrouping of subcontracting SMEs to reinforce their competitiveness with a larger supply of services, broader technology and more adequate financial capabilities.
- Improve competitiveness of the SMEs.
- Facilitate the implantation of new firms to increase regional industrial potential.
- Help firms search for new markets in the international scenario.
- Set in motion a strategic intelligence approach in the aeronautical sector.

These complementary measures generally involve collective action and specific individual aid. To finance these actions, 23m euros will be mobilized in the period 2001-2004 within the ADER Plan.

Balance of these Actions

There were 338 firms in the ADER Plan in 2002. These are firms that have either received detailed information on the ADER or have obtained aid in the framework of given actions.

Before the actual start-up of the various actions of the Plan, an awareness campaign was launched in 2002 in the eight Departments of the Midi-Pyrénées Region, followed by various meetings set up by local partners of the ADER Plan. In this stage 113 firms, in 136 visits throughout 2002, were directly informed of the objectives of ADER by the Commissioners of Midi-Pyrénées, Subdivisions of DRIRE, Ariège Expansion, Ágata, CDDE 65, ADE 82, Mécanic Valle, ALD 46, etc. who held interviews with firms wishing to benefit from ADER actions.

After these visits, the DRIRE in charge of the Secretariat of the Technical Committee for Orientation (CTOA) of the ADER[25] Plan analyzed the firms' objectives and propose the launching of the actions requested. Composed of representatives of the local financiers and partners, the Committee met five times in 2002 to examine the objectives of the firms visited in order to validate their participation in collective and individual actions. In 2002, 298 Midi-Pyrénées firms profited from at least one collective or individual subsidy from the ADER Plan.

[25] The Technical Orientation Committee has benefited from cooperation at the following levels:
the State: el DRIRE, the DREE, the recotorate, the Prefecture with the Datar and the SGAR).
the region: the Regional Council and MPE, the CCI (a representative from the Midi-Pyrénées VVI) the General Council, and MPE, the CCI (a representative for all of the Midi-Pyrénées CCIs, the general Council, the UIMM and the Bank of France.

Table 4.19. Distribution of firms receiving aid by region

ARIEGE	20	6,71
AVEYRON	21	7,05
HAUTE GARONNE	135	45,30
GERS	7	2,35
LOT	22	7,38
HAUTES PYRÉNÉES	26	8,72
TARN	54	18,12
TARN ET GARONNE	13	4,36
TOTAL	**298**	**100**

The balance of this financial collaboration between the State and the region, shows that, in the fiscal year 2002, the State and the Midi-Pyrénées Region jointly pledged 5,799,756 euros to the ADER Plan excluding the area of contracting and training.

Table 4.20. Distribution of financial pledge State/Region

IN EUROS	STATE + FEDER	REGION	TOTAL
COLLECTIVE ACTIONS	622 910	401 005	1 03 915
INDIVIDUAL ACTIONS	2 697 613	2 078 228	4 775 841
TOTAL	3 320 5523	2 479 233	5 799 756

These resources facilitated numerous successful exchanges between regional services and local partners in the eight departments of the Midi-Pyrénées region and the experience is considered adequate by the members.

In January 2005 the ADER 2 Plan was published. Participants expect that funding will be around 100m euros of which one third would be financed by the State, one third by local organisms and one third by firms.

4.4.2 Governance of the ASD Sector in Aquitaine

It would be impossible to deal with the ASD sector in Aquitaine without referring to the D of Defense. This difference is significant when comparing Aquitaine with the Midi-Pyrénées because it explains why Aquitaine, as a result of decreasing global orders for weapons during the 1990s, began to diversify into civil aeronautics. The defense aspect also explains why territorial governance in this region is significantly different from that of the Midi-Pyrénées.

1. A Historical Perspective[26]

As in the Midi-Pyrénées, the first stage of the aerospace industry in Aquitaine was dominated by the State. Sectorial and territorial regulation of the industry is clearly defined at the national level until the 1990s. Hence, in the context of centralization and growing weapons expenses, local intervention is scarce during this long period. In fact, the first actions in favor of an ASD fabric in Aquitaine did not appear until the beginning of the 1990s.

- ASD at the beginning of the 1990s: a sector in need of aid

The weapons crisis situation came about when the fall of the wall of Berlin set off a drastic reduction in military orders in favor of industrial orders in the region. The most obvious example of this is the abandoned Hades ballistic missile project. Regional awareness of the problem and possible actions to be implemented first appeared in a report published in 1992 by the Regional Economic and Social Council of Aquitaine (CERS-Aquitaine). The report affirmed that there was a crisis and that it would last for a long time if nothing was done to end it. It predicted that employment would fall by 4,000 to 5,000 jobs due to decisions made in 1992-1993. Moreover, the perspectives for 1994 were even worse. The Employers' Union also announced its concern that ... *nearly 63,000 jobs of the 170,000 industrial jobs in the area are either directly or indirectly related to armament activities in our region, mainly in Gironde.*

At a second level, the CESR considered that wage-earners and subcontractors should not have to suffer from choices that are not incumbent to them. The collectives and large contractors should dedicate more economic and social resources to efficiently manage the situation of those men and women facing painful changes. The CESR report suggests that collectives should get the State and large national defense firms to guarantee the perpetuity of ASD production in Aquitaine and even the promise of privileged treatment. The report simultaneously proposes that contractors and subcontractors be assisted in diversification efforts. Subcontractors should commit internal resources to diversify their activities and establish technological transfer devices for local subcontractors to be selected for the various aid programs and access national and European markets.

From our present-day perspective, the CESR report correctly described the spirit of local actors at that time, one of incredulity at the crisis and of turning to the State, as the main client/producer in the industrial fabric of

[26] The reader can refer to the EETSE territorial report on the region of Aquitaine for a more detailed presentation of these historical details.

Aquitaine, to accept its direct and indirect responsibilities in this crisis. In fact, the possibility of endogenous development is hardly mentioned in the report which emphasizes development from above and proposals to maintain or propose new work loads on the firms and/or finance them with public funds (national or European) to help the SMEs. The statement of the council definitely does not consider the establishment of an independent territorial governance as the key to overcoming the crisis. Thus, local intervention aimed to protect the status quo without a real development strategy. Three main resources were to be mobilized in the region.

The main source of funding was from the central State. The FRED (Defense Restructuring Fund) was established in 1992 by the Ministry of Defense with the objective of reducing the economic and social consequences brought about by the restructuring of the military defense industry. This fund aimed to revitalize unemployment pockets being restructured through collective actions carried out by local operators in the reconversion of the local economic fabric and/or aid to investment for the creation, installation or development of firms within the depressed area (subsidy of a 20% maximum of the firm investment).

The starting up of the operation involves the collaboration of a large number of local agents, particularly in the framework of the attribution commissions[27] which design the future regional aid. For example, for the center of Bordeaux a tripartite agreement - State/Region/Department - was established to initiate this fund. The Regional Council and the General Council agreed to equally share the cost of subsidies assigned by the State. When the first FRED applications appeared in 1992, the Ministry assigned 5m francs, the General Council and the Regional council 2.5m francs each.

- By December 31, 1994, the 210m francs assigned to FRED at the national level were distributed among 611 projects. By 1996 n Aquitaine this fund had contributed to the start-up of 79 firms and distributed

[27] The atribution commission was made up of an existing structure that was rehabilitated for the occasion through the admission of the General Council into the Regional Committee for the support of SMEs (CRAPME). The following organisms participated in this Committee: the prefect of the region, the prefects of the departments, the representatives of the various services of the Prefecture of Gironde, the regional delegate of industrial restructuring, the general treasurer of the region of Acquitaine, the director of the Bank of France, representatives from fraud avoidance services, the regional management of international commerce, from the regional industry management, from research and environment, from the delegation of artisan commerce and the regional management of agriculture and forests.

28.5m francs in aid. This represents, however, only a small part of total aid invested in the area for economic development.

- Official and/or regional funds. In 1992 the region of Aquitaine set up the Regional Aid Fund for Change in Defense, Weapons and Space Industries (FRAMIDAE). This fund provided 14.3m francs for the CRAPME, 4.5m francs in 1992 and 9.7m in 1993 and was not renewed. At first, the fund was tagged for financial and marketing diagnoses for 29 firms in Acquitaine (14 in Gironde, 12 in the Atlantic Pyrenees and 3 in Lot in Garonne). Later the fund allowed for direct help to firms through a) financial assistance by refundable loans for 20 firms; b) support to commercial reinforcement by contracting executives or assigning collaborators to 8 firms, and c) aid to firm regroupings or the creation of common services. However, the fact that this intervention program was not renewed would seem to support our opinion that the Region still assigns little significance to aid devices for its ASD indus-try. It is considered that the State, or if necessary a higher entity such as Europe, should manage the crisis.

The crisis at the European level and in particular in Germany led the European Commission to adopt a European initiative called KONVER which aimed to "assist regions weakened by decadence of defense industries or installations". Following the usual norms for EU funds, KONVER only financed up to 50% of each project while the rest should come from official and/or regional funds. Fourteen regions have benefited from 215m francs of which 15.2m francs were for Aquitaine[28], distributed among the unemployment pockets of Bordeaux-Arcachon, Bergerac, Périgueux, Bayonne, Pau and Oloron Mauleon. In this first period, the three large funds - flowing from the State, the region and Europe respectively - provided most of the budgets used by the Aquitaine public system for the first improvement measures.

However, other alternative funding possibilities were available to firms. Long-standing actors such as DRIRE, ANVAR and ADEME among others, still constituted potential sources of financing for projects that were included in their competencies (investment, innovation, environmental issues). Thus industrialists sometimes sensed some dispersion in funding devices and some have a negative opinion of the complexity of the system. The Chamber of Commerce and Industry authorities attempt to orient the industrialists but this does not avoid duplications of subsidies. At the same

[28] Acquitaine is next to the last in French regions receiving aid although at the end of the second period - in reality 1996-1999 - Acquitaine became the major beneficiary of the program.

time, this period coincides with the development of technopolies which extends even more the number of potential actors.

In an evaluation of public policy in this period, B. Jullien y alii (2002) point out that the system in Acquitaine responds to the crisis with great institutional creativity. In the face of the crisis, there is a significant mobilization of local actors even as the impression of dispersion persists. Along with the funds that structure the intervention, the actors manifest some concern as to existing devices, whether industrial or institutional. The sudden increase in funding devices illustrates the lack of consensus as to the objectives of aid for the sector. The local public aid system varies between policies to help firms dependent on the weapons and defense industry to exit the sector while others aim to reinforce the position of SMEs in this sector.

- Centralization and clarification of intervention strategies in the second half of the 1990s

After 1996 errors committed in aid programs in the initial period were corrected and a centralization of public intervention and definition of local governance strategies took place under the auspices of the new Regional Delegate for Reconversion and Restructuring of Defense (DRRIRD).

The first step was to obtain a precise diagnosis of the situation in Aquitaine and in the firms, particularly the SMEs which are, by definition, heterogeneous and unknown. The objective from then on would be to assign the majority of resources available to firms that present credible projects based on their technical and organizational competencies and, specifically, to help them formalize these projects. This priority in projects was accompanied by priority axes for the region emphasizing the ASD sector. The State-Region agreement was signed April 25, 1996 and explicitly formalized the objectives that should be achieved and the resources to be employed.

The policy of sectorial diversification of defense-related firms was destined to disappear even as it was becoming a reality. The strategic orientation of regional intervention now considered that transformations in the supply market imposed geographic diversification and, therefore, subsidies for internationalization became a priority for intervention. For this reason, the Aquitaine region participated in interregional cooperation programs with local actors from the Spanish Basque Country, Northwest England and Italy. At the same time, the Regional Council emphasized the exploration of new markets and cooperation with firms in Québec, Canada. Thus, by the end of the 1990s all programs in the evolution of local governance gave priority to inserting local firms in international markets. These initiatives, among others, indicate a certain change in the sectorial location of

the SMEs. Initially DRRIRD priority axes for intervention aimed to convert firms to new "non-military" markets and often non-aeronautical and non-spatial markets. The reluctance of the firms to make this change, some unfortunate experiences and the continuation of the global sectorial situation combined to promote a reorientation of global strategy. Aeronautics and aerospace were from that moment the priority and access of associations to international and exporting markets was essential.

However, this fiscal period was not prosperous due to the structural weakness of SMEs in Aquitaine. Local actors strongly encouraged the regrouping of firms in the region to restructure the industrial fabric and to be able to participate in the local tenders which began to appear toward the end of the decade: the construction of the Lase-Mégajoule, the Falcon 7X, the A380 and the A400M.

To reach the two objectives of internationalization and participation in the large local programs being defined at that time, the institutional actors counted on the help of local contractors. In fact, one of the characteristics of this second half of the 1990s is the cooperation between public institutions and the industrial world.

This is the context in which the present system of territorial governance grew. It can be summarized in these three points:

- The definition of a strategic local development policy came very late.
- For a long time the main institutional actor was the representation of the State in the Region.
- Within the region several actors appeared to propose the construction of technopolis and other formulas that could lead to an endogenous development approach.
- These three points are the status quo when the Regional Council became the main actor in territorial governance.

2. The Axes of Strategic Development in the Region

From this point on, the aerospace sector would become the vocation of Aquitaine. Aid for the sector is designed to promote development of firms and their stability in the region. However this policy is less explicit than in Midi-Pyrénées as indicated by the lack of an ADER Plan. In fact, interventions are implemented through many tools and instruments requiring analysts in the sector. It is necesary reconstruct and assemble many details to arrive at a clear picture of actions.

The main goals of the Regional Council in favor of the aeronautical/aerospace industry are:

- "promote innovation, research and technological transfer;

- improve SME competitiveness;
- internationalize and diversify the industrial fabric;
- make available to the sector an operative industrial engineering tool;
- facilitate the creation of firm groups;
- defend and promote industrial concerns;
- increase the value of the territory for foreign investment."

The instruments mobilized to achieve these objectives do not appear to be sufficient. Thus, supporting R&D in the SMEs not only involves supporting innovation and R&D but also improving the competitiveness of the SMEs and, eventually, depending on the nature of the project, helping them to diversify their clients geographically and sectorially. Therefore, this study will stress three structural aspects of the intervention of local institutions symptomatic of the present relationship between the institutional and the industrial worlds.

Advanced Training and Research

Advanced formation and research are closely linked in the French system. As opposed to Midi-Pyrénées, Aquitaine does not have a fabric of specific aeronautical engineering schools such as ENSICA, ENAC or SUPAERO. This absence does not mean that there are no laboratories or training institutions connected to the ASD sector since there are many universities and specialized schools associated to this sector.

In the 2002/2003 school year, Aquitaine had 83,207 students in advanced training distributed among 26 institutions, 5 universities and 11 engineering schools. Recently some of these institutions have reinforced their enrolment in the field of ASD and their training and research sectors are carefully synchronized with regional concerns.

- The ENSAM (National Superior School of Arts and Trades): besides their usual training program which is also of interest to ASD, this institution offers a degree in Aeronautical and Space Engineering.
- The Paul Pascal Research Center is a unit of the CNRS in physical chemistry specialized in formulated materials, complex, non-linear structures and dynamics, functional liquid crystals and - somewhat removed from ASD concerns - biotechnology.
- The engineering school MATMECA trains in the field of the mechanics of fluids and solids and numeric simulation.
- The ENSCPB (Bordeaux National Superior School of Chemistry and Physics) mainly trains engineers in materials.

- The ENSEIRB is of interest to firms in the ASD such as Thales who specialize in electronics, computer science, telecommunications, robotics and signaling and imaging.
- The ICMCB (The Bordeaux Institute of Condensed Material Chemistry) offers a two-year post-graduate program in Science and Technology directly based on the ASD sector in Aquitaine. It also offers post-graduate courses in chemistry on Aggregates and Colloids as well as Synthesis and Properties of Inorganic Materials (SPMI);
- The Bordeaux Para-scholastic Nuclear Center in Gradignan participates in University of Bordeaux I courses, particularly in the post-graduate course on Astroparticles, Plasmas and Corpuscles, thus transferring its competence in the field of plasmas and particle physics.
- The IMA (Institute of Aeronautical Maintenance) trains technicians and engineers in the field of aircraft repair and transformation;
- The Universities of Bordeaux I and Pau-Pays de l'Adour (UPPA) offer post-graduate courses linked indirectly to the ASD sector[29] and some of them are taught jointly with other institutions cited above and with research laboratories such as the Center for Laser Applications (CELIA) and the Transfer Platform (PALA);
- Outside of Gironde, ESTIA (the Superior School of Industrial Technology and Projections) trains engineers, staff for consulting and methods firms, production managers and personnel in charge of large projects.

The Regional Council esteems that 42 laboratories and 1000 researchers work directly or indirectly in ASD-related fields. The potential for research is very significant but there does seem to be some dispersion of resources. In this sense, the region decided to define priority axes, including the ASD sector, in order to reinforce regional potential and associate all the components. The Region participated in the funding of the Bordeaux Polytechnicum which planned to federate 8 engineering schools, the University of Bordeaux I and an on-the-job training center, with some laboratories directly involved in ASD research. In the field of optics, the conditions for thesis scholarships were also reformed to bring them nearer to the regional strategic concerns and the Region subsidized 6 sectorial poles in technological transfer of which two are directly involved in ASD - the PAMM, (Aquitaine Mechanical Materials Pole) and the PEITICA (Aquitaine Electronics, Informatics, Information Technologies and Communication Pole). These poles are key mediators of technological transfer in Aquitaine. The

[29] For example, the post graduate course in Mechanics and Engineering or that of Electronics, Electrotechnia, Automatics, etc.

insertion of SMEs into technological transfer networks is one of the priorities of Regional entities. Although the large groups know local actors (various schools have representatives from the large firms among their members or even on their boards), the SMEs are less practiced in resorting to experts in the academic sector. In this sense, the Region co-finances a Technological Prestation Network for SMEs and encourages the PAMM and PEITICA to maintain contact with the SMEs through, for example, the organization of an Aquitaine Technological Fortnight. Finally, Aquitaine was also endowed with a CNRT in poly-materials and compounds sustained by the Region in the framework of the State-Region plan 2000-2006. Research is in the fields of aeronautics and aerospace (thermal materials, structures and methods), energy (energetic materials and electrochemical storing), microelectronics (assembly, substrata and interconnections) and disperse media.

Coinciding with the support described above, the Region defined the main priority actions, two of which are of special interest because they illustrate the will to unite industry and research and to construct projects that are structural in the long term.

The first refers to the development of an aerostatic sector in the region. The second, originating in earlier ballistic missile development, involves the development of regional capability in the field of atmospheric return. The Aquitaine Association of Atmospheric Return was constituted in 1999 by the University of Bordeaux I, EADS-ST and the Regional Council. Later the CEA-CESTA, Dassault Aviation and SNECMA Solid Propulsion joined the Association. The aim of the project was to develop a vehicle for atmospheric return which led EADS-ST to associate with CEA-CESTA, SPS (Snecma Solid Propulsion), the research laboratories LCTS, IXL, Labri and MAB (Bordeaux Mathmatic Applications). Recently the projects have advanced and, in association with the European Space Agency and the CNES, the Region awarded 1.3m euros to fund the construction of two experimental vehicles: "Expert" whose maiden flight is planned for 2006 and "PreX" which will be the first hypersonic glider developed in Europe and whose maiden flight is set for 2008 (APS, 22 Oct 2004).

The various experiments and instruments just described illustrate the support coming from institutional, industrial and research spheres and how the regional approach reinforces territorial governance. The following are some examples, quoted from the Aquitaine Regional Council, of laboratories that associate with industrialists and academic research:

- "The Aquitaine Laboratory for Aerothermic Research (LARA) is a mixed laboratory: Turbomeca and the University of Pau-Pays d'Adour".

The CNRS, the University and EADS Space Transportation created the 3AR Group for research on micro-gravity.

- The Thermostructuring Compounds Laboratory (LCTS) is a unique internationally recognized experience. This common laboratory for SNECMA Solid Propulsion, the University of Bordeaux I, the CNRS and CEA was created twelve years ago and now employs forty researchers.
- The University of Bordeaux I, the Regional Council, EADS-Space Transportation, Dassault Aviation, SNECMA Solid Propulsion and CEA-CESTA decided to join in their efforts to develop the design, experimentation and promotion of atmospheric return technologies." (Aquitaine Regional Council)

Mitigating Structural Insufficiencies at the Industrial Level

Regional policy also promotes actions at the industrial level, as had already occurred to some extent in the previous period. Therefore, some interventions favor the contractors such as the local funding of some of the indirect investments needed for the enlargement of the Dassault factory. The project for the constitution of an excellence pole around Turbomeca (5,000 related jobs) in the field of motorization of helicopters indicates a similar approach. Even in project form, this initiative initially concerned Turbomeca, an affiliate of the Safran group originating from the fusion of Snecma-Sagem, but has been favorably informed by the Region. It is presented as the engine manufacturers' response to the fragility of the subcontracting fabric in the region. Subject to competitive difficulties in supply cost in an activity of precision mechanics where geographic dispersion (series size, products deadlines, response flexibility, coordination) is a problem, the motors manufacturers attempted to help the SMEs in its area so that they can adapt to the new ways of subcontracting involved in a new externalization policy.

Similarly, Messier-Dowty also launched an initiative to structure the subcontractors in its area so they could become front line suppliers. The program, called Lean, essentiallt involves training and mobilizes funds provided by the Aquitaine Regional Council and FRED. Although the Region is the main actor in local action, there are other institutional active agents: DRRIRD, ANVAR, the DRIRE, etc. The local approach actually mobilizes, whenever possible, all of the actors in an attempt to federate their individual funds to reach significant quantities. An example of multilateral intervention of private and public agents in territorial governance is a collective federation initiative between the Union of Metal Industries and Trades, the CCI, the BAAS, 2AD, EADS-Sogerma and THALES.

The relative failure to get local SMEs to participate in the A380 program made local actors aware of the need to develop specific tools to encourage the participation of regional firms in the new program for a military transport aircraft, the A400M. The aeronautical market was undergoing significant change but it was obvious that the local productive fabric was not prepared to respond to these new transformations[30]. The intervention is to last two years and basically councils subcontracting firms in the presentation of projects to the Airbus A400M tender. The initiative is exemplary in the collaboration between firms and institutions, the basis of the whole program. The financial structure of the project is another element that demonstrates collaboration of the various potential agents in the project. Thus, in the initial funding program the State through the FRED contributed with 426,719 euros, the region 326,000 euros, Europe through the FEDER 281,350 euros, the large industrialists 159,686 euros, and UIMM 18,396 euros[31].

Other examples of collaboration among local actors are:

- The network of Aquitaine Regional Centers of Technical Support and Innovation (CREATI), created in 1993, resumed in 2003 the collective action called PAR-TECH promoted by the DRRIRD, whose objective is to organize technical suppport from the large industrial groups for the SMEs. They annually contact an average of 250 firms and make more than 60 business deals.
- The project for computer up-dating of SMEs in the ASD sector directed by the Union of Metal Industries and Trades with the support of the DRRIRD.
- The Web project for 2005 on technological and economic innovation and knowledge is leadered by the Aquitaine CRCI and 2ADI. This initiative is a prolongation of a similar action promoted by the DRRIRD in 2004 and cofinanced by the region, Bordeaux Tecnowest and UIMM.
- The temporal initiative of the Aquitaine Regional Council designed to help SMEs assume the "risk-sharing" clauses in the new tender design from the large industrial groups. In 2003 three firms benefited from the corresponding refundable advance payments totalling 1,216m euros.
- The southern Aquitaine inter-entrepreneurial cooperation initiative within the framework of inter-regional cooperation between Aquitaine and

[30] These transformations involve ways to generate added value to the principle of the supply chain, already present in the sector but not recognized by many firms, and incorporate modular logic into the organizational structure of the value chain (Frigan, V. And Talbot, D., 2005).

[31] See *Air & Cosmos*, 17 March 2003.

Midi-Pyrénées. The goal is to encourage collaboration among firms in the metal sector specialized in aeronautics, defense and transport to present local joint manufacturing bids in tenders.

- The Technoparc project initiated by Tecnopolis Bordeaux Technowest. The model for this experience is based on another carried out in Saint-Laurent-Montreal (Quebec, Canada) and the objective is to bring industrialists (particularly foreign firms) and research and training centers together in the same location. The project includes the creation of firm incubators specialized in aeronautics, aerospace and defense.

These initiatives in the ASD sector demonstrate the mobilization taking place both at the institutional and the entrepreneurial levels to validate the aeronautics/aerospace vocation of the region of Aquitaine.

The Position of Aquitaine in Territorial Competition

One of the objectives of regional policy established since the implantation of Roxel in 1992 is to attract investments in the aeronautics/aerospace sector. To achieve this objective territorial marketing action aimed at consolidating the participation of regional industry at the national and even European level must be taken. These actions highlight the proximity of the major productive centers in Aquitaine (Pyrenees-Atlantiques and Gironde) to the Toulouse aeronautics pole. This proximity of the two regions is evident in the so-called Aerospace Valley talks or in the joint preparation of various publications such as *Air & Cosmos* and *L'Usine Nouvelle* or in their joint participation in the Bourget international trade show and the annual Aeroslution Salon. However the articulation of both regions is still somewhat limited due to deficient transportation infrastructures, and the industrial culture in some areas such as Gironde which are still specialized in defense and space.

However, the increased value of the local space and its articulation have led Aquitaine to undertake the construction of an aerospace cluster with the Land of Hamburg and the region of Midi-Pyrénées in order to increase economic and student exchanges and design more harmonious research and training programs (PCRD) among the three territories.

In the line of promotion of the region of Aquitaine, since 2000 business trips have been organized to establish contacts between Aquitaine SMEs and the large Canadian contractors such as Bombardier, Bell and Pratt&Whitney and, in 2004, with producers in Andalucia (Spain), the future headquarters of the A400M project final assembly. Attracting external firms to the region is a recurring phenomenon, but the scale for this promotion and experiences considered successful by local actors are still unanswered questions. If the region really wishes to increase its power of at-

traction, it will be necessary to seriously analysis the organic and functional borders of the territory.

4.5 Crossed Perspectives

Meeting Points of the Territorial Governances of Aquitaine and Midi-Pyrénées

An analysis of territorial governance in the two regions could be summarized in two major points: on the one hand, a convergence of practices notwithstanding their differences and on the other, a will to federate or associate the regions in spite of structural differences.

4.5.1 Convergence within Diversity

As mentioned in the introduction to this chapter, territorial governance can only be understood within a comprehensive perspective which simultaneously and intrinsically includes the evolution of the particular sector and of the institutional system at the national and world level. It is within this double articulation that local agents (firms and institutions) should define actions and design strategies. Global institutional and industrial changes influence actions at the local level. Thus various authors (Perrat, Gilly, 2003; Le Galès, 2004), although diverse in their discussion of specific actions, point out the potential increase in territorialization of governance.

1. Increase in Territorialization

The double articulation materilizes in convergent ways in a given industrial structure at the regional level and likely and legitimate that the behaviors of regional agents will tend to converge. In the aeronautical/space industry in France, decentralization opened the door to relatively similar opportunities and difficulties for the local agents. Moreover, industrial restructuring and processes of privatization and externalization have been relatively similar in both regions.

Both industrial and institutional regional agents have agred to take the lead in their own economic destiny. Proof of this fact is the President of Aquitaine's position in favor of a "regional industrial policy". Existing instruments demonstrate the willl to promote the regional aeronautical industry at the level of contractors, subcontractors and suppliers. Both regions are concerned with promoting innovation, research and training and rein-

forcing synergies among industrialists, particularly between SMEs and large groups.

The emphasis placed on innovation, training and research decidedly favors development of specific territorialized resources. Aware that future competion among regional spaces cannot be cost-based, regional institutions propose to launch its industrial base up the quality ladder. In firms and particularly in the large groups, there is still ambiguity as to the construction of local resources. Some large firms plan to explicitly secure themselves in the region. Thus the large groups allocate industrial location according to opportunities offered to them by the regions and financing of regional projects becomes increasingly important. For example, in the French context of decreasing national public spending on R & D, the groups attempt to anchor themselves locally to mobilize regional aid to replace the State funds. The Expert/PreX program in Aquitaine is an example of this. In the former arsenal mentality the central government would have financed the project.

From now on, the industry/region tandem will search for complementary funds at the European level. Within the logic of geographic anchoring, the large firms, who are the main contractors, will attempt to increase the capability of local subcontracting firms and the actions mentioned in the former section show the determination to help reinforce local subcontracting firms. These initiatives generally include not only direct aid but also the participation of contractors into the local institutions responsible for individual and collective measures aimed at local SMEs.

However, despite participation in the construction of specific local resources, the same firms often contribute to destabilize and blunt efforts to strengthen the capability of local SMEs. Externalization practises, particularly the implementation of these practices, deteriorate local relations. Moreover, by increasing their requirements with risk-sharing, development issues, etc., the contractors exclude potential smaller subcontractors from their tenders. As occurred in the automobile industry, a new category of industrial actors has appeared, the global systems manufacturers ("équipmentiers") with production and R & D centers worldwide, who are the only firms capable of participating in the contractors' tenders in the front line. This tendency does not imply a decadence of the large aerospace regions, but it does lead to the location of foreign firms in the territory in the logic of geographic proximity and this weakens relations already established between SMEs and contractors. Territorial governance proposes to anchor these new systems manufacturers in the territory too, and provides mechanisms and resources for the insertion of local SMEs into the value chain in optimal conditions although they may occupy lower levels in the value chain, that is, subcontracting firms at the second or third level.

2. Diversity in the Development of Territorial Governance

Although convergence in the degree of implication of local institutional actors in the local sectorial dynamic is evident, there is not a general consensus as to the ways to do it. The strategies are very diverse. The contexts of the two regions are different and this explains why actions in favor of the various industrial sectors are also different.

Regional industrial structure justifies this diversity. In the case of Aquitaine, the industrial structure is more diversified than that of the Midi-Pyrénées and therefore, the regional government of Aquitaine feels obligated not only to support the aerospace sector, but also other sectors such as forests, wood and paper; enology and viticulture and tourism[32]. Thus a specific plan for the aeronautics/aerospace sector such as that in Midi-Pyrénées has not been possible in Aquitaine because it would give the impression that the other productive sectors in the region are less important.

Moreover, diversity is justified by learning processes and the agents present in the region. The history of both regions shows that the search for autonomy in local actions is earlier and more intense in Midi-Pyrénées than in Aquitaine where awareness of the possibility of intervening locally has only recently arrived (1998-1999) with the change in political majority. Another aspect is the early implication of private agents of the Midi-Pyrénées in the system of territorial governance, as in the case of Airbus. In the case of Aquitaine, management of the large groups remained at a distance from the system of territorial governance and only recently, with the change in leadership, have they manifested their will to participate. Another factor is the heterogeneity of the large groups (aeronautical manufacturers, space propulsion, electronics, etc.) and the lack of a firm like Airbus of great economic impact. Therefore, the region of Aquitaine is currently defining the objectives and strategies of local policy toward the sector.

The presence of a large number of Higher Institutions of Aeronautical Engineers in Midi-Pyrénées has led to intense connections between the industry and research centers, which has not occurred in Aquitaine. The organization of these schools encourages close collaboration with the industries of the aeronautical sector while simultaneously training their future employees, all of which reinforces local relations and networks[33]. In this

[32] An example are the competitive poles in Aquitaine (Agro-Bio-Salud; Laser-Optic; Forest-Wood-Paper; Touristic Valley and imbedded systems in Aeronautics-Space).

[33] The study carried out by the CRCI-Aquitaine in 2002 on firms in the sector indicates that 46% of the executive and engineering contracts in this region are carried out at the national and international scale ("L'aeronautique-espace-

context, territorial governance mobilizes different instruments depending on the learning obtained, relations established and experiences. Convergence as to the principle of local intervention and the need to intensify relations among all the parties implicated in the definition of territorial governance (public-entrepreneurial-investigation institutions) does not imply that implementation cannot involve very different operative strategies. In sum, each region is inscribed in a different historical path in a reflection of local political history, of their local industries and their present day industrial structures.

4.5.2 Toward an Interregional Governance?

The Aeronautic/Space/Embedded Systems Competitive Pole

There are two ways of interpreting the project for an aeronautic/space/embedded systems competitive pole (AESE). One considers that the project institutionalizes the dynamics of local systems and describes the industrial, scientific and institutional dynamics of the aeronautics sector in Toulouse. In the case of Aquitaine, the project would be understood as a strong incentive to reinforce local synergies which are still disperse. A second way of interpreting the AESE is as a project aimed at institutionalizing inter-regional policy demonstrated by the fact that it is a joint candidature presented by both regions to the DATAR program. It is in this light that the AESE project is discussed here.

1. Competitive Poles

The September 14, 2004 decision of the Inter-ministerial Committee on Territorial Adaptation and Development (CIADT) led to a new industrial policy to create competitive poles to reinforce specialization in French industry, promote favorable conditions for the appearance of new activities of international projection and improve territorial capability of attracting investment and counteract industrial delocalization.

According to DATAR, a competitive pole is a combination of firms, training centers and public and private research centers integrated into an association within a given territory whose objective is to achieve synergies to the point of reaching the necessary critical mass around common innovative projects with international projection. The association is to be organized around a market, a technological field or an industrial sector.

Defense en Aquitaine", Convention IRES-CGT, *Document de travail ADEES Rhône.Alpes*, 05-2004).

Therefore the key terms in the definition of a competitive pole are **firm + training center + research unit** as well as the three decisive factors of **association + innovation + international projection**.

Methodology: To encourage the creation of competitive poles and reinforce existing poles, a call for proposals for the constitution of poles based on public-private associations in the field of technologies and French industrial specializations with proven potential. Firms, research and training organisms, financial entities, territorial collectives, Administration (central and European) could be participants. An inter-ministerial task force then studied the reports elaborated for each proposal by independent experts. DATAR along with the General Direction of Entreprise (DGE) of the Ministry of Economy, Treasury and Industry were to present the recommendations of the inter-ministerial task force. An initial classification and evaluation of poles was carried out in the summer of 2005 by the CIADT.

Funding: In 2005 financial resources tagged for the launching of this strategy of competitive poles will reach 750m euros over a period of three years of which 370m euros come from the State budget.

Competitive poles, geographically defined and classified, will benefit from fiscal measures in all or part of their territory, particularly as concerns corporate taxes as long as the authorized European limits are maintained, and from reductions in the social cost of labor destined to R&D jobs. Moreover, they may receive subsidies from territorial collectives, particularly from the regions, and from European Structural Funds as long as the maximum EU limits are not exceeded. All of these aid possibilities are conditioned by the beneficiaries' commitment to not delocalize any of the activities subsidized.

The ANVAR will allot a part of its financial aid fund to competitive pole projects in the form of refundable advance payments. The BDPME/SOFARIS will increase resources assigned to the SOFARIS-Regions funds to reinforce the bank credits and loans. Another 8m euros in credits have been approved for promotion, collective actions and engineering.

2. The Candidature of Midi-Pyrénées-Aquitaine

The local actors of the region of Midi-Pyrénées presented a project for the constitution of a competitive pole in the field of Aeronautics/Space/Embedded Systems due to the existing regional potential in this sector. The inclusion of the technological sector of Embedded Systems is justified by its intersectorial nature showing that the project is not only aimed at aeronautical and space activities, but also at the automobile and train sectors since these sectors all deal with the control and maneuverabil-

ity of vehicles. The project includes a broad panel of firms such as Airbus, Astrium, Alcatel Space and regional SMEs, laboratories (CNEs, ONERA, universities and large schools) and institutions (CNRT, DRIRE, MPE).

The agents from Aquitaine followed the example of their counterparts in Midi-Pyrénées by elaborating a similar proposal for Aquitaine. The promoters of the projects attempted to integrate the firms of Thalès, EADS-ST, EADS-Sogerma, CEA, AIA, SAFT, Dassault, Turboméca, SPS, Messier-Dowty, SME, research laboratories linked to the University of Bordeaux I, the Pau and Pays de l'Adour (UPPA) and the large engineering schools, local institutions such as the Regional Council, 2ADI, some sectorial poles, Materials CNRT, the UIMM or representatives of the State in the region (DRIRE, DRRIRD).

In both cases the promoters of the project are the Regional Councils, who were to deposit the projects in the Prefecture (28/02/2005), and operative structures in charge of the elaboration of the file, directed in each one of the regions by an industrialist (the president of Airbus in Midi-Pyrénées and the president of Thales in Aquitaine) and coordinated by two public organisms (CNRT-AE in Midi-Pyrénées and 2ADI in Aquitaine).

The joint application is made up of a 1) common section (the justification of the denomination of pole, according to the criteria imposed by the DATAR, and the structure of shared governance to guarantee later follow-up of the pole) and 2) a specific project for each region with strategic activities (eight DAS have been defined including a total of 36 projects) and programs structuring transversal activities (12 DAT projects defined independently by each region).

The parallel collective and individual activities of the joint project of the two regions may increase the probability of being awarded the denomination of competitive pole on the part of the central government by fulfilling the criteria of critical mass required by the DATAR. However, that the joint project was even formulated leads to another interpretation, that of a true project of inter-regional collaboration.

The competitive pole file contains one main innovation: the creation of a joint governance structure for both regions. Although it is early to evaluate the efficiency of this proposal (supposing that the pole is validated!), it is true that the project lays the groundwork for inter-regional cooperation in the aeronautical and space sector. Moreover, initiatives such as the creation of a socio-economic observatory in the sector in which research teams from both regions are integrated, can contribute to reinforce cooperation (OSEA project).

This innovative governance structure proposes three objectives: 1) promote territorial attraction and marketing of the pole; 2) define, orient and evaluate strategic growth of the pole through a Development Guidance

Plan (SDD) and the definition of specifications for project approval within the framework of the pole (creation of an "Approval Committee"); 3) Carry out an efficient follow-up of future projects (location, assembly and evaluation).

To achieve these objectives, institutions will be created *ad hoc* in charge of implementation. The figure 4.8 shows the overall organization of the proposed governance structure.

The General Assembly (AG) is located at the head of the structure in accordance with the legal format of a type 1901 association. The General Assembly will be made up of representatives from the firms, public and semi-public firms, training organisms and socio-economic agents. The effective power of the AG will be in the hands of the firms and representatives from the world of research and education. The Administrative Council will be in charge of operation of the GA and will have an office, a president, elected for three years from the industrialists of Midi-Pyrénées, a vice-president elected from among the industrialists of Aquitaine, a secretary and a treasurer. The Regional Councils will participate in the Administrative Council meetings.

Day-by-day management will be in the hands of an Executive Committee (COMEX) in charge of overseeing actions within the pole. Besides the representatives from the DAS and DAT projects, the members of COMEX will be representatives from the regional coordination units. The coordinating units in Midi-Pyrénées and in Aquitaine aim to integrate the regional level into the proposed inter-regional scale.

The effort, already made, in institutional construction has represented an opportunity for the regional promoters of the project to initiate a joint line of work and has reinforced territorial dynamics, whether the denomination of competitive pole is granted or not.

In sum, the largest aeronautic/aerospace activity in France (excepting the region of Paris) is to be found in two regions of southwest France, Midi-Pyrénées and Aquitaine. Both regions have developed in parallel with great synergy despite the sectors having been originally built on two separate blocks: military activity in Aquitaine and civil activity in Midi-Pyrénées. The construction of an aircraft or a spaceship requires the collaboration of a great number of trades and tasks which the large firms do not always prefer to develop internally. Thus, many SMEs in the metal-mechanics sector, and later in related services, have grown up around these large firms creating, over time, whole subsidiaries.

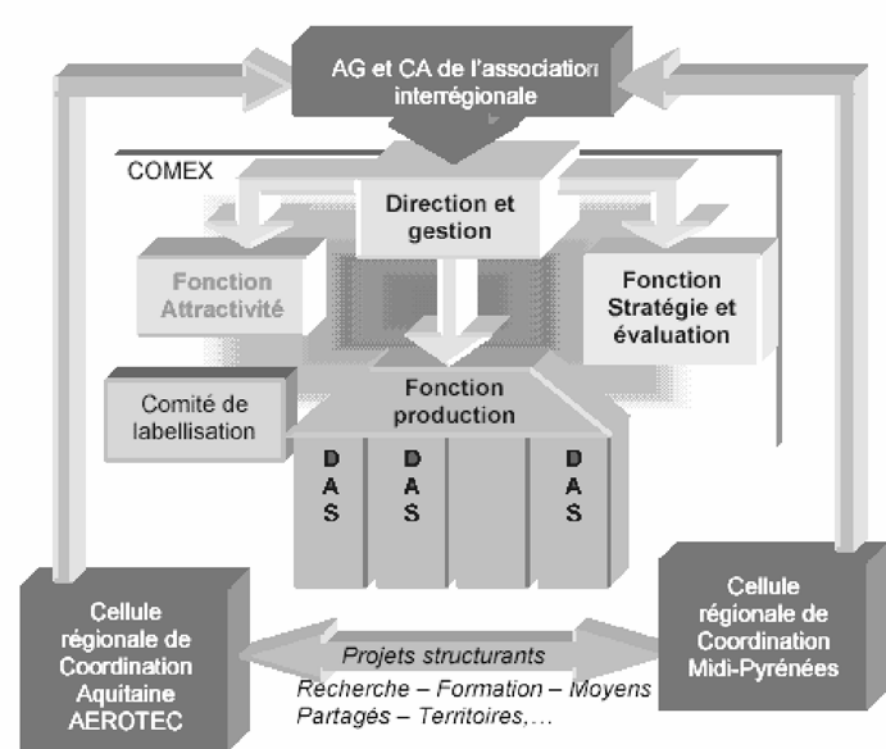


Fig. 4.8. Governance structure

5 Aeronautics in Spain: Specialization & Beyond

5.1 Basic Data of the Sector and the Territories

The emergence and development of the Spanish aeronautical sector was military in nature, which is why today's industry is characterized as being dual, as occurs in other European countries. Not until after the Second World War, does commercial aviation begin to develop and expand. Its present day entrepreneurial structure relies on a small number of large and medium size firms (>250 workers), a few medium size firms and a large number of small firms. Thus, no more than 300 firms make up the aerospace[1] sector in Spain, of which a 90% are SMEs, who produce a 15% of total turnover. A 96% of the total turnover is manufactured by 32 firms of the Spanish aeronautics sector (ATECMA, 2005). This group is formed by six large companies (>1,000 employees), two with a workforce of between 250 and 1,000 workers, nine firms with an employment of between 100 and 250 workers, and finally, 15 small firms (<100 workers).

The large firms are basically devoted to development and manufacturing of aircraft and large structures for flying. With respect to medium size firms, these are devoted to aeronautical engineering and complete the segment of aeronautical systems and equipment. Thirdly, the smaller firms manufacture and develop compound materials, capital goods, various equipment, mechanization and surface treatments.

[1] The space sector is made up of a total of 15 companies and an equivalent number of industrial subcontractors.

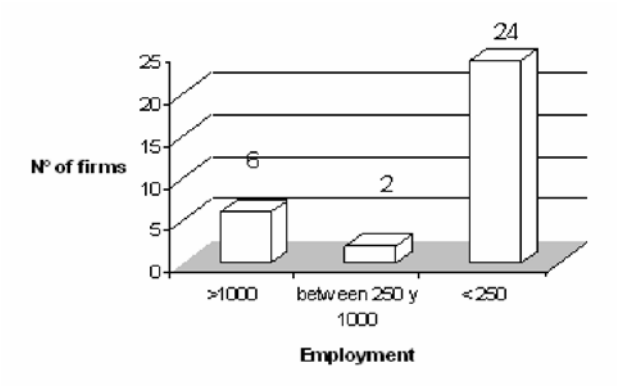


Fig. 5.1. Entrepreneurial structure (2003)

Source: ATECMA, 2005

The Spanish aeronautics industry has followed the path of growth that characterized it since the mid nineties, a time in which this industry followed a restructuring and consolidation process through mergers and the creation of new groups. The objective was to be able to count on leading firms with sufficient capacity and potential for competing in an ever more competitive global market. The result has been a growth process that has permitted that the importance of the sector in 2003 reach a 0.43% of the Spanish GDP and a 0.12% of the Spanish working population.

Table 5.1. Key sector data (2003)

Importance of the sector	0.43% of Spanish GDP 0.12% of the Spanish working population
Employment	23.256 persons
Turnover	3.188 thousand €
Expenditure in R+D	13,9 % of turnover
Exports	69,8 % of turnover
Purchase orders	199 % of turnover

Source: ATECMA, Statistical Report 2003

As can be observed in figure 5.2, the employment increased progressively during recent years from 18.343 jobs in 1997 to 23.256 jobs in 2003, which represents a 21% growth rate for the period. Specifically, between 2002 and 2003 employment grew a 2.3%, creating 532 new jobs.

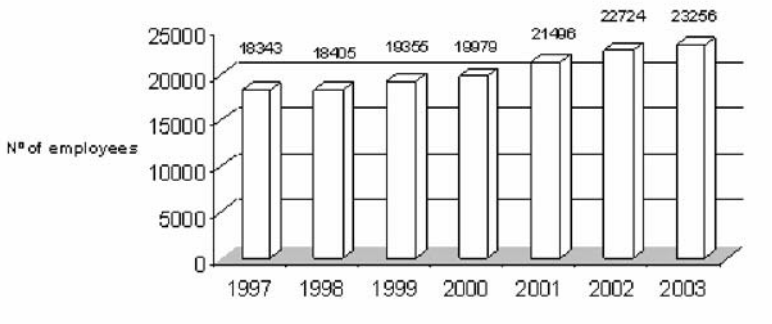


Fig. 5.2. Evolution of employment

Source: ATECMA, Statistical Report 2003

As can be seen in table 5.2, at least a 30% of the employees that work within the aeronautics industry in our country have a University degree. Close to 50% are operators that have been well trained in professional vocational schools, or in the industry itself. Last of all, the administrative personnel and other workers that in general have not received a university education are also present in this industry. Nevertheless, even if these workers have not gone to university, most have received adequate training so as to work in a sector as sophisticated as is aeronautics.

Table 5.2. Distribution of national employment in aeronautics (2003)

		Number	%
By qualificatión	Managers, Engineers and University graduates	6.983	30%
	Operators	11.150	48%
	Administrative staff and others	5.123	22%
	Total	**23.256**	**100%**
By activity	R + D	3.424	15%
	Manufacturing	16.525	71%
	Rest	3.307	14%
	Total	**23.256**	**100%**

Source: ATECMA, Statistical Report 2003

On the other hand, as can also be seen in table 5.2, the majority of workers operate within the area of manufacturing (71%). Furthermore, a 15% of the turnover of the sector is spent on R+D+I, which shows the importance of this field in the industry.

With respect to the turnover, the data is very similar. The sector increased its consolidated turnover by 23% between 2002 and 2003, and reached 3,188 million Euros during the fiscal year 2003, after the recession felt in 2002, a year in which turnover was reduced by 2.25%. As can be seen in figure 5.4, however, in recent years sales has increased from 1,421 million Euros in 1997 to 3,188 million obtained in 2003, with a growth rate of 55.5%. This important increase was due to the participation in various international programmes, among which stand out the A-380 by Airbus.

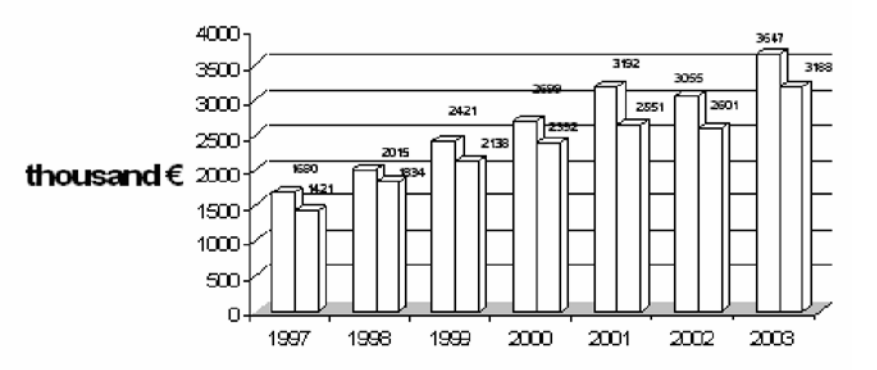


Fig. 5.3. Evolution of turnover

Source: ATECMA, Statistical Report 2003

Therefore, from 1997 to 2003 (figure 5.4), both turnover and employment have grown steadily. Nevertheless, the growth rate for turnover (55.5%) has been much higher than employment (21%), which has allowed productivity (measured as volume of turnover per employee) to grow during the last six years (except for 2002), reaching a growth rate of 43.8%.

With respect to research and development activities, the aerospace industry is the sector that most invests in R+D. In fact, the expenditure in R+D with respect to turnover reached 444 million Euros in 2003, which represents a 13.9% of total turnover for the sector. The evolution of expenditure in R+D in recent years has grown from 206 million Euros in 1997 to 444 million in 2003 (figure 5.5).

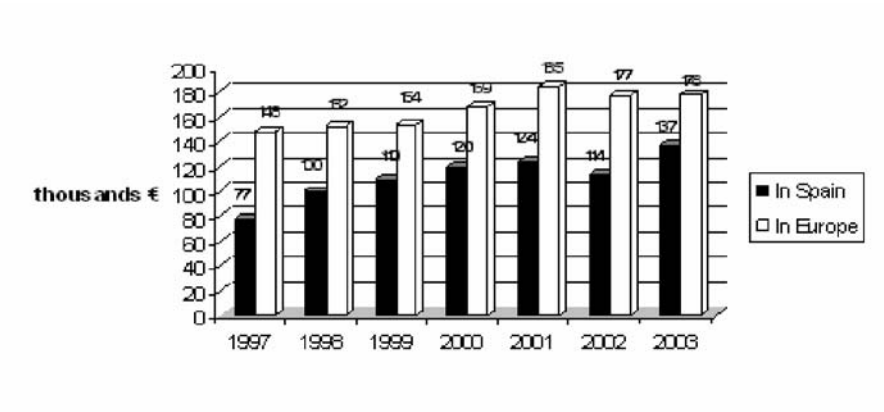


Fig. 5.4. Evolution of Productivity

Source: ATECMA, Statistical Report 2003

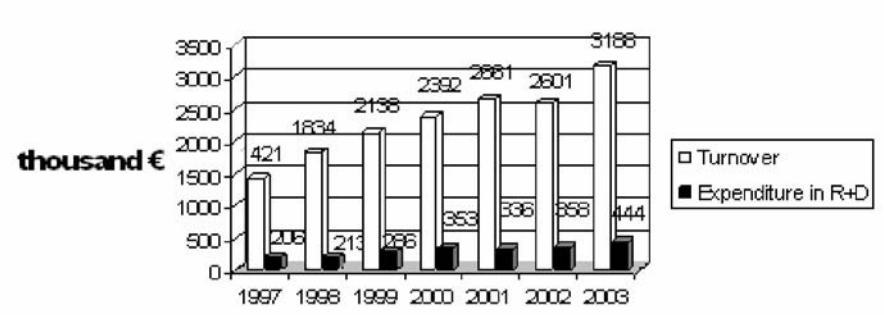


Fig. 5.5. Evolution of expenditure in R+D

Source: ATECMA, Statistical Report 2003

Today, the Spanish aeronautical industry represents a 5% of the European capacity and occupies the fifth position in the European context according to the number of workers.

5.1.1 The Aeronautics Sector in Madrid and in Andalusia

Regional Data

As can be seen in figure 5.6., Madrid is the Spanish region with the greatest turnover. Specifically, Madrid has 61.4% of the total Spanish turnover. In absolute terms this means 2,400 million Euros. Andalusia occupies the

third place in volume of sales, after the Basque country, with a turnover of 600 million Euros, which represents a 15.6% of the total.

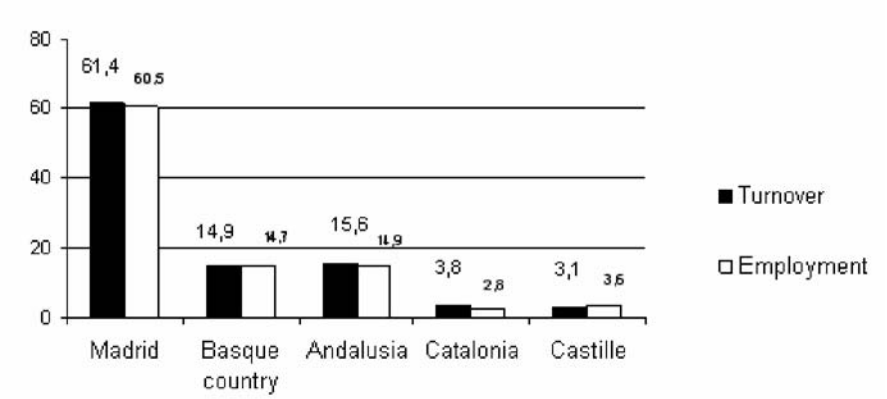


Fig. 5.6. Turnover and employment by regions, 2003 (in %)

Source: ATECMA, Statistical Report 2003

With respect to employment, the data is very similar. In the Community of Madrid 60% of the workers in the sector are employed, whereas Andalusia employs 15.2% of the national total (figure 5.6).

5.2 Organization of Production

5.2.1 Industrial Characteristics of the Productive Fabric

1. Andalusia

A large part of the aeronautical firms in Andalusia do not devote themselves exclusively to that activity, and work in other activities as well, such as the mechanics, various equipment, or design (see figure 5.7). Over two thirds of the firms work mainly in mechanics, sheet metal or composites, with a low grade of integration in the production, since it only occupies one link of the product chain. A 38% is specialized, therefore, in the aeronautical sector. A fact to point out is the recent increase in the number of specialized firms in engineering activities, by the high value added they produce, stimulated by the attraction that European aeronautic projects have, the support to plants location given by the regional government and by greater development of research.

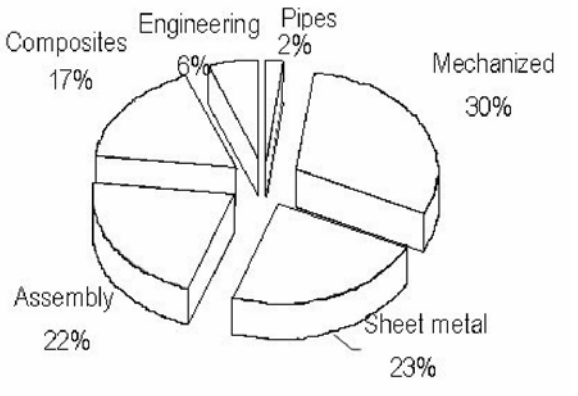


Fig. 5.7. Aeronautical firms in Andalusia (%) by activity sector

Source: Data from Survey

35% of the firms invoice over half of its production in the civilian sector as opposed to 14% that does it in the military one. This situation is determined by the importance of the civilian markets after the restructuring of the defence industry. It is foreseen that this tendency will continue due to the construction of the A380 and A400M[2] by the local firms.

94% of the firms are private, and only a 6% is of mixed capital. Over half of the firms are independent firms, a third form part of a group, mostly a Spanish group, and the rest have other types of organization. Its age is marked by the boom of the second half of the 80's and these last ten years[3] (see figure 5.8.). Thus, it is a young and emerging fabric, despite the fact that 52% of the firms are over ten years old, basically firms whose origins were linked to other sectors (maintenance, metal-mechanics) and who were incorporated into the aeronautics later on. Recently created firms are specialized only in aeronautic activities.

[2] Within the framework of the A400M Project, the region of Andalusia will be responsible for the final assembly of the aircraft, test flights and client delivery.

[3] The outstanding dynamism of the sector in the 80's was favoured by the participation of CASA in the development of various civilian planes, the construction of the Airbus plant in Puerto Real in 1988 and the incorporation of metal-mechanical workshops and firms to activities in aeronautics. The high rate in creation of firms in the last 10 years is thanks to the good perspectives created by the cluster Andalusia Aeroespacial-that disappeared in 2003- and the demand from the European A380 and A400M projects.

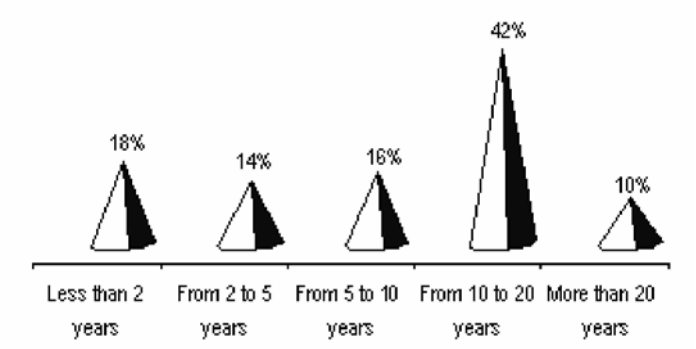
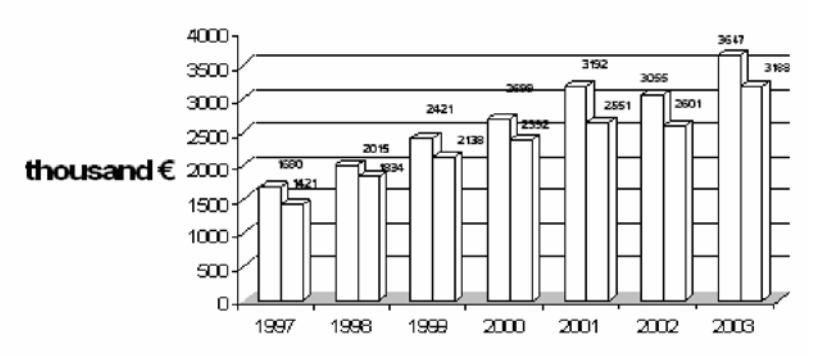


Fig. 5.8. Aeronautical firms in Andalusia (%) by seniority

Source: Data from Survey

The amount of sales, between 2001 and 2003 has been on the rise, even though there of the aeronautics activity in total sales has been diminishing (see table 5.3). 63% of total sales in the aeronautics sector of Andalusia is made by the three largest companies.

Table 5.3. Volume of sales of the aeronautical firms in Andalusia (thousands €).



Source: Data from Survey

Nevertheless, in the structure of the Andalusian fabric the SMEs continue to be dominant, from the point of view of turnover; a 95% of the firms invoice a 70% of total sales, in contrast with what happens on the national level, where a 5% of the firms invoice an 85% of the total sales. Only four aeronautics firms in Andalusia invoice more than 10 million Euros annually.

The greatest volume of sales are directed to the regional and national market (see figure 5.9.), although the specific sales of aeronautics activities

are more focused towards the regional market. The European and international markets are still residual for the Andalusia firms, yet, a 27% exports[4].

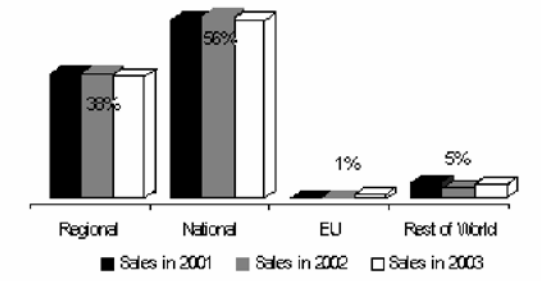


Fig. 5.9. Turnover of Andalusian aeronautical firms (%) by market location

Source: Data from Survey

With respect to business results, the majority of firms in Andalusia had profits in the three years of the period under study (see figure 5.10). If only the aeronautics activity of the firms is considered, the percentage of benefits is reduced, since within the group of firms with economic losses are found some of the large firms, that produce most of the turnover in the sector.

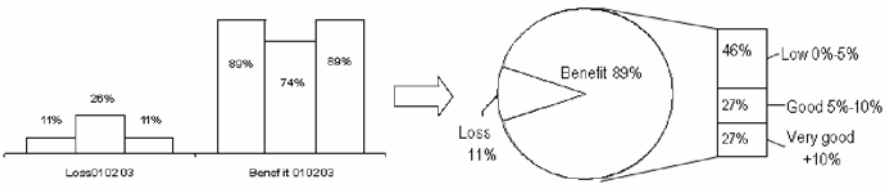


Fig. 5.10. Andalucia aeronautical firms (%) by financial results

Source: Data from Survey

The analysis of profitability and productive efficiency, through the operation margin, indicates that over half of the firms obtained what can be termed good or very good profit levels for this sector[5] Particularly, those

[4] The operative margin objective or BAIT of EADS-CASA is in the 10%. Data confirmed through interviews with managers of EADS-CASA and in the company's annual reports.

[5] The operative margin objective or BAIT of EADS-CASA is in the 10%. Data confirmed through interviews with managers of EADS-CASA and in the company's annual reports.

firms with benefits over a 10% of its sales volume, are devoted to mechanization activities.

Among the factors of the milieu, the best considered attribute by the firms in Andalusia, for today's conditions as well as for the future, is geographical proximity[6]. The worst considered attribute is the unavailability of qualified labour, and financial difficulties in order to confront the investments and assume the risk of subcontracting. Yet, the low wages makes the work force competitive. This, combined with training initiatives carried out by firms and other actors, with the support of the regional government is, in most cases, contributing to closing the gap between the needs of the sector and what is found among the working population in Andalusia.

2. Madrid

The productive fabric of the aeronautics sector in the Community of Madrid is, basically, a small and medium size entrepreneurial structure. Over half the firms have less than 50 employees and only an 11% of these have more than 249 workers. Some entrepreneurial organizations in particular have over 5000, as does EADS-CASA, S.A. Limited liability companies are more frequent, followed by public limited companies, though within the group we also find economic interest groups.

64% of these firms are independent, but 32% of these are a part of entrepreneurial groups, whose headquarters, in more than half the cases, are located in Spain (two thirds of the firms) or in a EU country. Furthermore, 36% of the firms are participated by other firms, and total equity belongs to other firms in 80% of cases.

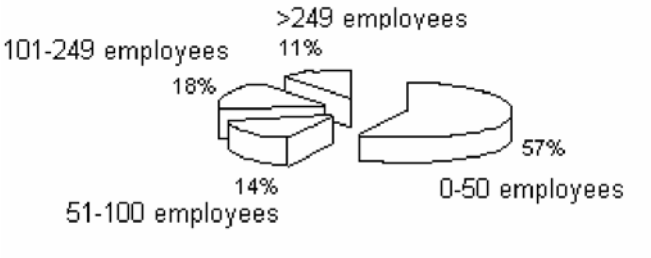


Fig. 5.11. Size of the aeronautical firms in Madrid, by employment 2002

Source: Data from Survey

[6] Geographical proximity is understood as a firm location close to the final integrating firm plant (particularly, the EADS-CASA integration centre) and to the modular integrating firms, whose headquarters and work centre is in Seville and Cadiz.

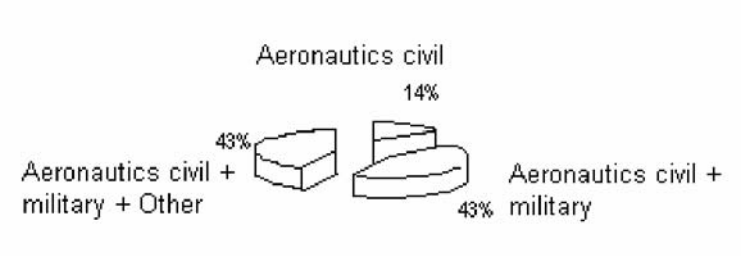


Fig. 5.12. Size of aeronautical firms in Madrid, by sector in 2002

Source: Data from Survey

Firms that operate within the aeronautical sector are prevalent, both in the civilian as well as military fields and those who share activities carried out in other sectors (see figure 5.12.). This distribution is born of the diversification strategy, implemented during recent years, particularly by the SMEs.

The characteristics of the aeronautical industry (an extensive product cycle and a global, institutionalized, dual and cyclical market) set low activity volumes, in some segments and firms. This implies a low use of the productive capacity and therefore, certain difficulties for survival exclusively with the aeronautics production. This is why only a 14% of the firms analyzed devotes all of its productive activity to the civil aeronautics sub-sector.

The entrepreneurial fabric is not very old. 21% of the firms are over 20 years old, whereas 71.4% was founded more than 10 years ago, and only 7% of these were recently created. Nevertheless, the origins of some of these firms go back to the first or second third of the last century, as is the case of today's EADS-CASA.

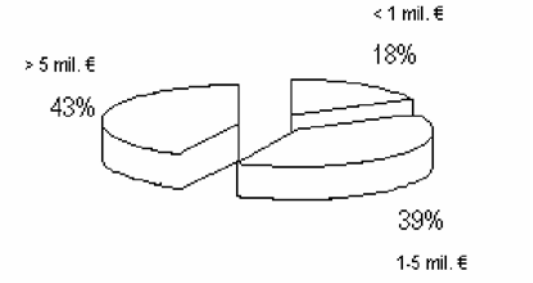


Fig. 5.13. Sales volume of aeronautical firms in Madrid, 2002

Source: Data from Survey

As a whole, the total turnover of the sample firms went up in 2002 to 1,500.36 million Euros, approximately 57.7% of the Spanish production. Specifically, the sales of 43% of the firms were over five million Euros (see figure 5.13.).

Over half of the firms surveyed say that 2002 was a good year, and very good from the point of view of the profit rate. Only 7% say they suffered losses. Therefore, a stable industrial fabric exists and with financial capacity.

The production of the firms is directed towards different markets. Almost all firms are present in the national market, whereas 43% of them devote their sales volume exclusively to either the regional market or to the European Union market. Of the firms, 2/5 make over 80% of their productive activity within the national and regional areas, and only 7% does so in the EU.

The productive units considered tractor or final integrators and the module large integrators, present an important degree of internationalization, opposed to the tendency in the rest of the firms that limit their activity more towards the regional and national geography.

During 2001 and 2002, 46% of the firms have opened new markets (see graph 5.14.), preferably in the national level (85%), although a significant percentage of firms, the medium and large, have also gotten clients in the international and EU market (46% respectively).

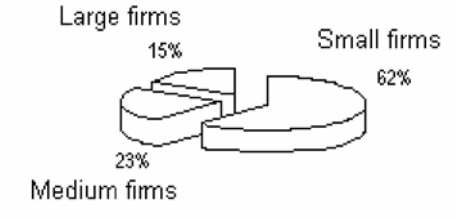


Fig. 5.14. Opening of new markets by Madrid´s aeronautical firms, according to size, 2002

Source: Data from Survey

This reflects the relevance of commerce between Spanish firms and their role as supplier to European aeronautical firms (ATECMA, 2003)(see table 5.4.).

Table 5.4. Geographic destination of new markets of the Madrid aeronautical firms, according to size – 2002

Destination of new markets	Size of firm		
	<50 employees	51 to 249 employees	>249 employees
regional	11,1%	0%	0%
national	33,3%	42,9%	66,7%
UE	16,7%	28,6%	33,3%
Rest of the world	16,7%	28,6%	33,3%

Source: Data from Survey

The firms in Madrid think that the region has all the necessary means for the location of their activities. The availability of input factors is seen, in general, positive; except those of support to research organizations. Nevertheless, they think the situation today could improve, except for the availability of qualified labour (see table 5.5.).

Table 5.5. Assessment of the milieu factors

Milieu factors	Assessment of the milieu factors (% of firms)							
	Favorable or very favorable		Slightly favorable		Unfavorable		Very unfavorable	
	Present situation	Evolution	Present situation	Evolution	Present situation	Evolution	Present situation	Evolution
Availability of qualified labor	42.9	53.6	21.4	25	17.9	7.1	14.3	7.1
Social climate	32.1	50	53.6	46.9	10.7			
Endowment of technical infrastructures	28.6	46.4	53.6	32.1	10.7	7.1	3.6	3.6
Salary costs	21.4	35.7	42.9	32.1	25	25	7.1	
Presence of research centers	17.9	25	35.7	46.4	28.6	14.3	14.3	7.1
Organisms supporting	14.2	32.2	25	28.6	32.1	21.4	25	14.3

Source: Data from survey

Geographical proximity plays a determining role in the industrial, scientific and technical cooperation relations for 68% of the firms. The main advantage of its location in this territory is thanks to its proximity to the clients, whereas the lack of financial support, both for investment and growth of the firm as well as for implementing innovation processes, is the major disadvantage.

5.5.2 Firm Typology

The aeronautics sector in Spain is a system made up of a various set of firms, with relation to size, production capacity and the level of knowledge, which will determine their place in the productive chain. The externalization processes of the large companies had led to the creation and location of specialized firms near by, that participate in aeronautics construction through subcontracts. Therefore, different levels and types of firms can, in general, be identified in the organization of production. The classification of firms under study was made with relation to the aeronautical sector of the territories studied. This distinction is relevant, since a firm can belong to one category or another, depending on its final market. In this way, cases like Airbus Spain or EADS-CASA may be final integrators, if the reference is the national aeronautical sector, or module integrators, if we consider the European aeronautical sector.

A first level, made up by the group of tractor firms or final integrators. These are large firms that are at the beginning of the chain, since they undergo the complete manufacturing or integration process of the aircraft. They have the capacity for design, manufacturing and assembly. They generate knowledge and have important levels of investment in both technology and subcontracts.

A second level, made up of what is known as module integrators or firms specialized in composed materials, equipment and systems, design and manufacturing of structures, engineering services in aircraft production and design of various equipment, among others. They are leaders in their respective business segments. They do not have the capacity to integrate planes or final aerospace products, but do have engineering and R+D capacity on specific components, subsets, and equipment or systems. They are highly specialized, experienced and have a good image. Their activities and products are differentiated, and are complementary in order to obtain other integrated objectives, which is why strong competition between them does not exist. High levels of investment are required for the development and production of its activity. They work on the international level. Their subcontracting relations with the final integrators functions under "complete package" schemes and are solely responsible for them.

A third level is made up of second division contractor firms, specialized in one or various phases of the production process. They depend on the knowledge of the final integrators and module firms. Within this set can be identified:

- A group made up of a series of firms, which by their size and production volume, cannot be considered SME in the traditional sense of the term.

They are manufacturers, under the specifications and design of the tractor and module integrating firms. Some of these firms are recently collaborating with the final and module integrators in the phases of design and calculus. This is the result of the integrated process policy of the tractor firms, which include engineering and design, manufacturing of components and assembly and termination activities.

- A SME set, the majority very small and originally family firms, whose major activity is not aeronautics –electronics, mechanization, welding, etc.-but who undertake very divers tasks for the first and second level firms. Firms devoted to the manufacture of various equipment belong to this group. This includes all sorts of manufactures of components and mechanical parts, electrical and hydraulic, destined to form part of more complex sets. They usually manufacture following determined blue prints. These firms also work for other sectors for the purpose of diversifying their production.

The aeronautics industry in Andalusia[7] is made up, principally, of firms belonging to the third level (94%) and known as auxiliary industry. They are medium and small in size, with atomized structures and an insufficient financial capacity. Their productivity is low, as a result of their small installations and low technological level. Their activity is mostly devoted to manufacturing and closely linked in the past to CASA, which is why they are strongly affected by the recession phase in the cycle of the aeronautics sector.

The modular integrators (EASA del Sur[8] and SACESA) and tractor firms (Airbus España-Puerto Real and EADS-CASA in San Pablo) represent a 3% respectively of this sample.

This configuration may be affected by the consortium Sevilla Control, created in 2004 by a set of five auxiliary firms (Sevilla Control, AyG Sevilla, TECAER, Aeroestructuras Sevilla and Aeroestructuras Cádiz) for the purpose of achieving a structure strong enough to face a greater work load and so try to obtain a position as module integrator. The entire staff of this group has 300 workers and an estimated turnover of 30 million Euros per year.

Another three firm group also has an intermediary position (SK-10 Andalusia, Intec Air and Air Group) which is developing its organization, either internally or through strategic alliances in order to achieve the optimum size that will permit them participate in the contests for obtaining work on the A380 and A400M.

[7] The list of firms selected for the study can be found in table A of the annex.
[8] Affiliated with Gamesa Aeronautica.

The capacity of the aeronautics sector for generating induced effects in the economic activity has been insufficient for promoting a solid auxiliary industry. Very few firms have been able to step up to the first level, since this would mean having the sufficient engineering and technical capacity as well as management for obtaining the contracts in the work programmes the Community receives.

The demand oligopoly of tractor firms permits them impose the risk contract in the sector as a mode of production. It is they who establish the negotiation conditions with the module integrating firms, who are given the responsibility for the design, manufacture, finance, and quality control of the subcontracted work. The income for this work is not fixed, but depends on the profitability of the global project in a percentage previously negotiated. Similarly, the modular integrators subcontract part of the work load to the auxiliary group so as to reduce costs, for lack of production capacity or because of the specialization of the work to be done, but it has sole responsibility as far as the tractor firm is concerned.

This form of contract is unique in the region, and is in tune with the sector's practice on the world level, given that it represents important savings and fewer risks for the tractor firm. Nevertheless, it carries with it technological, organizational and financial demands for the subcontracted, that the auxiliary sector in Andalusia does not reach most of the time. Despite this, it also has positive consequences for these firms, since in some cases they are implicated in the most valuable productive process phase.

This system of subcontracts is provoking a horizontal integration of the auxiliary firms, as the only way for continuing to be competitive. With this process the firms seek to eliminate cost redundancy, take advantage of scale economies and gather sufficient capacity for answering the new demands for excellence in the sector. In Andalusia this tendency faces a natural climate of suspicion. There is still a certain reticence on behalf of many of the entrepreneurs of the sector about this cooperation, because of bad previous experiences. This causes many small firms to continue working exclusively in manufacturing and not reach the sufficient capacity to assume other phases of production.

The aeronautics sector in Madrid[9] is a system made up of a small number of tractor firms, around which are grouped a set of small and medium size firms, whose major activity is often different from that of the aeronautics industry, but carries out different subcontract jobs for these final inte-

[9] It should be pointed out that the sample of firms interviewed correspond mostly to the aircraft sub-sector; it has focused on those specialized in the manufacture of components and parts, and in those called final integrators, within the framework of the A380 project.

grator firms. In this way, in the fabric of the aeronautics sector under study in Madrid[10] we find firms of the different levels previously mentioned.

EADS-CASA and Airbus-España[11] stand out as the final integrators, with a sales volume of 1,281.2 million Euros and a workforce of 7,413 workers in 2002. They carry out design and high value added engineering activities in the various plants. Firms like Hexcel Composite (composed materials), CESA (equipments and systems), Gamesa Aeronáutica (design and manufacturing of structures, engineering services), SENER/Boreas (aircraft production engineering, structure design and various equipment) and CRISA (space and avionics) form part of the module integrator group[12], with a turnover of approximately 336.4 million Euros and employs 2,182 workers.

The remaining entrepreneurial fabric corresponds to the third level, within which the group formed by firms[13] like Aerlyper, S.A, TECNATION, ACATEL,S.L. TECNOBIT,S.L., Composystem, S.A., TEGRAF Engineering (incorporated into the TAM group in 2003), among others, should be pointed out. This set of firms has begun develop design and calculus capacities, as a result of the subcontracting policy of the tractor firms. Their joint turnover rose to 50.7 million Euros with a workforce of 458 workers in 2002.

Lastly, at the lower levels of the chain is the group of SME, the auxiliary industry. Among these firms are: San José Villa, S.L., Jupasa, S.L., Industrias Carmora, S.L., Alta Precisión de Mecanizados (APM), Alta Precisión Industrial Mecánica (APRIM), Talleres Dumandi, S.L., Consuegra, S.Coop.Ltda., Huercam, S.L., Sistemas Mecanizados Avanzados, S.L. (SMA), Mecanizados Escribanos, Quality Metal, Ramen, Grupo TAM, G.A.Z.C. and OSSMA Aeronáutica, S.L. Their sales volume rose to 35.3 million Euros and the employment rose to 302 workers in 2002. It has a very low degree of internationalization, for they only work for the Spanish tractor firms and particularly in Madrid, on which they depend. This means a high level of competition, which in some cases means facing cost reductions, and to a lesser degree, specialization or differentiation of production (Community of Madrid, 2000).

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[10] The list of firms selected for the study can be found in table B of the annex.

[11] Only consolidated data was available for both firms on the national level. Given that the interviews were made in Madrid, the information obtained has been given to represent the Madrid region, even if various plants of these companies are located in Andalusia.

[12] Firms such as AISA and ICSA also pertain to this group which have not been interviewed.

[13] This group of firms also includes Aries Complex and CADTECH engineers.

Throughout the last decade of the XX century, entrepreneurial groups have been created among this set of small and medium size firms, for the purpose of having the necessary technology available for the integration of products and so undertake greater value added tasks for the tractor firms. This is the case of the groups TAM, Grupo Aeronáutico de la Zona Centro (G.A.Z.C.) and the OSSMA group.

The TAM Group, established as an Economic Interest Association, is created in 1991. Today it is composed of seven firms – among them CM8, CEDYPSA, Quality Metal, S.A., MAAC Manufacturing – with complementary technologies and productive means. The firms in the group work autonomously and share services and common activities (quality, administration, sales and training). Among their major specialties stand out mechanical engineering, design, CAD/CAM development and programming; the integration and assembly of aircraft structures and aeronautic components; and the design, development and manufacture of parts and various equipment.

The group works in the aeronautics, aerospace, automotive, railway and scientific research sectors. It offers training courses, geared towards the specific needs of the aeronautics industry, given in their own headquarters, both for their own personnel as for that of other firms.

Among its major clients is found EADS-CASA and Airbus Spain. For the A380 project the Tam group designed and manufactured various equipment finishes for sealers and coverings of the drift, the stabilizer poles and the horizontal stabilizer, and for seventeen fuselage panels.

The Grupo Aeronáutico Zona Centro (G.A.Z.C.) is composed of the following firms: Talleres Pibab, Anonizados Herrero, San José Villa, Utillaje Huertas and Martos JJN,S.L. Its main activity is the conventional mechanization of various parts and components, as well as the finishing process for some of these. For the purpose of improving its competitiveness and increase its participation in the productive value chain, it has a design station Catia, and has implanted a centralized control system for production. Its main client is EADS-CASA.

The OSSMA Group, was created in 1999 after the merger of the aeronautics production firms OSVIMA and SMA and also works with two R+D firms. The management of the group is focused on administrative, suppliers and clients tasks, whereas manufacturing is carried out independently in each one of the factories.

The joining of the two firms has permitted join design, programming and numeric control activities with the manufacture of various equipment and brazier goods; and they use conventional mechanizing technology and numeric control, and the specific application of Catia design.

The location of tractor and modular integrator firms in different municipalities of the region of Madrid has shaped a map where three distinct large industrial poles can be seen. Here is where practically all of the aeronautics industry of Madrid is focused: Tres Cantos, Getafe-Parla-Mostoles and the Corredor del Henares. In the area of Getafe and neighboring municipalities is produced the largest concentration of aeronautics industry firms in Madrid.

5.2.3 Specialization and Cluster

1. Andalusia

In Andalusia, 97% of the firms work as subcontractors. This practice has increased, both in the number of firms, as in percentage of income over total sales (see figure 5.15.). It is not surprising, given that the small auxiliary firms are the more numerous group of the entrepreneurial fabric. These firms depend on the load of work given by other firms.

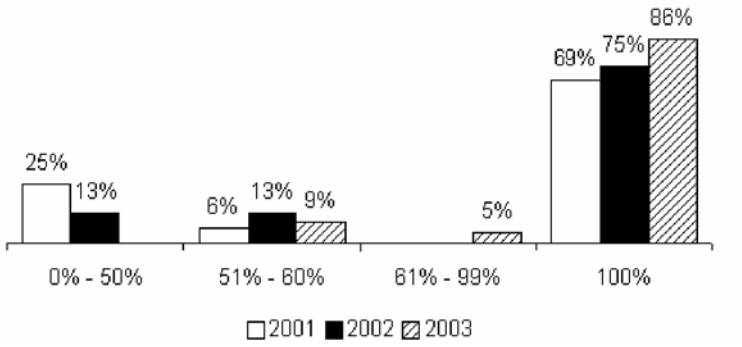


Fig. 5.15. Aeronautic firms in Andalusia (%), According to proportion of subcontracting received on its sales

Source: Data from Survey

73.2% of subcontracts are made for subcontractors in Andalusia (basically tractor and modular integrator firms), 22.2% comes from the rest of Spain, and only 4.6% are international, particularly from the EU (France). The subcontract conditions specify the needs of quality control norms, usually established by the tractor firms which they divulge through the chain of subcontracts.

The firms under subcontract show little leeway (see figure 5.16.). Only about 25% of these make decisions about the characteristics of the products and the more adequate production methods for optimizing production.

Over half receive the materials necessary for their work always or often from the subcontracting firm and only a 4% of the times receives financial assistance.

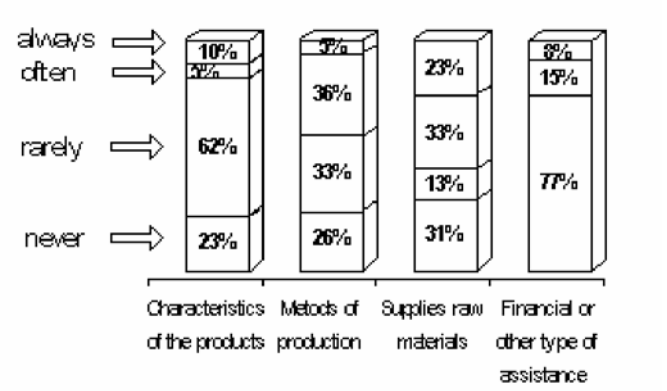


Fig. 5.16. Aeronautical firms in Andalusia (%), according to the conditions of the subcontract obtained

Source: Data from Survey

With respect to the assigned subcontract, 55% of the aeronautics sector firms subcontract activities to other firms. These are third level subcontracting firms – auxiliary firms – that distribute their work load between the small firms of the sector. As can be seen in figure 5.17., the tendency is to increase the load of the established subcontract with respect to total costs. This shows greater capacity on behalf of the Andalusian firms for accepting and getting greater work loads.

The major market to which the firms go to subcontract is regional, in which 80.2% of the total is under subcontract. This generates a positive effect in the aeronautics sector as a whole, redistributing the work load and facilitating that the value added not be lost outside the region. The rest of the volume is basically directed to the rest of Spain, whereas only a 1.5% is under subcontract in the EU or internationally.

This territorial distribution of the assigned subcontract is justified, above all, by the improved information that the firms who decide subcontracts have above those firms closer to their environment. The geographical proximity allows for a more direct control as to where and when of the service subcontracted, and at the same time facilitates a better negotiation, according to its evolution.

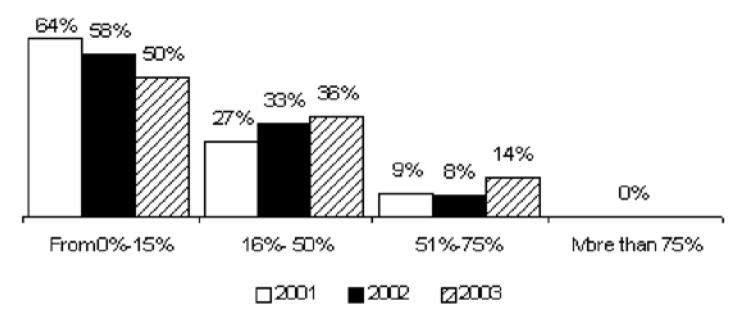


Fig. 5.17. Aeronautical firms in Andalusia (%) according to the interval of assigned subcontract over total costs

Source: Data from Survey

With this system, the characteristics of the products, production methods, and the supply of raw materials are given by the final and modular integrator firms, who impose them directly or through other assigned subcontracting firms, under subcontract themselves.

As can be seen in figure 5.18., the characteristics of the product are the conditions that the firms impose most when subcontracting. Very rarely, is any other kind of assistance different from this given, and when it occurs, it is in the nature of technical assistance, but never of a financial nature. The lack of financial assistance is understandable, since one of the motives of subcontracts is to diversify costs in order to carry out the work load. Furthermore, the firms in Andalusia, because of their size and position in the market, don't usually have sufficient resources available for financing other firms, and have difficulties in funding their own financing.

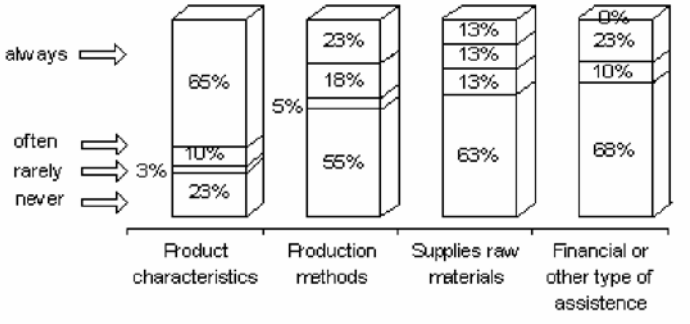


Fig. 5.18. Aeronautical firms in Andalusia (%) according to the conditions of the subcontract

Source: Data from Survey

2. Madrid

The organization of production has a local component. 79% of the firms indicate subcontract a part of their activity. This assigned subcontract represents a third of the production costs for half of the firms, and over 90% of these costs for only 8% of them. Of the total of assigned subcontracts, those with an industrial nature are more relevant, and affect 59% of the firms; whereas specialized subcontracts are made for a third of the firms, although for 17% of the firms this represents over 90% of the costs.

The firms under subcontract present differences that depend on the contract policy of the tractor firms and on the segment of activity in which they work. In general, the firms that work in engineering and design activities and thus with a greater R+D component, usually work with a limited number of subcontractors. The large tractor firm EADS-CASA has a greater number of subcontractors available, given that its present policy tends to externalize a larger number of activities. Yet, increased transaction costs are changing this situation. The tendency is to reduce the number of "risk sharing partners", selecting the strongest, with the best internal and external structure, and with a greater value added in their components. These risk sharing partners should count on an adequate size that will allow them the development and design of the whole contract package; the making and maintenance of the documentation; the design and manufacture of various equipment, prototypes and tests of subcomponents… so as to allow for maximum integration of elements, commitments and long term contracts, and above all, take risks.

Assigned subcontracting has a regional basis. Over 70% of the subcontractor firms are located either in the municipality/metropolitan area or in the province, and to a lesser degree in the region of Madrid. There are also examples, however, of subcontracting part of the activities to productive units on the Spanish (13%) and European Union (4%) level. In general, the firms that assign subcontracts, the subcontracting firms in over 90% of the cases establish the characteristics of the products and usually indicate the production methods. They often supply the raw materials (46% of the cases) and to a lesser degree provide financial assistance (21%) (See table 5.6.).

Table 5.6. Conditions of the subcontract given to the aeronautics firms in Madrid, 2002

Subcontratact Conditions	Frequency			
	always	often	rarely	never
The client establishes the characteristics of the products	58,3%	33,3%	0%	4,2%
The client establishes the production methods	41,7%	50%	0%	4,2%
The client supplies the raw materials	16,7%	45,8%	29,2%	4,2%
The client provides financial assistance	4,2%	16,7%	29,2%	45,8%
The client provides another kind of assistance	0%	29,2%	41,7%	25%

Source: Data from Survey

In most cases the subcontractor firms are required quality control norms, both the general norms in effect today for the sector as well as those of the module intequator (75%), in 13% the general norms exclusively and only 8% those of the module intequator. The quality controls are carried out, in general, by both firms.

82% of the firms have worked as subcontractor for other firms – received subcontract-. This subcontract represents 100% of its productive activity for over half of these firms. Furthermore, 44% of them make industrial subcontracts, as opposed to 22% that carry out specialized subcontract activities. These percentages show that most of the aeronautics fabric in Madrid carries out activities in the lower levels of the value chain of the sector; when it is compared with other European regions specialized in these activities. This fact is related, in part, with the slight level of participation of the Spanish administration in the European aeronautical and aerospace programmes.

As in the assigned subcontract, the subcontractor firms present a regional base, they locate, preferably, in the municipality/metropolitan area, and to a lesser degree in the province and region. Nevertheless, 17% of the firms that assign subcontracts is located on the national level. Very few of the European Union and international subcontracting firms assign tasks to firms in the aeronautical sector of Madrid; 83% and 91% of the subcontractor firms state they have no relations with subcontracting firms on the European community or international level.

The characteristics of the products are almost always established by the subcontracting firm. Often, the production methods are specified, although

in this case it appears that the regional subcontract for firms have a little more leeway, though continue to be very dependent on the subcontracting firms. The supplying of raw materials and financial assistance is usually taken care of by the subcontractor firm (see table 5.7.). These firms, in 96% of the cases, are required quality control standards, specifically, both the general standards of the sector, as well as the specific standards of the final or module intequator, as said by 78% of the firms.

Table 5.7. Conditions of the subcontract of the aeronautics firms in Madrid, 2002

Subcontracting conditions	Frequency			
	always	often	rarely	never
The client establishes the characteristics of the products	73,9%	26,1%	0%	0%
The client establishes the methods of production	21,7%	47,8%	26,1%	4,3%
The client supplies the raw materials	17,4%	34,8%	26,1%	21,7%
The client provides financial assistance	8,7%	8,7%	30,4%	52,2%
The client provides other kinds of assistance	13,0%	21,7%	47,8%	17,4%

Source: Data from Survey

5.2.4 Labour Market and Innovation

1. Andalusia

The fast rate of growth of new firms devoted to aeronautics activities during recent years in Andalusia has led to a rapid increase in the number of employees in the sector (see table 5.8.). Over half of these employees work in small firms (from 10 to 50 workers), a prevalent size in the lower level firms of the value chain (mechanization and sheet metal). Firms with over 100 employees correspond to a group which includes certain modular integrators and various firms devoted to less specific activities within the aeronautical sector, such as mechanics and machinery in general, or the manufacturing of electric components (see figure 5.19.). Engineering firms generally have a small size, but with a predominance of highly qualified personnel.

Table 5.8. Employees in the aeronautics firms in Andalusia (nº and growth)

	2001	2002	2003	02/01	02/01	03/02	03/01
Nº of Employees	1.895	2.229	3.003	18%	18%	35%	58%

Source: Data from Survey

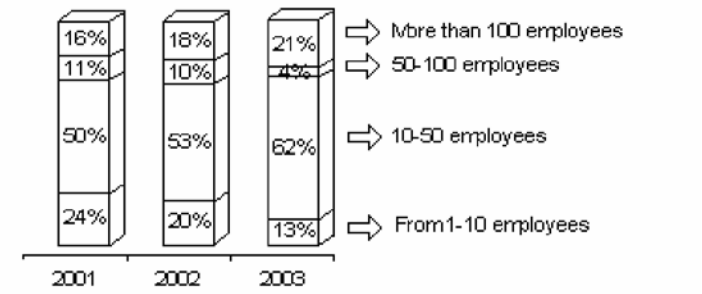


Fig. 5.19. Aeronautics firms in Andalusia (%) according to number of employees

Source: Data from Survey

From the point of view of the skills (see figure 5.20.), the productive fabric in Andalusia shows high specialization in manufacturing and to a lesser degree in assembly. Half of total employment is done by skilled workers, whereas managers and top technicians with university degrees represent a 24%.

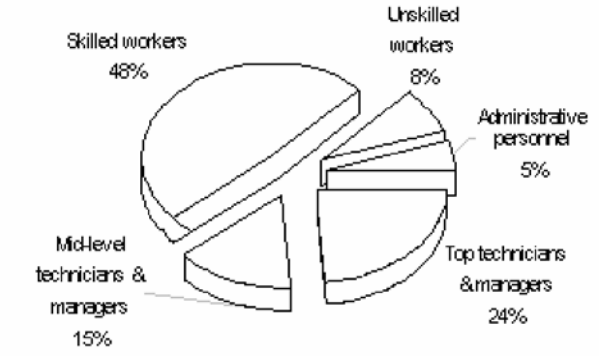


Fig. 5.20. Employees (%) in the aeronautics firms in Andalusia according to qualification

Source: Data from Survey

Within the category that groups together top technicians and managers, the most representative qualification is that of engineer. Thus, a 45% of the firms analyzed have more than three engineers on staff. In this sense, the

support being given to training, both graduate and vocational, on behalf of the national, regional and local governments for the purpose of eliminating training deficiencies should be pointed out. In Seville, aeronautics engineering has appeared as a university degree for the first time in 2002, and not until 2007 will the first licensed engineers graduate.

This situation with respect to the qualification of workers in aeronautics firms in Andalusia has continued in recent years, but it is true that even though all professional groups have increased considerably in absolute terms, it is the group of assembly workers, particularly the qualified ones, that has grown most with respect to the total (see table 5.9.). This contrasts with the pretensions of the entrepreneurs of mechanizing the productive process and devote more jobs to research and development activities.

Table 5.9. Aeronautics firms in Andalusia (%) according to qualification of employees 2003

	2001	2002	2003
Top technicians	31%	27%	24%
Mid level technicians	16%	15%	15%
Skilled workers	42%	46%	48%
Unskilled workers	6%	7%	8%
Administrative personnel	5%	5%	5%

Source: Data from Survey

To conclude, it can be said that the employment structure in Andalusia is a true reflection of the specialization of firms there, and of the perspectives brought forth by the sector in the region, that have stimulated the creation of new firms and the incorporation of others that had not participated there before. Despite the fact that engineering firms have had a greater presence in recent years, the number of workers introduced has been less than in the construction and assembly firms, which can be seen by the increased participation of the blue collar workers and in the descent of university graduates and/or top technicians with respect to the total number of workers.

Besides hiring new workers in the sector, all of the firms analyzed have made some sort of move with respect to employment (see figure 5.21.). 95% have hired and only a 33% have fired, which is coherent, keeping the sector's favourable dynamic in mind, which has led to increased personnel

because of the greater work load. The number of firms that have undertaken training actions should also be pointed out (an 86%).

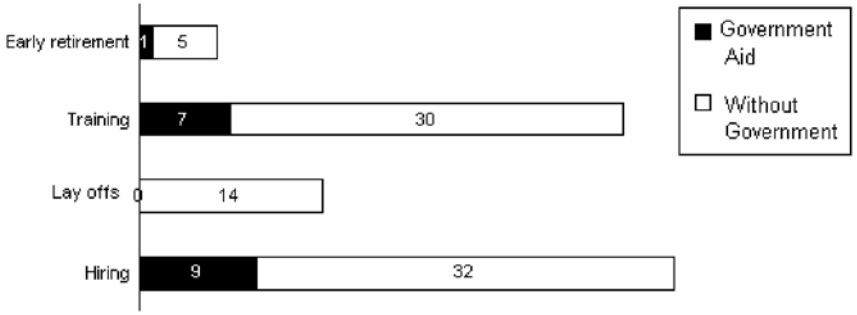


Fig. 5.21. Aeronautical firms in Andalusia according to type of actions carried out in employment

Source: Data from Survey

The regional government has supported the hiring (20%) and training (19%) policies, carried out by the aeronautics firms in Andalusia. These policies are part of the Junta de Andalusia's (regional government) commitment to support the private initiative employment policies as complementary to public policies, and they are managed by the Employment Service of Andalusia (SAE).

The majority of firms in Andalusia (88%) consider that they have developed innovative activities.

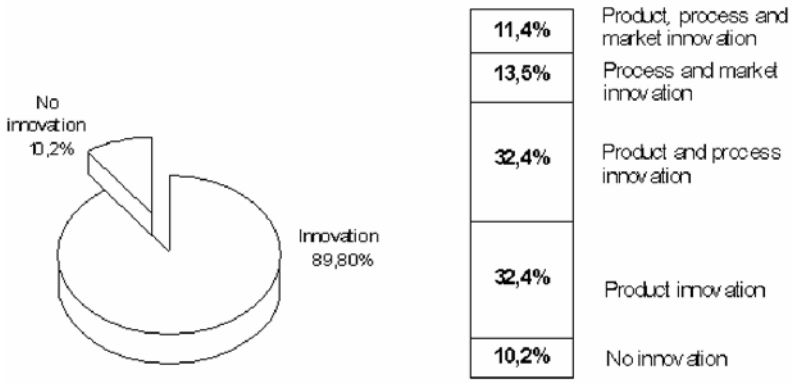


Fig. 5.22. Aeronautics firms in Andalusia (%) according to technological innovation activities

Source: Data from Survey

As can be seen in figure 5.22., process and product specialization, and particularly that focused only on process, are what has been most frequently made by the firms located in Andalusia; which, on the other hand, is in accordance with its manufacturing and assembly specialization. To maintain the quality of the product is the main reason given for innovation. The wish to both satisfy the contractor and keep or increase the market share are the following reasons thought most important by the innovative firms. Given that most of the turnover of these firms comes from subcontracting, it isn't surprising that such a reason is thought equally important when innovation is concerned.

Furthermore, by focusing on the conditions set by the contracting firm, it is logical that the innovations be generally directed towards the process, since the type of product and its conditions are usually predetermined, and so these firms are only motivated by process innovation for improving their production.

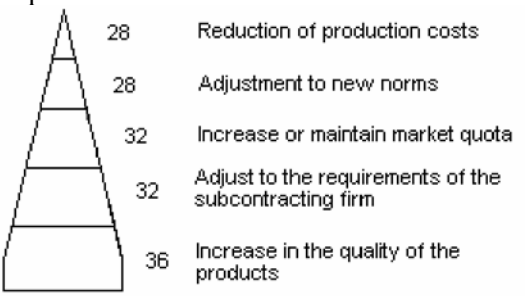


Fig. 5.23. Aeronautics firms in Andalusia (%) according to main reason for innovation

Source: Data from Survey

As far as personnel assigned to R+D activities, only a 29% of the firms keep workers devoted exclusively to these activities, particularly, the engineering firms and some of the large firms. Most have only one or two employees devoted to these tasks, although in one case, Ghesa, has 20 workers.

In 54% of the cases, investments in innovation have been supported by the Public Administration, specifically by the regional government through projects co-financed by the European Union. The average amount of this aid[14] was 30% of the necessary investment. As a result of these investment,

[14] This aid is a result of the *Consejería de Empleo y Desarrollo Tecnológico* de la Junta de Andalucia and its Order of December 21, 2001, in which aid to firms in the aeronautics sector for the period 2000-2006 are open. This aid represents up to 40% of the investment, and if it is for a SME, an added 15% can be obtained.

49% of the firms obtained certification. In all cases, it is process certification that we are talking about, specifically of type UNE/EN/ISO 9001 or UNE-EN 9100: 2003. Generally speaking, the modular integrators have these certifications.

Meeting these norms is essential for the firms in Andalusia who aspire obtain work from the new aeronautics activities that are to develop in their Community. The Junta de Andalucia (regional government) aware of the importance, has begun, through the IAT (Instituto Andaluz de Tecnología, or Technology Institute of Andalusia) and in collaboration with EADS-CASA and Airbus España, an initiative focused towards helping firms within the sector in the setting up of necessary management systems.

This is the main reason that leads firms to cooperate: The need to innovate in processes and product, particularly among themselves (see figure 5.24.).

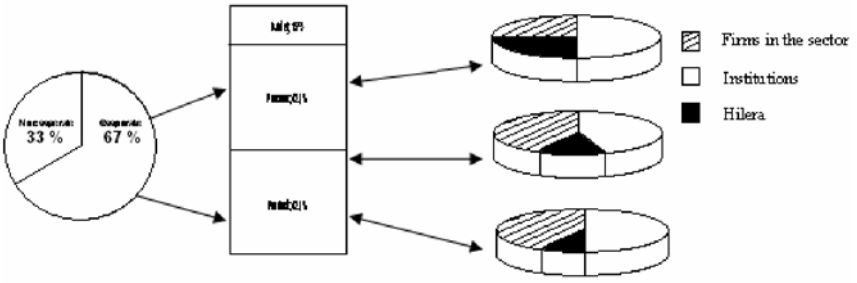


Fig. 5.24. Aeronautics firms in Andalusia (%) according to cooperation activities

Source: Data from Survey

In recent years (see table 5.10.), strong investments have been made in modernizing, widening and relocation of installations on behalf of the aeronautics firms located in Andalusia. These investments are the result of the good perspectives created by the sector in the region, that has attracted new firms, with the consequent need to invest in equipment in order to begin to work, and this has forced those already there, to equip themselves, both in quantity and complexity, according to the work load. These investments have mostly been carried out by the modular integrator firms, like EASA del Sur and SACESA.

Furthermore, in order to stimulate location of firms in the Technological and Aeronustics Park of Andalusia (Aerópolis) and in the Bay of Cadiz (TecnoBahia) an added 10% is possible. This Order reflects the active role of the administration in Andalusia in the development of the aeronautics sector faced with the needs resulting from the modernization and growth of the sector in Andalusia.

Table 5.10. Investment by the aeronautics firms in Andalusia in machinery and/or equipment goods

	2001	2002	2003
Total investment (thousand €)	13.465	3.868	4.928
Sales (thousand €)	137.206	141.780	178.774
% Investment over sales	9,8%	2,7%	2,8%

Source: Data from Survey

2. Madrid

In 2002, the total workforce of the set of firms was around 9,252 workers, which represents 67.6% of employment in the aeronautical sector in the region of Madrid, and 40.7% of national employment. The tractor firms and the module integrators had, on average, a larger workforce than the group of firms known as third level firms, where small firms, with less than 50 employees and mostly family firms are a most important part.

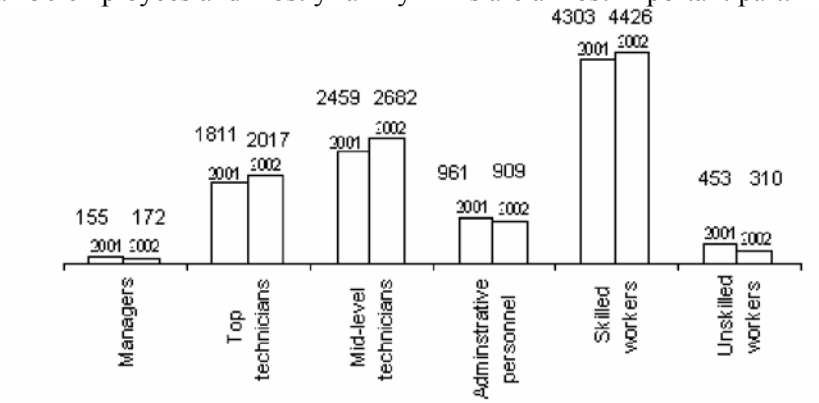


Fig. 5.25. Distribution of employment of the aeronautical firms in the region of Madrid, according to professional categories, 2002

Source: Data from Survey

The number of university graduates and technicians vary according to the size of the firm. In general, this collective represents, on average, in each of the firms interviewed, over 10% of the workforce, though in some cases they represent over half of the workers (see figure 5.25.).

They carry out managerial functions and those related to technical tasks of the production process and product development. The largest group is made up of skilled workers, around 42%, below the average in the sector on the national level (48%). Given the characteristics of the sector, they have a high level of qualification. The administrative staff represents a lit-

tle less than 10%, and barely 3% is what non-skilled workers represent within the workforce of these firms.

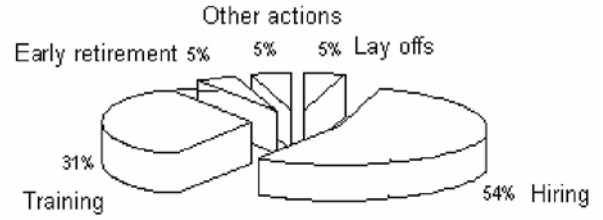


Fig. 5.26. Actions regarding employment made by the aeronautical firms in Madrid, 2001-2002

Source: Data from Survey

Between 2001 and 2002, employment rose a 3.7%. This growth was produced mostly in the categories of managers and top and mid level technicians (university and vocational school graduates), whereas administrative and blue collar workers diminished in number. Proof of this is the employment initiatives that have been carried out by 57% of the firms in recent years. Among these stand out the contract measures for personnel (75%) and training (44%), in accordance with the recent changes that have affected some tractor and module integrator firms and the launching of projects for the construction of new aircraft (see figure 5.26.).

Fig. 5.27. Innovation Activities of the Aeronautical Firms in Madrid, according to Size 2002

Source: Data from Survey

75% of the firms have innovated during the last three years. These are mostly process and product innovations, although 29% of the firms have carried out innovation in the product, process and market (see figure 5.27.). Small firms basically carry out their innovative activity in the area of processes and to a lesser degree, in that of product. Market innovations are almost nonexistent within this group. The medium and large firms

show a more balanced distribution between the different types of innovation, although in the case of the large firm, product and process innovations prevail.

The motor force for innovation for all of the firms is to gain or to maintain the market share. Added to this in most cases (91% and 86% respectively) are aspects like increased product quality and cost reduction. For the firms, reasons such as adaptation to standard norms or the requirements on behalf of the firms that assign the subcontract, are very important for almost ¾ of them (71% each of these reasons). This could imply a certain justification, a priori, for the innovation strategy of the firms in this region.

The majority of firms (81%) devote funds for R+D+I activities. These investments represent less than 20% of total costs for 43% of the firms and less than 10% for a third of them. The number of full-time employees in these activities varies according to the size of the firm. Only 10% of the firms lack this type of employee, which coincide with those that don't invest in innovation. These employees represent less than 10% of the workforce for 38% of the firms, whereas for a third of the firms, 20% of the total employees.

Despite the fact that 75% of the firms state having carried out some sort of innovation, only 19% of the firms have protected themselves through patents.

During the last 5 years, 80% of the firms indicate no patents. Thus, this is a sector that registers few patents, even though it is intensive in knowledge and has a high technological level. The reason for this might be that once the work load is assigned in a specific aircraft construction project, it obtains a certain monopolistic income, very similar to the patent process. Furthermore, it may be determined by the very organization of production. Patents are only registered by few firms, either those that carry out specialized subcontracting, or by the module integrators, though in some cases it may be related to the investment in R+D; and on the other hand this is low in some firm groups (less than 10% of sales).

Nevertheless, 24% of the firms admit using patents from other firms. The use of patents of foreign firms (60%) and those of the other firms of the region of Madrid and of the EU (20% respectively) are the most often found. The small number of patents does not seem to be justified by the greater use of foreign patents, since more than ¾ of the firms don't use this system.

For the development of innovation, cooperation with other firms or institutions plays an important role for over half of the firms. In 56% of the cases these cooperation relations are established for the development of product innovations, predominantly for joint R+D+I projects with firm in

the sector (44% of the cases), public or semi-public research institutions (38%) and with firms from the aeronautics filière (31%).

Cooperation for process development is established by 63% of firms, mainly with firms from the aeronautics filière and based on R+D+I projects (44%) with firms of the sector (31%) and to a lesser degree, with institutions (25%). Only a 6% of the firms maintain cooperation in order to carry out market innovations.

The innovation activity carried out by firms during the last three years has received support from the different administrations in 36% of the cases. This aid was granted for product innovation (64%) and process innovation (36%), and to a lesser degree for training (18%).

5.3 The Agents in Context

Both in the region of Andalusia as well as in that of Madrid, three large groups of economic agents can be singled out:

- Entrepreneurial agents, that include firms and associations
- Agents devoted to training and research in aeronautics.
- Public Administrations, with their different territorial levels, and

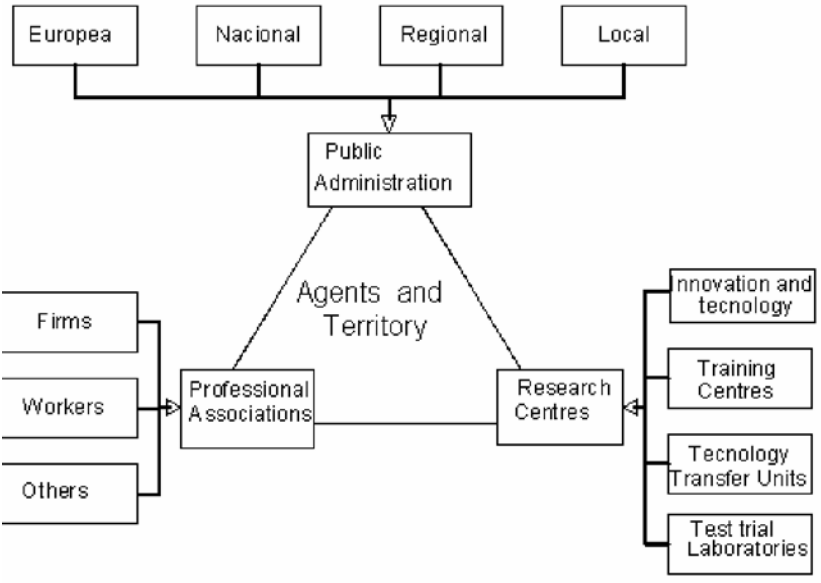


Fig. 5.28. Agents and the territory

Source: Authors

All of these actors, form a network of relations that has great impact on the aeronautical sectors of Andalusia and Madrid. These are characterized by the variety of actors that interact and complement each other in order to better cooperation and the decision making process. This set of relations is seen through the competitiveness triangle shaped by Government-firms-institutions, and that is being used in order to promote local development processes.

5.3.1 Business Agents

In this first group we can distinguish between private firms which have a business in this sector and the entrepreneurial associations.

1. Private aeronautical firms

The valuation made by private firms of the contribution of other actors to the functioning and development of its activity, may be seen in table 5.11.

Table 5.11. Firm's valuation of the other actor's contribution (%of firms)

How do firms valuate the milieu´s actors?	Firm´s valuation of the other actor´s contribution (% of firms)							
	Very important or Important		Indifferent		Of little importance		Unimportant	
	Madrid	Andalucía	Madrid	Andalucía	Madrid	Andalucía	Madrid	Andalucía
Municipal Goberment		10,3	7,1	3,4	21,4	13,8	42,9	72,4
Regional Goberment	25	72,4	28,6	17,2	32,1	3,4	7,1	6,9
Central Goberment	50	24,1	21,4	20,7	10,7	13,8	10,7	31
University & Research Centers	32,2	17,2	46,4	31	3,6	20,7	7,1	31
Professional Asociations	42,9	13,2	32,1	24,1	10,7	20,7	3,6	27,6
Industrial or Services Firms	32,2	37,9	17,9	13,8	14,3	10,3	21,4	27,6
Chamber of Commerce	17,9	27,5	32,1	20,8	14,3	20,7	25	24,1

Source: Data from Survey

- The firms in Madrid see the Central Administration (50%) and the business associations (43%) as key actors for their functioning and

development. Yet, the firms in Andalusia consider the important or very important for their functioning and development to be the Regional Government (72.4%), and secondly, but at quite a distance, the industrial or services firms (38%).

- Almost a 50% of the firms in Madrid declare that the university and research centres are indifferent for their development. Nevertheless, 32% of firms do value this sector as important or very important. In contrast to the aforementioned, in the Andalusia region, only a 17.2% of firms consider the university and research centres as important or very important. 83% of firms in Andalusia consider this sector as indifferent or very unimportant.
- With respect to business associations, in Madrid they are very highly regarded by the firms (43%), and yet, in the Andalusia region only a 13.2% of the firms considers them to be a key actor. Almost 73% of the firms in Andalusia state that the professional associations are indifferent or very unimportant for their development and functioning.

Last of all, another distinguishing feature to keep in mind between both regions, is that the large firms in Madrid are managed by aeronautics engineers with extraordinary power. This is a group of engineers who have fought for the growth and development of the sector within the region of Madrid since the sixties. A group of people that have created a very powerful lobby, and surprisingly, it has not existed during all these decades in Andalusia.

2. Business associations

The business associations that can be found within the region of Andalusia are the following:

- Federation of metal entrepreneurs (FEDEME). This is a professional organization, formed by industrial and commercial entrepreneurs from different branches of the field of the provincial metallurgical sector. FEDEME is devoted to the study of the sector, and has found in one of its studies that a 99 million Euro investment is required in order for the auxiliary aeronautics industry of Andalusia to be restructured and adjusted for carrying out the greater work load brought in by the new programmes being developed in the European community.
- The Andalusia Aeronautics Forum is promoted by the Engineering School of Seville, the Official College and the Association of Aeronautical Engineers (delegation in Andalusia) as well as the Guadalquivir Aeronautics Foundation. Their main objective is the creation of the necessary conditions and environment for the diffusion of information,

debate and discussion about Aeronautics in general and its industrial implications in Andalusia in particular.

- Chamber of Commerce, Industry and Navigation of Seville. Its participation in the aeronautics sector is through the commercial activities such as fairs, and work and field trips they make. Foremost is the entrepreneurial mission made in 2003 to Toulouse, which allowed for closer ties between French firms and those in Seville.
- Cartuja 93 Technological Park (in Seville). Established in 1991. The Department of Employment and Technological Development of the Regional Government of Andalusia intends to convert the Scientific and Technological Park of la Cartuja into one of the main instruments for the Director Plan for Innovation and Technological Development for Andalusia 2001-2003 (PLADIT).

The entrepreneurial associations found in the territory of Madrid are the following:

- ATECMA (Spanish Technical Association of Constructors of Aerospace Material). In Madrid this is the most dynamic and well known association, keeping in mind that it is a national association and thus, is also active in other Spanish regions. It is a non-profit organization, created in the fifties for the purpose of promoting the aerospace sector, which had three sub-sectors from its beginnings: Aeronautics, Space and Defence. Today, after half a century of existence, it can be said that the Spanish aeronautics industry and especially the industry in Madrid, is almost entirely represented by ATECMA. Its associate firms make up over 96% of the total business of the aeronautical sector. Specifically, ATECMA in made up of 36 associated firms, of which over 60% work in the area of Madrid and its surroundings. AS indicated in recent annual reports, and keeping the final objective of consolidating the aeronautical industrial fabric. The main goals of this association are the following:

  1. Favour the development of the aeronautical sector.
  2. Cooperate with the Central Administration and with the regional and local administrations, for the purpose of informing on the needs and the proposals of the associated firms.
  3. Stimulate cooperation and collaboration between the associated firms.
  4. Form part of the sector's lobby and think tank, following events and collaborating in the public aid programmes.
  5. Maintain and enhance relations with the European Union and other international organisms and associations.

6. Undoubtedly, ATECMA is one of the agents that has tried to consolidate the sector in Spain in past decades, and particularly in the area of Madrid is an important lobby in favour of the aeronautical sector. Through its intense participation in national and international forums, conferences, entrepreneurial meetings and conventions, it is constantly in touch with the areas of influence and power, be they local, national or European. It is here where it puts forth the needs of the associated firms and impels programmes and aid projects, coordinating the initiatives and proposals.

- School of Aeronautical Engineering: Besides meeting with the obligations required by the Administrations, the School also makes reports, technical studies, projects and statistics as well as other related activities, with the objective of stimulating the sector. It also acts as a regular consultant to different organisms of the Scientific and Technological Policy Secretariat of the Ministry of Science and Technology. This school is located in Madrid, and it is easily understood that its main task is to stimulate the sector in this region. Nevertheless, it also encourages other projects in other regions as is the case of Andalusia.
- Chamber of Commerce and Industry of Madrid. As in the case of Andalusia, its participation in the aeronautical sector is through the commercial activities and fairs they organize.

In sum, we can say that the role of the different professional and business associations, as well as that of the professional industrial and aeronautical engineering schools is crucial in the development of the aeronautics sector, both in Andalusia as well as Madrid. This is principally due to the environment of collaboration they foment with the firms of the sector and with the different Administrations in Andalusia, Madrid and Spain.

5.3.2 Agents Dedicated to Training and Research

Everyone knows the role played by research and technological development in the industrial environment is most important. Nevertheless, within the aeronautics sector, R+D is a basic and indispensable element for the growth, development consolidation and survival of the sector. The only products that are commercialized and that will give profits in the future are those that manage incorporate the greatest complexity and quality, and logically, all of these new products and innovations mean important increases in development and financial costs of the firms.

The main actors dedicated to research are not created nor exist on the local or regional level, but rather on the national or European level. In this

sense, it can be pointed out that in Spain exist five basic agents devoted to aeronautics research and training.

- First, the private aeronautical firms. These are the most motivated in discovering an economically viable and internationally competitive new product or prototype. Private firms actively participate in a large number of research projects, in some cases financing the project and in many cases contributing its most qualified personnel.
- Second, the university. Specifically, the Graduate Technical Aeronautical Engineering Schools of Madrid and Seville (E.T.S.I.A.) and the University School of Assistant Aeronautical Engineers (Ingenieros Técnicos Aeronáuticos) of Madrid (E.U.I.T.A). In table 5.12. are shown some of the more significant research projects that are presently under way in these Technical Schools.

Table 5.12. Aeronautics research projects in ETSIA (UPM) Spain (under way in 2004)

Name of project	Financial Entity
Study of hydrodynamic aspects of combustión and cargo transport problems.	DGES
Direct simulation of transitional bubbles in low pressure turbines.	ITP-PROFIT
Numeric study of turbulent flux.	CICYT
Low emisión combustor technology programme (Low Nox III)	European Union
Dynamic fluid study of sprinkler deflectors for the La Palma airport	Media Consultants

- Third, the National Technical Aerospace Institute, commonly known as INTA. This institute was founded in 1942 with the name of National Technical Aeronautical Institute and its basic function and objectives had to do with the industry. In the sixties, with the beginning of the conquest of space it changed its name to Aerospace, and today most of its work has to do with space. Yet, as can be seen in table 5.13., it also works in aeronautics. Its objective is to strengthen R+D and give technical and scientific support to Spanish institutions and industry. Its annual budget is close to 100 million Euros, of which most is dedicated to applied research and technological development. The INTA has advanced installations where test trials, ratifications and certifications for blue prints, motors, armament, electronic equipment, aircraft systems and equipment, avionics systems, are made.

Table 5.13. Aeronautics research projects for INTA (under way in 2004)

Name of project	Description
Integrated Air Vigilance System (SIVA)	Observation and vigilance system by means of electronic sensors that provides aerial images.
ALO Observation System	Observation and vigilance system by means of electronic sensors that provides aerial images.
ALBA Air Target System	System designed for training by short distance anti-aerial artillery units with real fire.
The Technoloical Copilot	System that detects the pilot's exhaustion and acts to avoid accidents.

- Fourth, the Centre for Industrial Technological Development (CDTI). This is a public entrepreneurial entity that depends on the Ministry of Industry, Tourism and Commerce, destined to promote innovation and technological development of Spanish firms. It gives financial aid to firms and facilitates financing to third parties for carrying out research and development projects. Besides this, the CDTI, among its other activities, also manages and supports the attainment of industrial contracts with high technological content promoted by different national and European organizations for Spanish firms.
- And last, we should also mention the Official Scientific Research Centre (CSIC: Consejo Superior de Investigaciones Científicas). Founded in 1939, it is the largest Public Research Organism in Spain, and participates in the scientific policy of all of the autonomous communities. This institution collaborates with all levels of the different administrations, with other research institutions and with the social and economic agents to which it contributes its research capacity and human and material resources for the implementation of research projects or under the guise of advisory and scientific and technical support. Given its multidisciplinary nature, the CSIC works in all fields of knowledge, devoting itself mostly to basic research and technological development, and believing most important the transfer of results to the firm sector.

The differences, with relation to R+D between regions studied are:

- The average expenditure destined to R+D in Madrid is far greater to that destined to the region of Andalusia. This fact shows a greater growth potential in Madrid than in Andalusia. It should also be remembered that the School of Aeronautical Engineers in Seville was born only two academic years ago.[15]

[15] Gálvez, C. and González, A. 2002.

- As shown in table 5.14., the qualification of aeronautic employment in Madrid and Andalusia adapts itself to the characteristics of the aeronautics productive fabric of each territory, pointing out the following aspects:

Table 5.14. Qualification of employment in aeronautics in % (2002)

	Madrid	Andalusía
Top Technicians and Managers	36,3%	9,7%
Mid level Technicians and skilled workers	46%	64,3%
Unskilled workers	3,9%	18,3%
Administrative Personnel	14,8%	7,7%

Source: Data from Survey

Top technicians (university graduates) and managers in Madrid represent 36.3% of total employment in aeronautics in Madrid, a much higher ratio than that of Andalusia, where it was only 9.7% of total employment there.

The largest group, both in Madrid and in Andalusia, is formed by mid-level technicians and skilled workers (in Madrid 46% and in Andalusia 64.3%). The unskilled workers in Madrid represent an insignificant percentage (2.9%), which is why many of these workers in Madrid have been promoted to the group of mid-level technicians and skilled workers.

Lastly, the administrative personnel is greater in Madrid than in Andalusia, logical, given the fact that in Madrid are the headquarters of the large tractor firms that employ an important volume of administrative and bureaucratic work.

A common characteristic between the aeronautical industry in Andalusia and Madrid is that in both regions the composition of the industrial fabric (mostly composed of small firms) does not develop intensive R+D required by the aeronautical sector. Therefore, in both regions the research and training centres stand our as key actor for the contribution of knowledge and capabilities that help raise competitiveness and the development of industry. It is essential that both Andalusia and Madrid be endowed with greater research and technological development budgets, that the number

and quality of research projects underway be encouraged, and that they be ever more integrated in international research projects.

5.3.3 Public Administration

The relation between the aeronautical sector and the administration is basic, due to the fact that satisfying the need for large funds is an indispensable element for the development and growth of the sector. Without an active public policy in favour of the Spanish industry it is difficult to foresee the possibility of being present in the small list of countries that are competitive today.

In Europe, and particularly in Spain, aeronautical firms contribute more to the financing of R+D than does the public administration. For this reason, the firms, individually and through their associates, keep asking both the national authorities as well as the European, for better conditions in public aid, better tax incentives for R+D and more guarantees of continuity in aid for long-term projects. Keeping this reality in mind, we will now analyze what have been the main course of action by the public administration in favour of the aeronautical sector. Specifically, which have been the major programmes and public support policies to this sector? We will study the different levels of governmental management: European, Spanish Central Administration and Regional Administration: Andalusia and Madrid.

1. European Union

Beginning with the actions set forward by the European Union in favour of the aeronautics sector, we find the Framework Programme for Research and Development, which is the main policy instrument of R+D in the European Union. It is in this programme where all of the European actions directed towards Research and Technological Development are grouped: basic research, technological development, innovation and even transfer of technology.

At present, it is the 6th Framework Programme that is under way (2002-2006), and has a total budget of 17,500 million Euros, of which 1,075 million are destined to Aeronautics and Space (840 million to aeronautics and 235 million to space). This represents a 53.6% increase with respect to the previous programme that was 700 million Euros.

The 6th Framework Programme has the characteristic of being divided into seven thematic areas that have priority and for the first time, Aeronautics and Space is one of them. The objectives within this area are:

- Strengthen the scientific and technological basis of the European aeronautics and aerospace industry through research efforts and favour the development of its international competitiveness; and
- Help develop the European research potential in this sector for improving the security and protection of the environment.

On the other hand, the work programme of this thematic area is divided into four research areas which are the following:

- Improvement in the competitiveness of the European aeronautics industry.
- Reduction of the environmental impact by the diminution of fuel consumption, CO2 and NOx emissions and other chemical contaminants as well as noise contamination.
- Reinforcement of aircraft security faced with the great rise in air traffic.
- Increased operative and security capacity of the entire air transport system.

In general terms, it can be said that putting into effect the previously mentioned initiatives will achieve a more integrated Aeronautics Sector, on the European level, with a greater number of joint programmes and greater collaboration and communication between the different Spanish and European firms.

2. Spanish Central Administration

In 1993, the Spanish government, for the purpose of launching and strengthening the aeronautics sector in an exceptional way put into effect the Aeronautics Technological Programme I known as PTA-l (1993-1998). The general objective of this first aeronautical plan was to increase competitiveness and improve the scientific-technological capacity of the Spanish firms, develop new technologies to be incorporated to aeronautic products and promote the participation of Spanish firms in European and international projects. As a result of all of this, they hope, other firms and technological centres would also be benefited.

According to sources of the Ministry of Industry, the total number of reimbursable credits made through the PTA-l between 1993 and 1998 was 121.88 million Euros.

Because of PTA-l, during the period 1993-1998, the sector managed to consolidate itself at the European and international level. The levels of specialization of the firms improved and this, in turn, helped the development of other auxiliary firms and subcontractors. According to the ATECMA data (1999:14), the PTA-l created 1,506 jobs. Furthermore, the

contracts generated by this Plan represented over 35 million €, that was divided between subcontractors, technological centres and universities.

In 1999, the Central Administration put into effect the Aeronautics Technological Plan II, known as PTA-II (1999-2003) which meant a follow-up of the achievements made with PTA-I. The general objective of PTA-II, as indicated in the Order by which the norms for financial aid to research and development projects in the aeronautical sector within PTA-II (1999-2003)[16] are established, is to continue during the specified period of time, the scientific-technical training of the firms. More specifically, it pretends achieve the following objectives:

- To place and secure the industry as a centre of excellence and technological and industrial specialization in specific areas.
- Facilitate the participation of the Spanish firms in the international aeronautical programmes and consortiums.
- Spread technological knowledge to all who in some way create added value in the sector.
- Induce a culture that chooses innovative investments that could not have an immediate profitability, but that assure the long-term survival and viability of the firms.

According to sources from the Ministry of Industry, the total number of advances to be reimbursed made through PTA-II between 1999 and 2003 was approximately 165.24 million Euros (see table 5.15.). One must add the aid given in the years 2001 and 2002 through the National Aeronautical Programme of PROFIT to this amount. This financial aid was of two types: credits to be reimbursed, that represented 2.58 and 2.76 million Euros during those years and subsidies that represented 0.5 and 0.7 million Euros respectively. The total amount destined between 1999 and 2003 was 171.78 million Euros, a 41% more than the previous programme (PTA-I).

[16] BOE (Official State Bullitin) nº 192, August 12, 1999 pp.29963-29980.

Table 5.15. Central Administration Aeronautical programmes (in millions of Euros)

Period in Effect	Program	Reimbursed Credits	Subsidies provided	Total resources provided
1993-1998	PTA-I	121,88		121,88
1999-2003	PTA-II PROFIT (2001-2002)	165,24 5	1,2	171,78
2004-2007	National R+D+i Plan			

Source: Data from Public Administration Surveys

Once finished with PTA-II, the National Plan of R+D+I 2004-2007 is begun, and is set up in Thematic Priority and Horizontal Areas. There are nine thematic areas within this plan, one of them is the Area of Transportation and Construction, within which we find the National Programme of Means of Transportation, and within this, the National Sub-programme of Air Transportation.

According to Ministry Order CTE/3185/2003 of 12 November of the Ministry of Science and Technology the objectives of the National Subprogramme of Air Transportation are:

- Contribute to the scientific-technological knowledge of the Spanish aeronautical firms.
- Secure the technological specialization of the industry.
- Facilitate the participation of the Spanish firms in the international aeronautical programmes and consortiums, particularly in the Framework Programme of the European Community for research, demonstration and technological development.
- Diffuse scientific-technological knowledge within the subcontractor firms, suppliers of equipment goods and in general, to all who intervene, directly or indirectly in the creation of value in the industry.

The objective of the National Sub-programme of Air Transportation is to contribute to the growth and development of the sector. Yet, the fact that since 2004 all policy actions designed to strengthen the industry have been limited to the National Plan in this sub-programme, this has led many

agents within the sector to wonder, particularly many of the entrepreneurs, if the sector has lost importance for the Central Government. After analyzing the Central Administration's actions during recent years and the future work guidelines it wishes to set in motion, it can be said that the central government continues to play special attention to the aeronautical sector. The main aims are the following:

- Establish and consolidate an aerospace cluster, for which a more integrated management of the aerospace and aeronautical sector should be made.
- Improve conditions so that SMEs have a greater presence in the large European projects.
- Continue to promote specialization in order to acquire a higher level of development and keep the leadership in certain business areas as in composites, where Spain stands out today.
- Achieve being present in all value chain activities, especially in those related to Research and Development (engineering and design activities) and not only in manufacturing as has traditionally characterized the industry.

3. Regional Administration in Andalusia

In general terms, the intervention of the regional administration can be divided into three large phases.

During the early 80s, the actions of the Junta de Andalucia, or regional government was basically focused towards macroeconomic and social objectives, besides encouraging traditional sectors in which it was thought Andalusia had competitive advantages. During this period, the aeronautical industry was not among the priorities of the regional administration. Nevertheless, this position changed during the second half of the 80s, when the Andalusian government and its commitment to give economic resources was strategic in the restructuring of this sector at that time. This restructuring process, based on entrepreneurial renovation and incorporation of new design techniques for manufacturing products and processes, as well as on the support given by the regional administration contributed to the sector's growth during the second half of the eighties.

During the early 90s, the regional administration encouraged the creation of an auxiliary aeronautical Andalusian firm association, known as ATASAER (Asociación Tecnológica de Empresas de Subcontratación Aeronáutica) whose objectives were: i). Raise the technical and trade capacity of the local firms; ii) Facilitate subcontracts with foreign aeronautical companies, for the purpose of slowly diminishing the dependence on

CASA; iii) Create a forum for meeting and discussion on the future problems of these firms.

During 1994-97 the regional government, besides continuing with the initiatives set forth in previous Plans, developed a greater variety of measures having to do with the industry. Among these, economic aid to the investments made by CASA and to those made by the auxiliary aeronautics industry (see the following table).

Table 5.16. Economic contribution by the Junta de Andalusia to the aeronautics industry (millions of Euros)

Aeronautical Industry	Management Centres	1994	1995	1996	1997	Total
Support to CASA in its productive diversification towards civil aviation	General Directorate of Industry, Engergy and Mining	4.8	5.3	6.7	7.2	**24.0**
Support to investments in the auxiliary aeronautics industry	IFA	3.0	3.5	5.7	6.8	**19.0**
Total		**7.8**	**8.8**	**12.4**	**14.0**	**3.0**

Source: Industrial Programme for Andalusia (PIA) 1994-1997

Another public initiative carried out was the Framework Agreement between the General Directorate of Industry of the Regional government of Andalusia and ATESAER in 1994, for which the AAe (Aerospace of Andalusia, a public limited company) was created, with both public (25% of the IFA-Instituto de Fomento de Andalucia) and private capital (20 SMEs of the aeronautics sector in Andalusia).

The regional government also decided to participate in the capital of the firm SACESA (Sociedad Andaluza de Componentes Especiales) founded in 1995 by IFA and CASA, which participated with 39.44% in its capital and 20.73% respectively. With this initiative, the Administration showed a more direct implication; now not merely based in design of support policies and subsidies, but by participating as a shareholder in firms.

In June of 1999, the regional Administration implemented one of the objectives foreseen in the Industrial Programme for Andalusia 1998-2001 (PIA II). The objective was to promote the transportation auxiliary industry sector, and especially in aeronautics, thus giving incentives to the promotion of industrial land, with suitable facilities for the location of auxiliary firms of the industry. Through this measure, the creation of the

Aerospace Technological Park of Andalusia (Aeropolis) was begun, for which a written agreement between the Regional Government of Andalusia and the Municipal Government of La Rinconada, the municipality where the Park is located, was reached.

Since 2001, the economic policy carried out by the regional administration in favour of the aeronautical sector changes to the better and is no longer based on a set of isolated instruments, but rather on a global view and with it, all the organisms and instruments that the regional administration has at hand is put at the service of the aeronautical sector.

For this, the Region's Department for Innovation, Science and Firms designed a Development Model for the Aeronautics Industry in Andalusia focused towards the creation of the necessary support for the development of a strong, diversified, innovative, competitive, high quality and attractive to new projects and investments, auxiliary aeronautical industry. This model is articulated through five types of strategic action measures, most favourable for the aeronautical sector in Andalusia (see table 5.17.).

Since the beginning of 2002, the Region's Department for Employment has developed a set of aid measures specifically for firms that carry out some activity related to the aeronautical sector.

The Aeronautics Fund was also created, with a budget of 96 million Euros until 2007, of which the regional government will contribute 12 million Euros each year, and each of the banks (El Monte, Caja San Fernando, Unicaja, Caja Madrid, Caja Granada, BBVA and La Caixa) 2 million Euros annually. The management of this fund will be made by IFA and Hélice Foundation. Furthermore, within the category of encouragement of the industrial activity, financial aid has also be given to help the investments made by the aeronautical auxiliary firms, focused towards meeting the infrastructure needs, as well as technological capacity, engineering, machinery, and equipment, so that these firms acquire the necessary capacity for carrying out both design as well as manufacturing of parts in order to meet the requirements of EADS, Airbus and Boeing.

Table 5.17. Coordinates of the Development Model for the Aeronautics Industry in Andalusia

Measures	Projects	Instruments	
Operative	Management Unit (IFA) Hélice Foundation Hélice. Net (SAP)	Single window Legal coverage for the firm Cluster Internet portal	
Financial	Aeronautics Fund	Integrated Operative Programme for Andalusia 2000-2006 Order 21 Andalusia´s Global Subsidies	
Logistic	Techno-Parks	Aeropolis Techno-Bay	
Tecnological (R+D+i)	Support engineering Technological Aeronautics Institute of Andalusia (ITA) Training according to the demanda Certifications	**Promotional**	National market Foreign market

Source: Made by us from the presentation of the Development Model for the Aeronautical Industry in Andalusia

For this purpose, the Regional Government of Andalusia has destined 47 million Euros for subsidizing the investments made by firms up to 40% of the investment.

4. The Regional Government of Madrid

The aeronautical sector is one of the major priorities of the development policy of the regional government of Madrid. This sector is strategic for the Madrid region because it is very innovative. It is placed ahead with respect to expenditure in R+D and it has a constant need to compete, based on the development of highly specialized products. Besides, it has a stimulating effect on technological innovation in other related sectors. For these reasons, during recent years, the regional government of Madrid has shown great interest in the industry, and therefore has implemented general policies.

The terrorist attacks of September 11, 2001 in the United States, as well as the exogenous factors like the conflict in Iraq, made for a significant reduction in the demand for air tickets and much uncertainty in the sector, all of which called the attention of the Community of Madrid.

To the factors previously mentioned should be added the impact that the development of the A-380 had at the time. Since the beginning of this dec-

ade, an important number of aeronautical firms had made large investments in fixed capital, in production plants and machinery, and the negative expectations at that time made it so that quite a few small firms within the sector experienced serious financial problems.

Within this context, the Department of Economic and Technological Innovation of the region of Madrid got in contact with the aeronautics sector through the ATECMA (Spanish Technical Association of Constructors of Aerospace Material) in order to analyze the actions that might be put into effect in order to maintain the aeronautical industrial fabric of the Madrid territory. In July, 2002 this Department subscribed a collaboration agreement with ATECMA in which the regional administration promised to adopt the necessary measures that will allow for continuous improvements and specialization, the adoption of technological innovation, and a greater internationalization of the firms. Furthermore, also as an answer to the financial problem of the SME, and within the framework of this agreement, the regional administration put into effect a set of aid tools especially directed to refinancing the debt of the SME of the sector through the Financial Agency of the Region of Madrid, of the General Directorate for Technological Innovation and of Avalmadrid, S.G.R.

Within what are known as the microeconomic policies for regional development, and more specifically those oriented towards the development of the aeronautical sector, the Department for Economy and Technological Innovation has just made public the "Aerospace Sector Plan of the Community of Madrid." The objective of the plan is to improve the competitive position of the sector through specialization in the successful segments of aeronautics, for the purpose of attracting firms and investment to the Region of Madrid. Among the main actions are:

- Establishing a Technological Centre for the Aeronautics Sector. With land from the IMADE and the Region's Department for Economy and Technological Innovation. In this Technological Centre would participate both the Polytechnic University as well as the University Carlos III of Madrid.
- The creation of an Incubator for Aerospace Firms.
- The creation of a new Innovation Network for the Aerospace Sector in the Region. The purpose is to improve the diffusion of innovation within the sector.

In this sense, on February 17, 2005, the Council made public that the concession of economic aid to firms in the aerospace sector of the Region of Madrid are regulated with the objective of supporting scientific research

and technological development activities and so improve its competitiveness and innovative capacity.

Furthermore, the Department for the Economy and Technological Innovation has prepared a Technological Innovation Plan 2005-2007 proposal, now under advisement, that includes among its programmes the development of high technology poles, which include support measures for high technology sectors, among which the aeronautical sector.

5.4 The Regional Governments of Andalusia and Madrid

Differences and Similarities

In Andalusia, after the process of devolution of competences from the central to the regional Government was beginning to take place, as a result of the approval of the Statute of Autonomy of Andalusia in 1981, the regional government (Junta de Andalucia) progressively acquired a key role in the design of economic and social policy strategies.

Thus, for the Government of Andalusia the aeronautical sector represents one of the important industrial bets for its capacity to create direct and indirect employment. In this sense, the regional government of Andalusia began a whole series of programmes that, though some are generic and not as intense as others, have made for a very active regional policy in favour of the aeronautical sector. The regional Administration has given economic resources to support the investments being made by firms. Economic aid is given to entities and firms if they are located in the Technological and Aeronautical Parks in Andalusia.

Similarly, the regional government of Madrid also stands out as a key actor for the articulation and consolidation of the aeronautical productive fabric in the Region with a set of programmes for strengthening the industry. It should be pointed out, however, and as proved by the statistical analyses of the field work developed in Andalusia and Madrid, that in Madrid the correlation between the level Administration and policies in favour of the aeronautical sector is negative. In other words, in the Region of Madrid, as the level of Administration lowers from Europe to National and Regional ones, the actions in favour of the aeronautical sector are fewer. Yet, in Andalusia the opposite occurs. As the governmental actions diminish, we find a greater number of actions and programmes put into effect in favour of the Andalusia aeronautics sector.

6 Aeronautics Agglomeration in Portugal

6.1 Basic Data of the Territory

Portugal faces the challenge of considering the advantages associated with the dynamism of the national aeronautic sector before possibly rising in the value chain. An analysis of the Portuguese productive specialisation shows that labour intensive goods (textile and footwear), or strong scale economies (automobiles and parts), or products obtained from local natural resources (bark, wood, paper, cardboard and food and agricultural products) predominate. On the other hand, goods requiring technology and knowledge represent only a small amount of the total produced and exported goods. According to data provided by the *National Institute of Statistics*, Portugal's GVA percentage in high technology sectors is approximately 35% in contrast to average values of 49% in the EU and 52% in the OECD. (see table 6.1). But Portugal is also the second European country, after Finland, with the highest increase in relative significance of high and medium technological intensity from the middle of the 1990's to the first years of the 21st century. The automobile sector contributed most to this change and has received significant investments in R&D.

The aeronautical field is included in the CAE 353 as "other transportation materials". The sector represents only 3% of exports and 2% of high technology imports. Also in terms of Technological Balance, the sector displays a high surplus revealing the presence of a dynamic sector in the Portuguese economy.

In his book "B*uilding Competitive Advantages in Portugal*" (1994), Michael Porter held that high technology industries, *per se*, do not determine competitiveness in a country such as Portugal. Portuguese competitiveness should be obtained through those sectors where there is tradition and competition, such as textile, florist, wine or footwear.

Nevertheless, Portugal has demonstrated potential in fields of higher technological content, such as the automobile sector. Recent evolution in

aeronautics indicates the possible creation of an aeronautical *mega-cluster*[1] in the country.

Table 6.1. Firms polled

Date of Creation	Name of Company	Location	Main Activity
1918	OGMA (commercialisation)	Alverca	Aeronautical maintenance and manufacture
1918	OGMA (manufacture)	Alverca	Aeronautical maintenance and manufacture
1945	TAP – maintenance and engineering	Lisbon	Aeronautical maintenance
1948	EFACEC – engineering	Lisbon	Conception, project and manufacture of electrical and electromechanical systems
1951	Aerocondor	Tires	Aeronautical maintenance
1968	Quinaço - metallic cut and shape	Sintra	Metallurgy
1969	Fundínio – aluminium smelting and injection	Porto	Manufacture of injected aluminium components, of high pressure, for the automobile and telecommunication industry
1970	Cinave	Lisbon	Manufacture of aeronautical navigation instruments
1978	Planimolde	Marinha Grande	Plastics
1980	A Brito – Portuguese Industry of Gear Assembly	Porto	Manufacture of precision components and brake and transmission systems
1982	Aerohélice	Alenquer	Maintenance of propellers
1986	Couro Azul	Alcanena	Tanned skins
1988	Astro Metalúrgica	Albergaria-a-Velha	Metallurgy
1988	Edisoft	Lisbon	Software service and development
1989	Plasdan	Marinha Grande	Plastics
1992	Agroar	Évora	Maintenance of light fire-fighters and forest airplanes
1995	LAS – Louro Airships	Lisbon	Aeronautical maintenance
1997	Almadesign	Lisbon	Project and Design
1998	Critical Software	Coimbra	Software development
2000	TeandM	Coimbra	Technical coatings
2001	Dyn'Aero Ibérica	Ponte de Sôr	Manufacture of light airplanes

[1] Concept proposed by the OECD, to be defined later on in this study.

This study is based on the analysis of a sample of 22 firms whose activity is directly or indirectly developed in the aeronautical sector. These firms are heterogeneous in terms of geographic and sector location, which guarantees the representativeness of the sample. The study also includes those firms that, although operating in other sectors, expect to rise in the value chain and enter the aeronautical sector.

54% of the firms studied are public enterprises, followed by private firms (41%). Only two firms are non-profit organizations. Most of the firms are of private capital (81%). Only one firm belongs to the public sector and two are mixed.

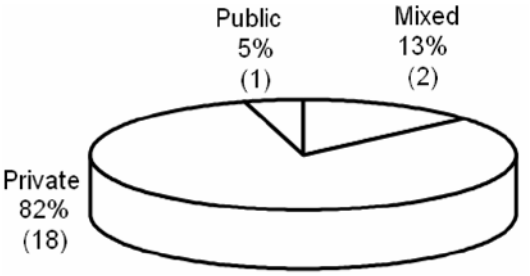


Fig. 6.1. Origin of the firms

Source: Own elaboration from Surveys

Independent firms prevail (64%), but a part of the capital (always more than 50%) of eight of them is held by other firms. Only two firms have more than 90% of their capital in other firms' hands. In most cases, 50% to 70% of the capital is in the hands of other firms.

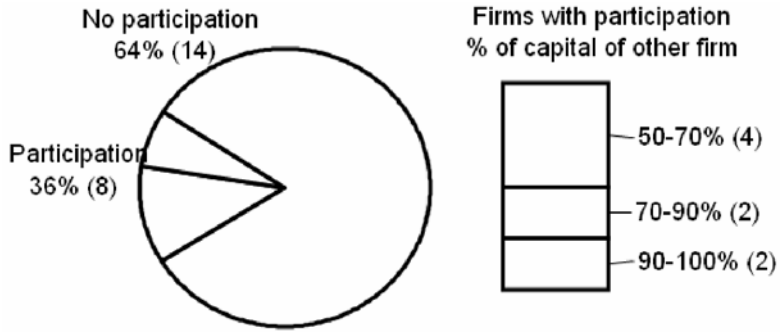


Fig. 6.2. Capital of the firms

Source: Own elaboration from Surveys

Half of the firms belong to large firms with headquarters in Portugal. Only two belong to foreign groups (one North American and the other French). Five of the firms are main headquarters.

Analysis based on production sector shows that most firms do not belong to the aeronautical sector but rather carry out activity in the automobile, plastic, tanning or metallurgy sectors. Three firms operate exclusively for civil aeronautics and none of them do so for military aviation.

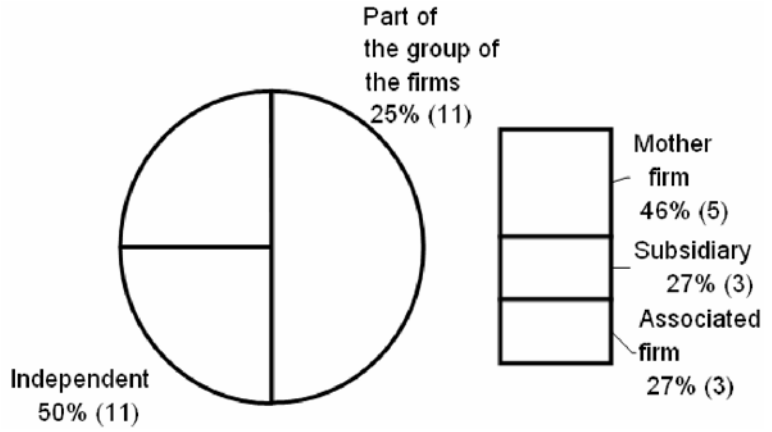


Fig. 6.3. Indepence of firms

Source: Own elaboration from Surveys

The predominance of other economic sectors is also notorious concerning the volume of sales. More than 36% of the firms hold between 75% and 100% of their total sales in other activity sectors different from the aeronautical one.

Military aeronautics has little significance in the sales registered in the surveyed firms. In 64% of them, the military sector does not have representation at all, and only 14% of them hold between 75% and 100% of the sales in this particular sector. For 32% of the firms, more than half of their sales have originated in the civil sector.

In 2002, 36% of the firms invoiced between 1 and 5 million euros. Six firms registered sales over 5 million Euros. The same number of firms declared having reached a volume of sales inferior to 1 million euros in that same year.

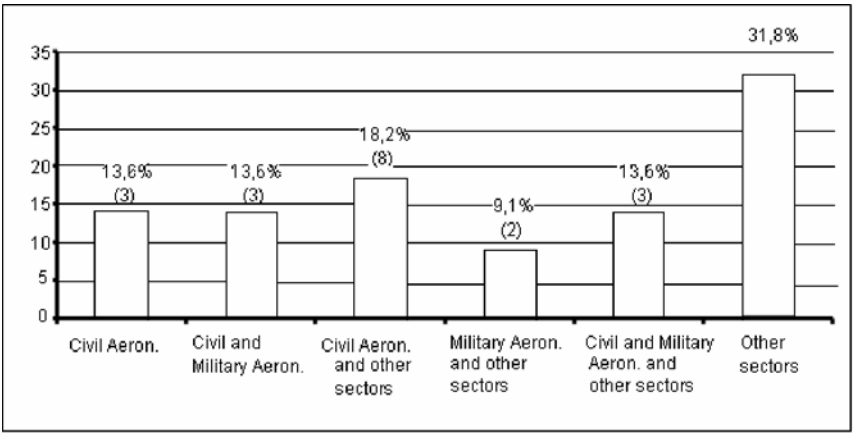


Fig. 6.4. Firm specialization

Source: Own elaboration from Surveys

Between 2001 and 2002, number of unprofitable firms decreased. Furthermore, the number of firms that had classified their financial results as "low" slightly increased. In 2002, only 8 firms declared having obtained good financial results, compared to 9 in the previous year.

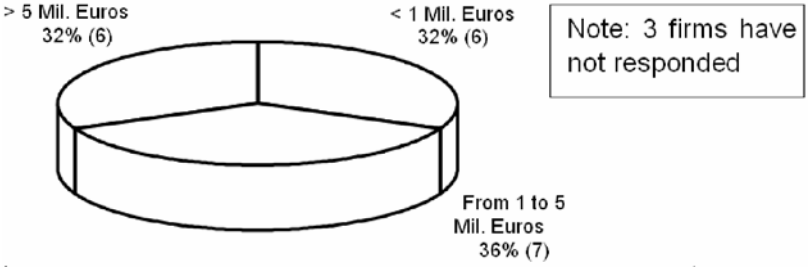


Fig. 6.5. Sales volume (2002)

Source: Own elaboration from Surveys

A negative aspect is the great amount expent on wages which increased considerably between 2001 and 2002, around 9 %, representing approximately 89% of total expenses. On the other hand, expenses for machinery and equipment acquisition decrease from a 15% to a 6% of the total amount. Costs of training and marketing, publicity and representation stand 3.7% and 1% of total expenses respectively.

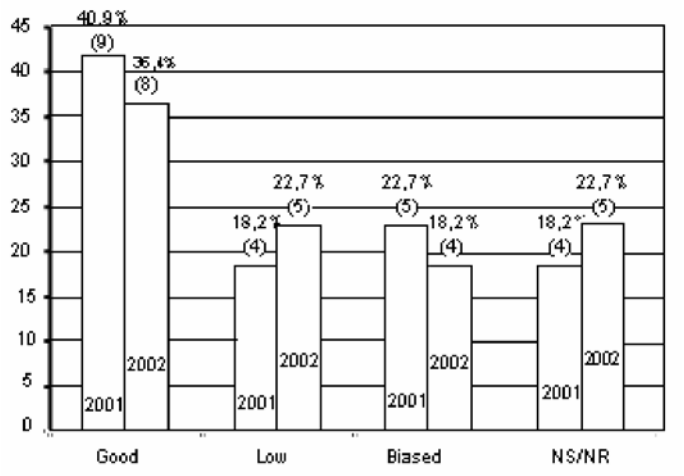


Fig. 6.6. Financial results of the firms

Source: Own elaboration from Surveys

The analysis of material and financial assets shows financial strength in most of the firms.

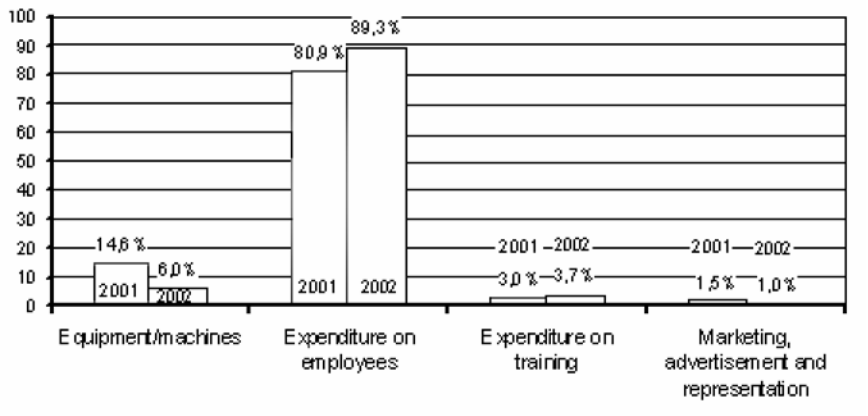


Fig. 6.7. Type of spending in firms (% of total spending)

Source: Own elaboration from Surveys

The sample is mainly representative by small or medium size firms: 9 of them had less than 50 employees and 11 had between 50 and 200 (data obtained from the year 2000). Between 2001 and 2002, there was a slight increase in firms with around 1000 and 2000 employees. In 2002, none of the firms had more than 2000 workers.

As a whole, the 22 surveyed firms employed, in 2002, 6550 workers. This statistic implied a decrease of 300 operators, compare to 2001.

In relation to the level of qualification, skilled workers (44% of the total employees), qualified technicians (22%) and advanced technicians (19%), predominate. The smaller level of qualification, that of the unqualified workers, represents only 3% of the entire workforce.

Generally, training employees takes around 11 years. The manager's high level of training, which represent 6% of the staff, takes an average period of 16 years. The superior and intermediate technicians are normally trained in 14 and 12 years, respectively. The unqualified workers are the ones that spend the lowest period of training, 8 years.

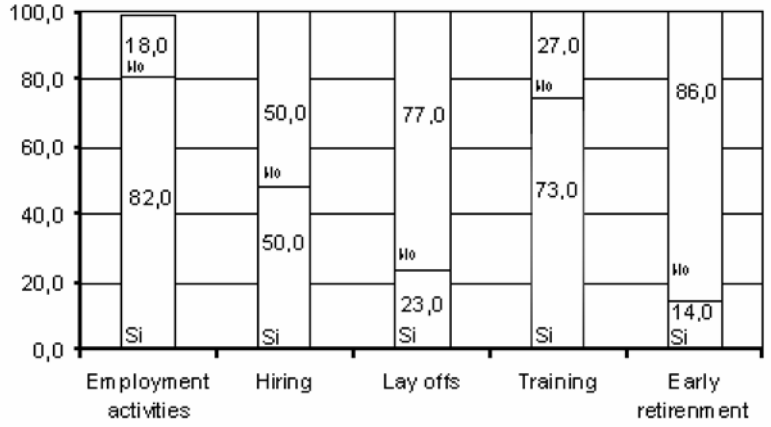


Fig. 6.8. Employment initiatives

Source: Own elaboration from Surveys

82% of the studied firms carried out employment activities. Training was the most frequent (73% of the firms), followed by contracting (half of the firms). Very few have received support to develop these activities. Only three declared having obtained this kind of insignificant assistance in order to facilitate the contract process of new employees. Three were also the firms that received training assistance to their employees, granted through European funds. Few firms laid off employees or sent employees to early retirements, though without assistance of any kind. 77% and 86% of them, respectively, declared not having performed this kind of activity.

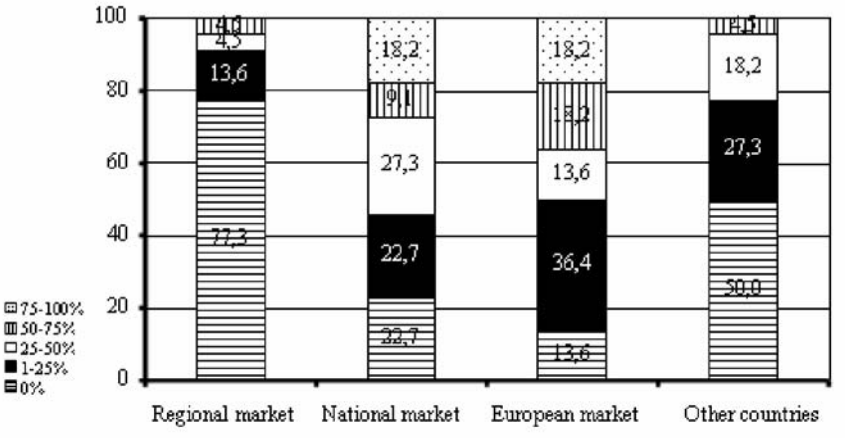


Fig. 6.9. % Sales volume by market (2002)

Source: Own elaboration from Surveys

National and European markets are the most significant. 18.2% of the firms hold between 75% and 100% of their sales in them. Only 22% of the firms sell in regional markets and half of them do not sell in the extra-communitarian market. Thirteen of the firms opened new markets in the last two years, mainly in European countries such as Germany, Spain, France, and United Kingdom. Six firms opened new markets in other parts of the World such as the U.S.A., Turkey or Morocco. None of them expanded in the regional market, and only 2 considered the possibility of joining the national market.

12 firms perform subcontracting operations with a strong regional nature, since subcontracted firms are mainly located in the metropolitan district or in the region of the subcontracting firm. More than 37% of the firms declare that between 75% and 100% of the subcontracting activity remains outside the district/region, but inside the national territory.

Only 21% of the studied firms subcontract part of their activity in the European Union. Only 7.7% of the subcontracting firms is granted to other countries of the world, that is, less than 20% of the total subcontracted firms. Firms of greater size are the ones responsible for the subcontracting in communitarian and extra-communitarian areas.

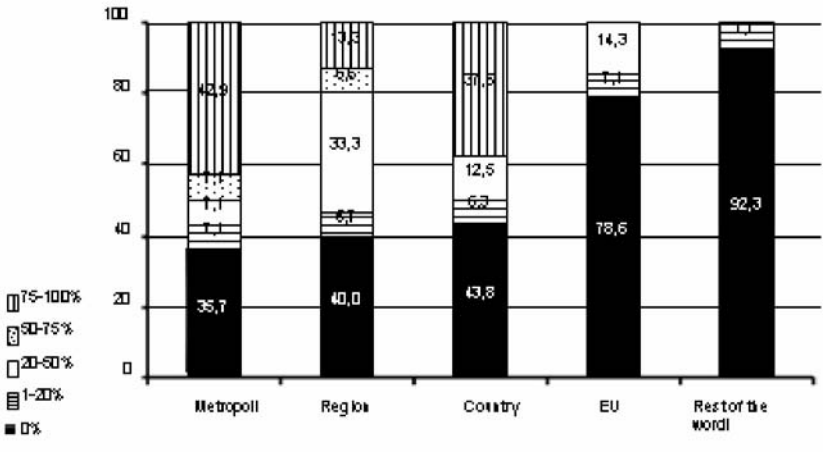


Fig. 6.10. Location of subcontracted firms

Source: Own elaboration from Surveys

The subcontracting represents less than a quarter of total production expending of the studied firms that pretend to subcontract some of their activity. In 2002, only 14% of the firms had subcontracting expenses that represented between 25% and 50% of the total production expenses. Industrial subcontracting is the leading one since it represents more than half of the assigned subcontracting for nearly 43% of the subcontractor firms. On the other hand, the specialized subcontracting is of relative importance only for 29% of these firms.

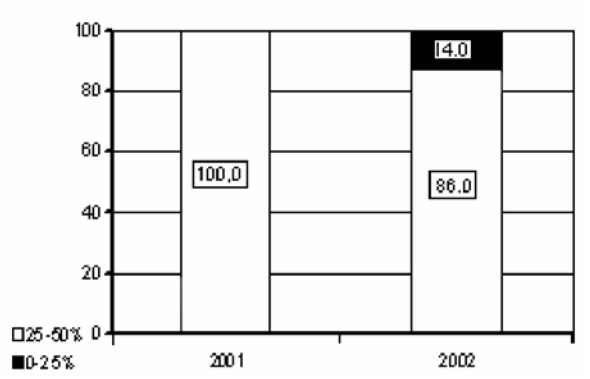


Fig. 6.11. Relative significance of subcontracting in total production costs

Source: Own elaboration from Surveys

Most of the firms that carry out subcontracting activities establish the characteristics of the product and the methods of its production. Only 23% of the subcontracting firms offer the client raw materials. Actually, 36.4% responded they never do. More than 72% of the firms never provide financial assistance, or any other type, to the subcontracted firms.

In most cases, quality regulations are demanded to the subcontracted firms, either current general regulations for the aeronautical sector (50% of the total firms) or constructor regulations (21%), or both (23%). Quality control is carried out by the subcontracting and subcontracted firms in more than half of the cases.

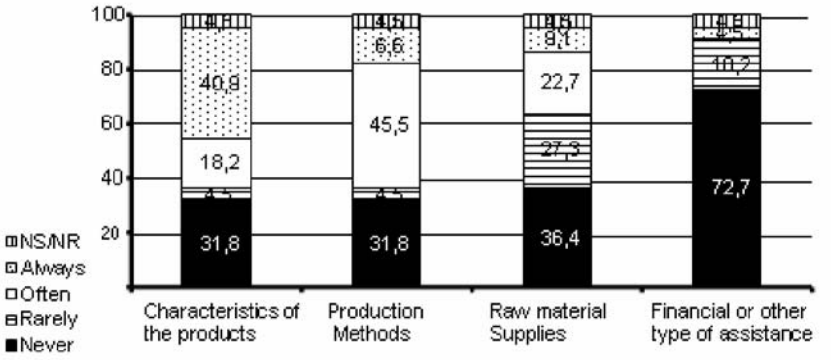


Fig. 6.12. Conditions of tendered subcontracting

Source: Own elaboration from Surveys

Eight of the firms surveyed already operated as firms subcontracted for others located in the metropolitan area or in the same region. Hence, as in the case of granted subcontracting, we verified the existence of a strong regional character in the performed subcontracting. Only 4 firms will work as subcontracted for the European Union and only 2 will do it for other countries of the world.

Only 7.1% of the firms subcontract, representing more than half of their volume of sales. For more than half of the firms, subcontracting activities generate less than 10% of the total sales. Firms mainly carry out activities of industrial subcontracting. This situation proves that most of these firms develop activities in the inferior levels of the value chain of the aeronautical sector.

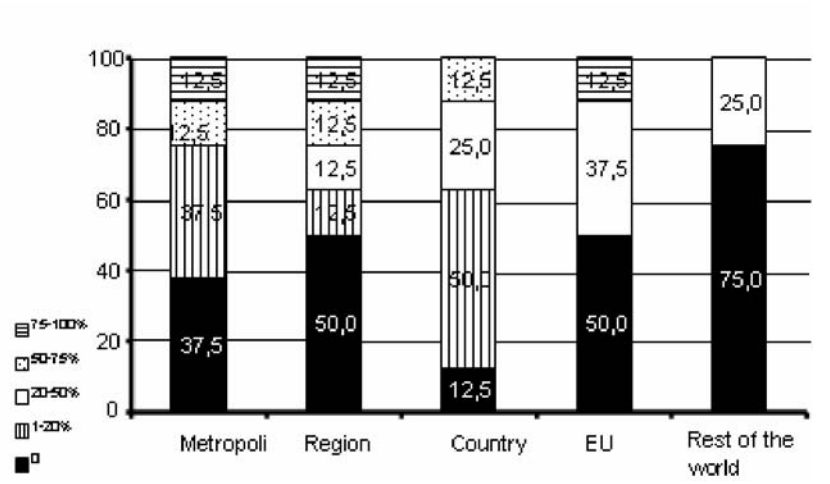


Fig. 6.13. Location of subcontracting firms

Source: Own elaboration from Surveys

Fig. 6.14. Relative significance of subcontracting in total sales

Source: Own elaboration from Surveys

The product characteristics are generally established by the subcontracting firm. Frequently, firms responsible of subcontracting specify the production methods and provide raw materials. In most cases, firms do not receive financial assistance in the performed subcontracting which manifests the fact that they do not need to carry out significant investments in order to respond to the demands of subcontracting firms.

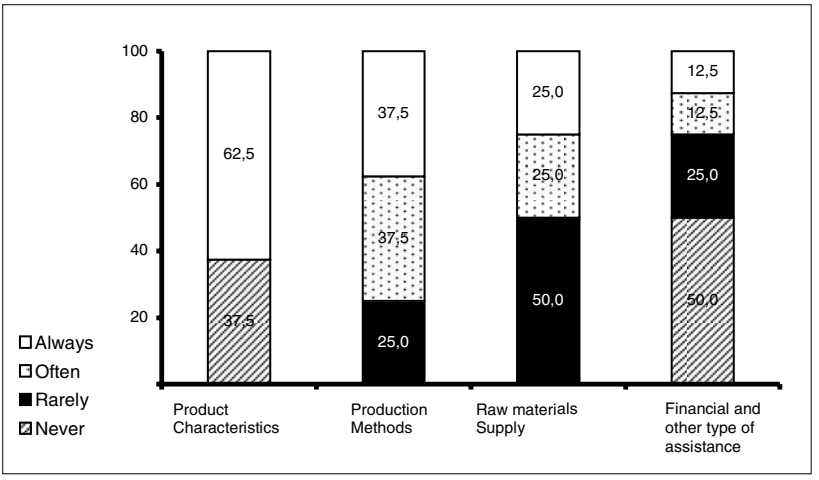


Fig. 6.15. Conditions of finished subcontracting

Source: Own elaboration from Surveys

To the great majority of subcontracted firms the execution of quality regulations is required. Regulations such as general (37% of the total firms), constructor and general (37%) and constructor (25%), are important.

In half of the cases, control of quality regulations is performed by both, the subcontractor and the subcontracted firm. Three of the eight surveyed firms that carry out subcontracting activities manage the execution of quality regulations. Only one firm declared the subcontractor firm to be responsible for the quality control.

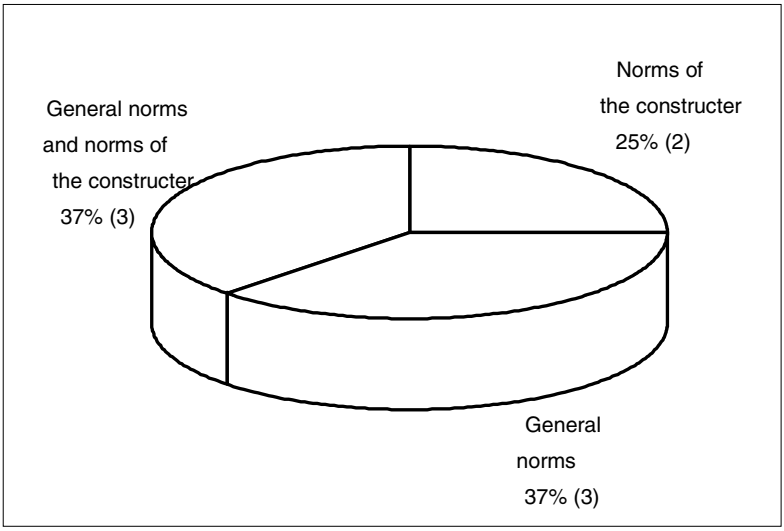


Fig. 6.16. Norms required by subcontracting firms

Source: Own elaboration from Surveys

Eighteen of the surveyed firms performed some kind of technological innovation in the last three years. Process (33%) and product (6%) innovations were the most important. Product, process and market innovations were carry out by 33% of the firms. SMEs also perform technological innovations, especially at the process level. Product innovations are more frequent in bigger size firms.

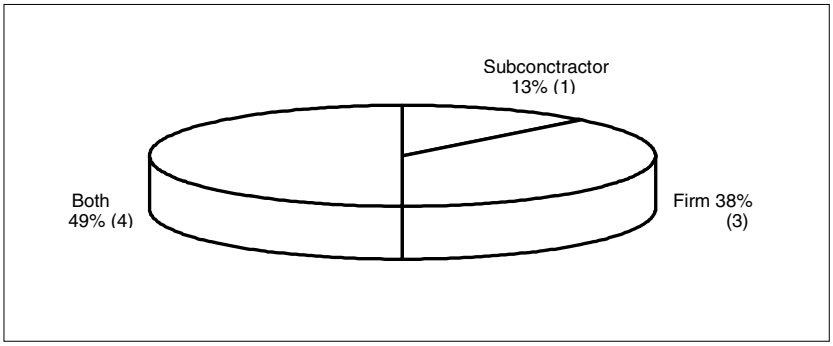


Fig. 6.17. Quality control norms

Source: Own elaboration from Surveys

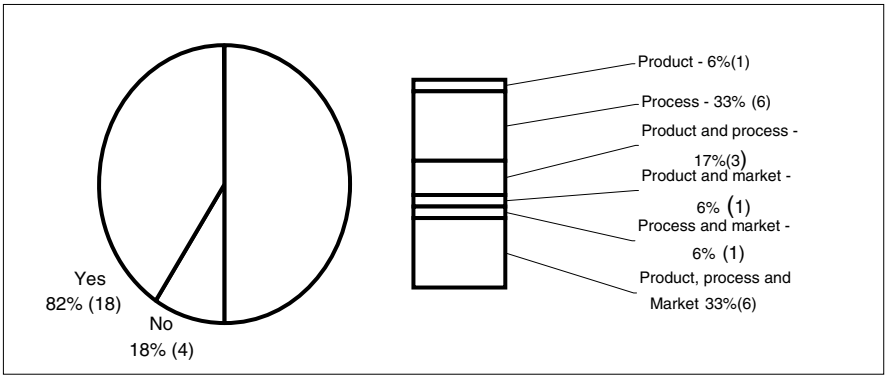


Fig. 6.18. Technological innovation

Source: Own elaboration from Surveys

Increase in the quality of the product and the adaptation to new regulations are the main reasons why firms are attracted to innovation. Other relevant factors of improvement are the reduction of production expenses and the temptation to either maintain or increase market shares. 72% of the firms will develop technological innovation due to the necessity of adaptation to the demands of subcontractor firms.

In 75% of the firms, expenses in technological innovation, either production expenses or those related to the volume of sales and exports, represent less than 10%.

Only 5.6% of the surveyed firms develop innovation activities that exceed 75% of the volume of sales and exports or that will represent between 50% and 75% of the total expenses. Nearly 150 workers operate, full time, in technological innovation activities, in the set of the 18 surveyed firms that carried out these activities in the last years. Half of these firms do not have full time employed inspectors, which represent less than 10% of the total number of workers in approximately 80% of the firms.

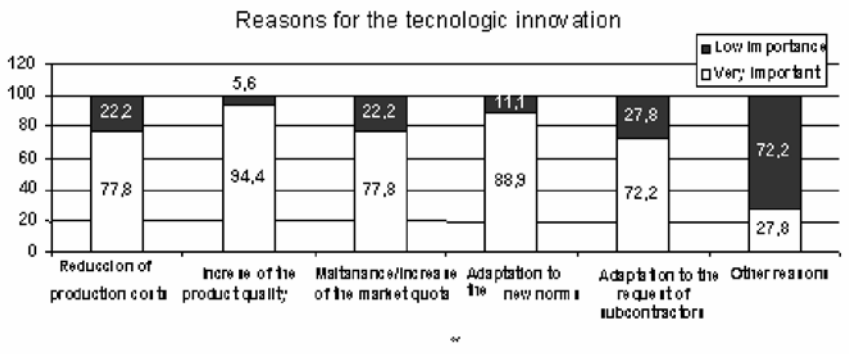


Fig. 6.19. Reasons for technical innovation

Source: Own elaboration constructed from the data gathered from the studied firms.

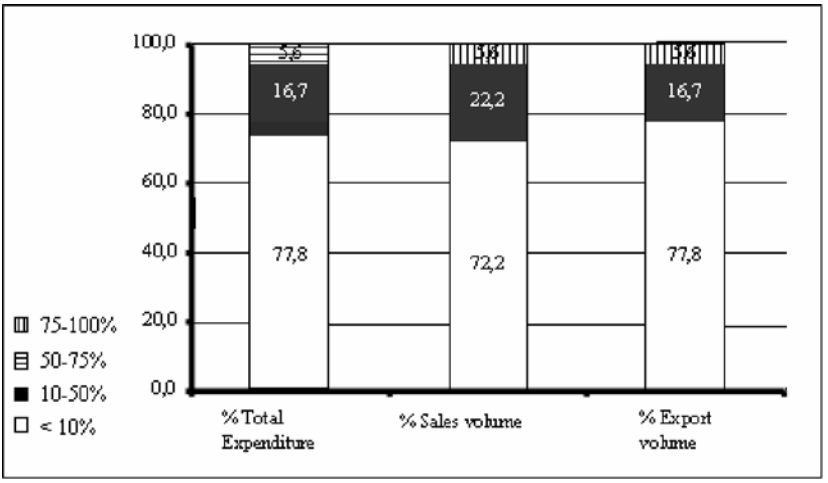


Fig. 6.20. Relative significance of technical innovation spending

Source: Own elaboration from Surveys

Although only 82% of the firms performed technological innovations, only 4 of them have registered patents in the last five years in a sector characterized by a high concentration of technology and knowledge. An interesting aspect is the fact that firms that protect innovation through patents are, mainly, SMEs and develop activities of specialized subcontracting.

Only two firms use patents of other firms. The low protection level of technological innovation cannot, hence, be justified by the use of external

patents to the firm. In terms of certification, 8 of the firms with technological innovation were not certified. Seven have obtained certifications of process innovation and 3 have acquired them in product and process innovation.

Fourteen of the firms with activities of technological innovation established cooperation relations with other firms or institutions in the innovation ground.

Cooperation for product innovation prevails in 61% of the total firms. There has been a development of common projects with other firms belonging to the aeronautical field (*Airbus*, *Thales* or *BAE Systems*) or with Research institutions (*Centro Tecnológico da Indústria de Curtumes* and *Instituto de Soldadura e Qualidade*) or college institutions (*Universidade de Coimbra* and *Instituto Superior Técnico*).

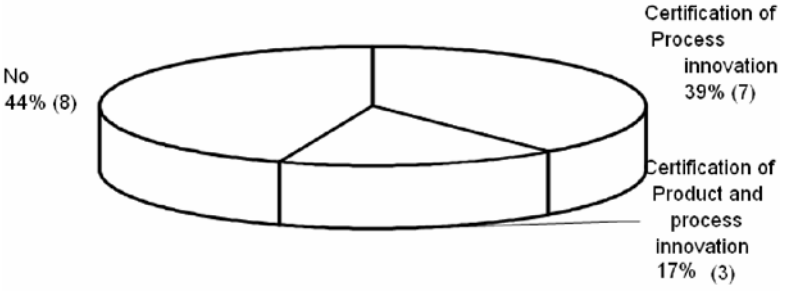


Fig. 6.21. Certification obtained

Source: Own elaboration from Surveys

Only 39% of the firms that carry out innovation activities establish cooperation for the purpose of process and market innovation. In the process innovation, cooperation with the *Institute of Soldadura e Qualidade* and *Instituto Superior Técnico* is significant.

Cooperation in market innovation is accomplished with firms belonging to the aeronautical sector. There was no evidence of cooperation among firms of the aeronautical field or with institutional agents.

Only two firms receive financial assistance for technological innovation, at the process and product level. None of the firms received assistance for market innovation. One of them obtained it for human resources training in the technological innovation area. This small granting of assistance for technological innovation is mainly due to the lack of information firms possess about available support.

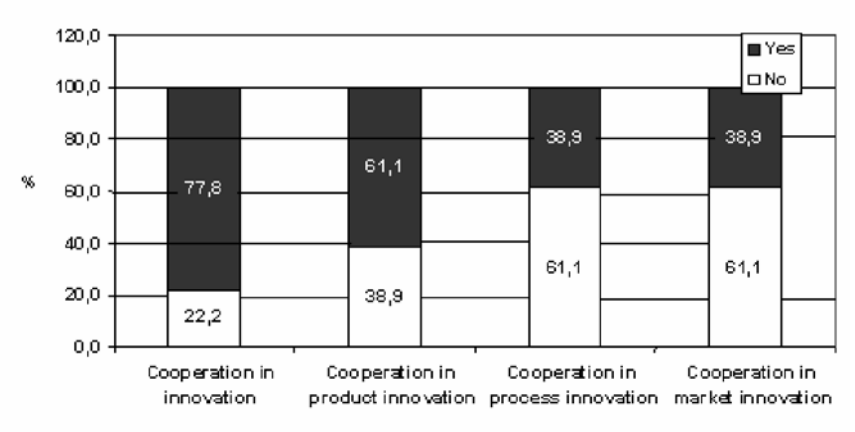


Fig. 6.22. Areas of technological innovation

Source: Own elaboration constructed from the data gathered from the studied firms.

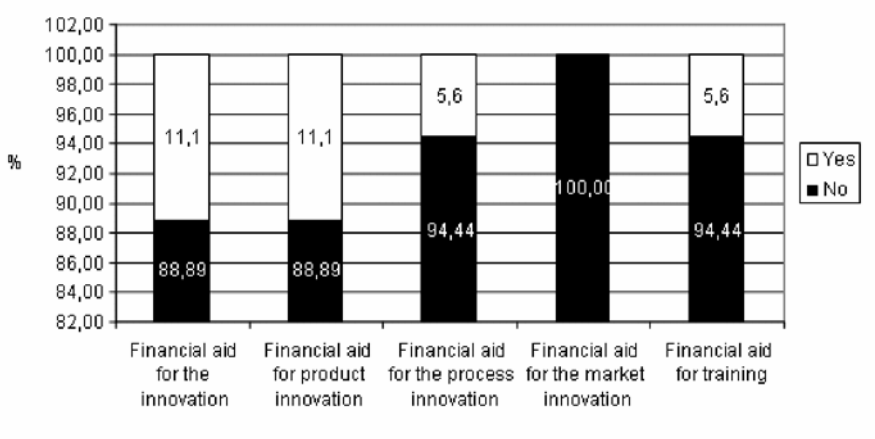


Fig. 6.23. Financial aid for technological innovation

Source: Own elaboration constructed from the data gathered from the studied firms.

The geographical closeness for the establishment of industrial, scientific and technical cooperative relations is regarded by 45% of the firms as "indifferent" and as "non-determining" by 23%. Only 18% of the studied firms consider it "determinant". Firms located in the metropolitan areas of Lisbon and Porto consider beneficial the proximity to chief centers, to

other aeronautical firms and to main university and research institutions. Also, this closeness implies a greater recruitment facility of skilled labour.

Firms that carry out their operations in sectors characterized by a strong geographical concentration, such as plastics in the Marinha Grande, tanning in Alcanena and software in Lisbon, consider proximity to firms and to technological and associative agents beneficial. Firms dedicated to the maintenance of light airplanes, located in the Alentejo, confirm the advantage to hold good accessibilities and a proximity to Spain.

Concerning the significance of activity agents, firms will attribute greater relevance to industrial and service firms and to university and research institutions, despite the fact that 41% showed certain indifference to the latter type revealing, hence, little regard towards technological innovation.

State institutions are revealed to be of little significance. Most firms barely gave any weight to local and regional authority. Central administration is only considered to be of some significance to 27% of the total firms. The lack of influence of associated institutional agents, such as professional associations and commerce and industry chambers, is another aspect to consider.

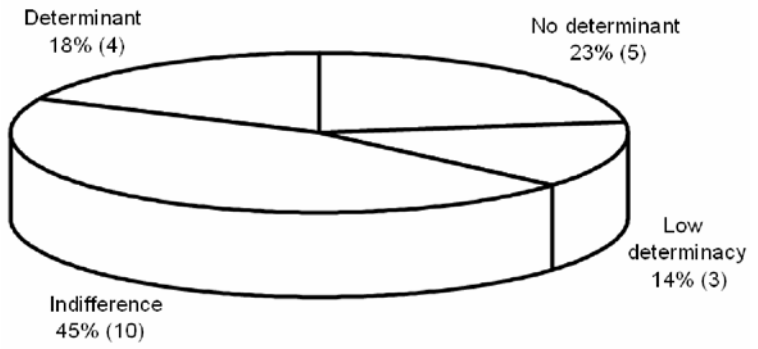


Fig. 6.24. Evaluation of the geographic proximity factor

Source: Own elaboration from Surveys

Overall, firms' judgment about current and future enterprise atmosphere is positive. This consideration is a positive aspect that influences factors such as the establishment of technical infrastructures and institutions of assistance to innovation and wage expenses.

Factors such as the lack of qualified labour force; lack of training and innovation support; peripheral location in the communitarian territory; distance to non-local clients; difficulties in the use of scale economies; elevated aeronautical rates; small productive tradition and insufficient institutional support to aeronautical industry; and the absence of a global strategy

for the Portuguese industry were all recognized as the most negative effects in an enterprise atmosphere.

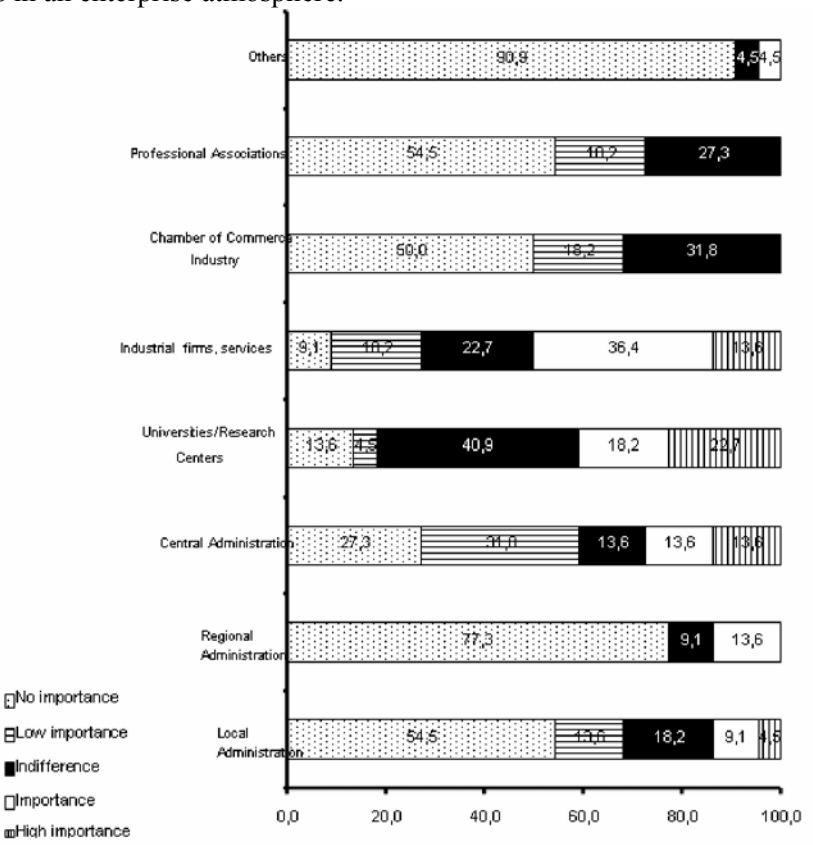


Fig. 6.25. Evaluation of the actors

Source: Own elaboration from Surveys

6.2 Industrial Organization

For a small country such as Portugal, with a low level of scientific, technological and industrial development, many types of advantages to join cooperative programs and projects with developed countries are provided. This capacity of involvement deals also with the existence of institutional actors that contribute to the technological reinforcement of national firms.

This is why active participation of Portuguese research groups in projects led by European constructors or laboratories is important.

Although capacities in the *Instituto Nacional de Engenharia e Tecnologia Industrial* (INETI) and in other public and private institutions remain, the only active laboratory in Portugal specifically oriented to aeronautics is the *Laboratório da Academia da Forca Aérea*. However, research carried out by the *Instituto Superior Técnico* and by the *Universidade da Beira Interior* are also significant.

Table 6.2. Institutions polled

Name of the institution	Location	*Main Activity*
INTELI – Inteligência em Inovação	Oeiras	Research in the aeronautical and automobile sectors
ISQ – Instituto de Soldadura e Qualidade	Oeiras	R&D; tendering of services; technology transfer
INESC-PORTO – Instituto de Engenharia de Sistemas e Computadores	Porto	Scientific research, technological development and advanced training in the field of information and telecommunication technologies
INEGI – Instituto de Engenharia e Gestão Industrial	Porto	R&D, technology demonstration and transfer in the fields of conception and planning, materials, production, energy, maintenance, management and environment
Universidade da Beira Interior – Departamento de Ciências Aeroespaciais e Centro de Ciência e Tecnologias Aeroespaciais	Covilhã	Education in the scientific fields of aerospace and aeronautical engineering; research and development in aeronautics and space
Madan Parque – Parque de Ciência e Tecnologia Almada/Setúbal	Almada	Technological Incubator firms; science and technology promotion and spreading; promotion of industrial property; distribution of strategic information for firms
CEDAT – Conselho Estratégico de Defesa e Altas Tecnologias (da Associação Industrial Portuguesa)	Lisboa	Institutional representation of firms connected to defence industries; research; promotion of firm and institutional incubators in the field of defence
CEFAMOL- Associação Nacional da Indústria dos Moldes	Marinha Grande	Representation and interaction of firms in the sector of plastic molds; firm cooperation; research; technical and professional training and diffusion of the sector of molds

Contribution from the training centers of TAP and OGMA for the preparation of specialized aeronautical technicians[2] is also important. The table 6.2. reflects an analysis of eight institutions that directly or indirectly carry out different activities related to the aeronautical sector.

[2] The Navy and the Army are also dedicated to training aeronautical technicians, after the political decision to equip these branches with aerial means (helicopters). The School of Military and Aeronautical Technology (Escola Superior de Tecnologias Militares e Aeronáuticas) perform polytechnic courses in the correct accomplishment of aeronautical knowledge.

There are also other relevant institutions, which were not possible to interview, such as the Instituto Nacional de Aviacao Civil, the Centro Tecnológico da Indústria de Moldes, Ferramentas Especiais e Plásticos, IN+ - Centro para a Inovação, Tecnologia e Politica Industrial del Instituto Superior Técnico, PIEP - Inovação and Engenharia de Polímeros de la Universidade do Minho, Faculdade de Ciências e Tecnologia de la Universidade de Coimbra or the Academia Aeronáutica de Évora.

INTELI – INTELIGÊNCIA EM INOVAÇÃO

INTELI is a non-profit private institution created in 2000 with the purpose of promoting technological innovation and development in the firm network through a cooperative philosophy.

INTELI behaves as a support for public policy and firm strategy in several crucial fields in the Portuguese aeronautical industry. INTELI seeks not only international emergence of specialist firms, but also their integration into the supply chains of large international consortiums and programs, taking advantage of technologies and competitions developed in other sectors.

This support of INTELI in public policy and firm strategy focuses in actions such as assistance to a *cluster* structuring in the definition of sectorial public policy; support in the gathering of foreign direct investment; definition and analysis of counterpart models; assistance to the conception and implantation of an aeronautical oriented tecnopole; enterprise strategies; reconstruction of essential firms in the aeronautical sector; encouragement of inter-firm cooperation; urging of firm participation in European consortiums; optimisation of logistic systems and promotion of engineering competitions and product development.

Activities such as training; organization of contacts and gathering of information related to suppliers; establishment of a regular interaction with the main national contributors in the field; organization of contacts and cooperation with international associations and institutions that intervene in the aeronautical industry; and technical assistance to national institutions, through ICEP, for the promotion and consolidation of foreign direct investment, are also important to mention.

The following projects are the ones developed by INTELI:

- Representation of national SMEs in the Group of SMEs belonging to the ASD - Association of Aerospace and Defence Industries of Europe (ex-European Association of Aeronautical Industries, AECMA), in association with DANOTEC – Associação das Empresas de Defesa e Novas Tecnologias;

- Coordination of PEMA, work group for the aeronautical field that gathers 12 national SMEs;
- Official contact point for Portugal of the AeroSME project, impelled by AECMA;
- Coordination of SME-DIG, work group of SMEs from EDIG – European Defense Industries Group;
- Joint coordination of a SMEs study in the field of defence, in collaboration with NIAG – *Grupo de Aconselhamento Industrial da NATO*;
- Repeated collaboration in industrial events, such as the English *Defense Manufacturers Association*;
- ACA membership - *American Countertrade Association*, in which INTELI collaborated in the organization of its world-wide conference in Portugal (Sintra) in March, 2004;
- Repeated research in fields of work returns and public policy for the industry, supported through PhD programs in the Technical Institute, with national and foreign supervision;
- Management of the *IStrat* information system, that includes detailed information on 48 industrial firms that operate in Portugal and whose technological level allow them to participate in the aeronautical sector.

INTELI takes part in cooperation programs with essential national and international actors of the aeronautical industry, such as the National Program SISCOOP, that promotes cooperation between SMEs, in association with PEMA Group; INAUTO Program, which develops the automobile industry; and *Interreg III B* Program, in association with CEIIA and the *Centro Tecnológico de Automocion de Galicia* (CTAG).

ISQ - INSTITUTO DE SOLDADURA E QUALIDADE

The *Instituto de Soldadura e Qualidade* (ISQ) collaborates in activities such as technology transfer and development, product and process innovation, structuring of management processes and quality, hygiene and security control, power and environmental control and human resources valuation. Its headquarter is in the Taguspark – *Parque de Ciência e Tecnologia*, 20 km from Lisbon -, but it has regional delegations all over the Portuguese territory. It employs 60 full time investigators.

All ISQ services are backed by properly equipped laboratories and by the activity carried out in R&D and training. ISQ owns laboratories in fields such as practice, technical and anticorrosion coatings and electromagnetic compatibility or weld and robotics testing. Some ISQ activities of R&D develop patents, as a result of collaborating with more than a thousand national and international associates, establishing research agree-

ments with university and research institutions. ISQ carries out firm research, an important activity in an interface institution. Some technology is developed inside the own firms.

The following projects performed inside the aeronautical field are the most significant:

- *High Precision Water Jet Cutting* (British Aerospace, Ltd/Military Aircraft)-Finished;
- *Micro-Drilling of Metallic Materials for Engineering Applications* (MICDRILL)-Finished;
- *Establishing a Documented Framework for Over the Net Concurrent Engineering and Cooperation Between Large Industrial Auto and Aeronautical Companies and SMEs* (NETFRAME)-In course;
- *Technologies and Techniques for New Maintenance Concepts* - In course(TATEM);
- *The Environmentally Friendly Helicopter Including Turboshaft Engines* (FRIENDCOPTER)-In course;
- *Intelligent Repair Process for Aeroengine Components* (AROSATEC)-In course;
- *Reparação Automatizada de Pás de Compressor*-Incourse (SIRBLADE)
- *Emat Inspection Technology* (EWI-Edison Welding Institute/USA)-In course;
- *Lead-free Soldering* (EU and USA partners/NASA,BOEING)-In course.

INESC-PORTO – INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES

INESC-Porto is a non-profit private institution oriented towards scientific research, technological development and advanced training in the area of information technologies and telecommunications. Intervention areas are represented by postgraduate training, consulting, research, technology transfer, development and demonstration. Research deals with optoelectronic and electronic systems, telecommunication and multimedia, information systems, engineering of production and energy systems.

In aeronautics, activities such as optoelectronic and electronics become important.

Findings through research are patented according to a pre-evaluation of market interests and a formal order managed by an industrial property agent. INESC-Porto is generally responsible for these patents, except in those cases where the project implies a *research under contract* and another condition is specified.

INESC-Porto regularly participated in programs of R&D of the *Fundação para a Ciência e Tecnologia* (FCT) and in programs of R&D within the consortium, in the range of the 6th *Frame Work*. Nearly 30% of the institution budget is dedicated to research contracts.

INEGI - INSTITUTO DE ENGENHARIA E GESTAO INDUSTRIAL

Located in Porto and founded in 1986, INEGI is an industrial research institute with public disposition.

In the aeronautic field, the most significant research are those related to metallic material testing for plastic conformation, damage simulations of sophisticated compound materials, technology development of aeronautic application, fast development of stamp tools for small sequences and seeking breakage criteria for polymeric and ceramic matrix compounds.

LOME (*Laboratório de Óptica e Mecânica Experimental*) is oriented towards the accomplishment of operations of R&D related to new optical/hybrid techniques for static analysis of displacements/deformations and to the study of vibrations and their application. LOME offers experimental support to project activities, inspection and non-destructive testing of structures and mechanical components. Research teams take part in national projects through the *Fundação para a Ciência e Tecnologia* (FCT) and in European projects. Some of these projects are developed altogether with industrial firms. Sometimes features of firm products are required from LOME. Research contracts for specific small size projects are available. This type of contracts may imply great significance for the development of major projects. LOME still develops activities related to composed materials features, defect detection in compounds and project support techniques. It participated in national and European projects designed to develop non-destructive inspection techniques to be applied in aeronautics.

INEGI co-works with other countries in order to develop competencies that will consent its entrance on international projects. There is a significant involvement in a research consortium, led by the French firm *Sagem*, which integrates *Airbus*, Mes*sier-Bugatti* (France), *lSkoda* (Czech Republic), *Samtech* (Belgium), *lNoliac* (Denmark), *Bam* (Germany), *A. Brito – Indústria Portuguesa de Engranagens* (included in the group of studied firms), Paderborn University (Germany) and IMMG (Mechanic Institute of Greece). This consortium is trying to develop a new brake system for airplanes - the *piezoelectric actuator for brakes* - that would be able to replace the current electromagnetic system.

UNIVERSIDADE DA BEIRA INTERIOR – DEPARTAMENTO DE CIÊNCIAS AEROESPACIAIS E CENTRO DE CIÊNCIA E ECNOLOGIAS AEROESPACIAIS

In the *Departamento de Ciências Aeroespaciais* of the Da Beira Interior University the Aeronautical Engineering degree and the master of Aerospace Systems is offered to a total of 160 students. Its content is primarily fitted in fields such as mathematics, physics and computation, and in all aeronautical engineering areas (aerodynamics, propulsion, avionics, flight mechanics, projects, structures, material, satellites, manufacture and maintenance). Some disciplines are shared with the Electromechanical Department degree. Teachers contribute regularly to the training of technicians who carry out their activity in firms belonging to the aerospace and aeronautical sector. On the other hand, professionals of these sectors contribute to the training of students.

Since these degrees enclose a strong practical component, interactions were established between the *Academia da Força Aérea y Aeropuertos* and OGMA. Some of the practical training is carried out in firms. Annually, an average number of 15 students finish their aeronautical engineering degree. In the last years, all graduates have been employed in their related field.

The *Departamento de Ciências Aeroespaciais* holds a research unit, the *Centro de Ciência e Tecnologias Aeroespaciais*, made up of the following laboratories: the *Laboratório de Aerodinâmica e Mecânica de Fluidos*; the *Laboratório de Sistemas de Aeronaves*; the *Laboratório de Mecânica de vuelo*; and the *Laboratório de Instrumentación y Control*. The main fields of research are based upon satellites, aerothermodynamics, control and security of aviation systems and transport efficiency, which concerns with the reduction of motor fuel consumption and emissions.

MADAN PARQUE – PARQUE DE CIÊNCIA E TECNOLOGIA ALMADA / SETÚBAL

Located in the *Faculdade de Ciências e Tecnologia* of the Nova de Lisboa's university campus, Madan Park is an interface center that aims to constitute a technological pole of firms and to manage innovation and technological transfer projects. The first Innovation centers are already operating. They are the *Centro de Excelência para el Medio Ambiente*, the *Centro de Robótica Inteligente*, the *Centro de Microelectrónica e Optoelectrónica de Processos* ad the *Centro de Diversificación Curricular*. Madan Park develops activities that include incubation of technological base firms; science and technology promotion and diffusion; support of university industrial property and diffusion of strategic information; promotion of

industrial debates among actors, such as firms, universities and technological and investigation centers, and military investment managers that lead to business opportunities.

Madan Park is the promotional agent of the Skylander Project, which seeks to develop an aeronautical pole in the region of the Alentejo (Évora) through the installation of an Skylander utilitarian light aircraft factory. It established contacts with the French firm *Géci International*, responsible of the subsidiary Skydesign. The preliminary studies of this project's viability were carried out by Madan Park.

CEDAT - CONSELHO STRATÉGICO DE DEFESA E ALTAS TECNOLOGIAS

The Conselho Estratégico de Defesa e Altas Tecnologias (CEDAT) of the Associação Industrial Portuguesa (AIP/CCI) aims to develop firms related to the field of Defence. CEDAT is associated to DANOTEC – Associação das Empresas de Defesa Armamento e novas Tecnologias. AIP/CCI is a member of ASD, AeroSpace and Defence Industry Association, which emerged as the result of the fusion between EDIG, European Defence Industry Group, AECMA, Association Europeénne des Constructeurs de Material Aeronautique, and EuroSpace. It still receives periodic information from WEAG, Western European Armament Group, that is also available for its associates.

CEDAT has been carrying out its performance together with the Government (Defence, Economy, Interior, Science and Technology, and Planning Ministries) and with a number of institutional organisms like the Armed Forces, the *Direcção Geral de Armamento e Equipamentos de Defesa* (DGAED), the *Instituto de Desenvolvimento e Inspecção das Condições de Trabalho* (IDICT), ICEP and INETI.

With contributions such as the new military strategic transport plane *Airbus A-400M*, the new transport helicopter *NH-90* and the EUROMALE program, CEDAT/AIP promotes Portuguese participation in European Armed Force programs.

CEDAT represents the Defence industry in institutions like the NATO Industrial Advisory Group (NIAD) and the European Defence Industry Group (EDIG), with the purpose of creating strategic platforms that would deepen markets, define norms and regulations, trigger co-operation in Defence R&D and establish consortiums, joint-ventures, alliances, acquisitions and fusions.

CEFAMOL – ASSOCIAÇÃO NACIONAL DA INDÚSTRIA DE MOLDES

CEFAMOL is a private institution with non-profit aims nor public use that holds more than 135 associates. It was the main driving actor of CENTIMFE – *Centro Tecnológico da Indústria de Moldes, Ferramientas Especiais e Pláticos*, founded on 1991. It aims to develop and expand the mold sector through cooperation and research or technical-professional training.

Since its foundation, CEFAMOL has contributed to the mold sector development, link between the associated firms. It systematically promotes the quality of Portuguese products participating in international fairs and firm missions; raising an independent industrial sector consciousness and spreading its national recognition through the celebration of congresses, its involvement in ISTMA - *International Special Tooling and Machining Association* - and through technical publications.

6.3 Agents in Context

Portugal's small dimensions, the coastal location of its main urban centers and the low development of some of its regions discourage the existence of a domestic network of air transport, inhibiting, hence, initiatives and policies.

The network focuses on firms that develop maintenance activities and answer to the necessities of primary level air operators. OGMA - *Aeronautical Indústria of Portugal* - and TAP - *Manutenção e Engenharia* (TAPME) - are the main protagonists.

Both firms have different performance fields. The mixed capital firm OGMA focuses on military activities, while public firm TAPME supports TAP fleets and uses excess for third parties, always within the field of civil aviation.

6.3.1 OGMA

The history of OGMA goes back to 1918, year in which the *Parque de Material de Aeronáutica* was created. Initially located in Vila Nova Rainha, it was later on transferred to Alverca. It aimed to support aeronautical military operations and directly depended on the then War Ministry. Afterwards, it became integrated in the *Fuerza Aérea Portuguesa* (FAP - 1952). From 1928 onwards, the firm began to be called *Oficinas Gerais de Material Aeronáutico* (OGMA) and it transformed into an independent

manufacturing establishment, maintained by the War Ministry and to the Military Aeronautical Management. Between the 20's and 40's, its tradition was based on manufacture mainly due to the collaboration with American and German Armed Forces. By integrating in the FAP, its preservation turned into great importance. The construction of complete airplanes finished in 1966. Until that date, nearly 500 were constructed.

With the increase of demand during the Colonial War, OGMA developed a greater capacity of maintenance and repair. But with the end of the War in 1974 a fall in demand, together with the end of maintenance activity for the U.S.A, took place. OGMA focused afterwards in the internationalization and synergies between civil and military areas. Armed Forces of other countries[3] gradually became its clients, either for the maintenance of French military transport *Hercules C-130* planes or for Dutch marine monitoring *Orion P-3* airships. Today EADS-CASA (Spain) and ERMA-CCHI (Italy) are also clients of OGMA.

The maintenance of military aircrafts such *as Lockheed Hercules C-130* and *Orion P-3*, together with their civil kinds, *Hercules L-100* and *Electra L-188*, were competencies that encouraged internationalization. However, granting OGMA the official title of authorized repairer of two new *Rolls-Royce* engines models, marked a key point of service given to exclusive civil clients. OGMA became the first firm in obtaining the title of world-wide MRO repairing center (*Maintenance*, *Repair* and *Overhaul*), which proves the international recognition of its capabilities.

At the beginning of the 90's, even with FAP collaboration, OGMA lost activity due to reductions in the Defence budget. In 1994, FAP pulled off and transformed itself into a state capital joint-stock firm. A new firm was hence created, OGMA – *Industria Aeronáutica de Portugal, SA*.

From May 1996 onwards, OGMA has mainly focused on the manufacture and maintenance of aeronautical items. In addition to Alverca's *heavy maintenance*, OGMA keeps technicians and carries out maintenance of assembling lines for regional European operators. It also sends maintenance equipment in several European locations. Parallel to other European countries, a holding was created to manage the commercial area of Portuguese Defence firms - EMPORDEF, SGPS, controlled by the Defence Ministry. This is how OGMA became linked to the Defence Ministry and EMPORDEF.

Having specified the commitments raised in the European Pact of Stability and Growth, the Portuguese state sold 65% of the stocks belonging

[3] Such as Spain, Morocco, Algeria, Chad, Angola, Ivory Coast, Gabon, Saudi Arabia, Jordan, Kuwait and United Arab Emirates.

to OGMA to the international consortium *Airholding*, constituted by EADS and EMBRAER, in December 2004. The agreement will provide OGMA a range of work load in the maintenance, reconfiguration and conversion of airplanes or engine maintenance. These projects are expected to increase the turnover in 22.5 m. euros (+ 17%).

The privatization of OGMA may imply a definitive linkage to the great European manufacturer, in addition to Portugal's possibility of acquiring *A400M* strategic transport airplanes. It can also reinforce its performance in the civil market of manufacture with the production of AIRBUS components. With the success of the consortium belonging to EMBRAER, a way to introduce TAPME in the capital of OGMA opened.

OGMA has today 1690 workers. Out of them, 820 are employed in the maintenance field. Its area covers 116 thousand square meters, holding 9 great shelters, offices with the capacity of repairing an ample range of engines, service for most systems and a manufacture, assembly and integration area of components. The productive activity involves maintenance and repair, together with helicopter and aircraft inspections, repair of electric and electronic systems of flight control, mechanical systems and other components. Portuguese general testing and motor repair services represent one of the greatest and best equipped complex of Europe[4]. Helicopters are also relevant to the welfare of OGMA, since it collaborated with their main manufacturers in fields such as maintenance, repair, assembly, manufacture and modernization.

6.3.2 AP – Maintenance and Engineering

The other essential component of the Portuguese aeronautical sector is TAP - maintenance and engineering (TAP - *Manutenção e Engenharia*).

TAP was founded in March 1945, with the commercial operation of the Lisbon-Madrid route. Until 1973, it profited from good international economic environment and from the monopoly of routes to ancient African colonies. The results facilitated the construction of excellent facilities, the acquisition of innovating technology and the constant renovation of fleets. But after 1973, TAP began to gather losses mainly due to the first petroleum crisis, decolonization, which bankrupted African lines, responsible of more than half of the profits, and 1975's nationalization. In less than two years, the whole strategy of TAP was reformed towards the need for new airplanes, which implied an enormous financial effort.

[4] The label of Heavy Maintenance Center was attributed to OGMA by ALLISON, one of the greatest constructors of turboprops.

The development of maintenance activities in the firm originated in the 60's with the construction of the great shelter nº 6, with enough capacity to gather 8 great airplanes. It kept offices of motor testing and repair, departments of mechanical and aircraft components and units of general support (machinery, tools, paint, cabin interiors, electrolytic treatments and non-destructive testing). These competitions trigger the entrance of TAP in activities of maintenance sales for external clients after 1974.

In the last two decades TAP serviced more than 500 clients in the area of maintenance and engineering, developing a set of activities in which international security became extremely demanding. Mainly, these activities consisted of fuselage preservation, general repair of motors, general repair and testing of components and systems, equipment adjustment, non-destructive testing, airship modification, maintenance definition and control, reliability and component control.

6.3.3 Small and Medium Firms in the Aeronautical Sector

In Portugal, a reduced set of firms committed to non-regulate air transport and to small airship and system maintenance skills still exist, and, in spite of belonging to other sectors, also encourage aeronautical activity. They are mainly SMEs involved in mechanical and electronic preservation. They handle mechanical metals and used aeronautical materials to carry out small airship maintenance or certain specialized operations.

The consolidation of the Portuguese aeronautical sector implies the existence of a national integrator that consents access to *first tiers* and Original Equipment Manufacturer (OEM). A set of opportunities exist hence for national SMEs, OGMA may operate as a connector, promoting development and manufacture projects and generating a value chain based on an enterprise supplier network, which would substantially increase the sector's turnover volume. Consequently, SMEs must diversify their activities and expand competitions through participation in national and international networks and consortiums. Some SMEs belong already to national or European enterprise networks. PEMA, *Portuguese SME for Aerospace*, or AEROSME are both good examples of this.

BOX 1. PEMA

PEMA is a group made up of 14 organizations, mainly SMEs, that carry out their activity in areas such as piece assembling, software development or airship manufacture. Most of them also operate in the automobile sector.

It aims to provide products and services to national and international aeronautical industry chains and to develop national, European or international projects in R&D.

PEMA seeks to uphold a representative group of Portuguese SMEs with enough capacity to provide backup information to political decisions in order to reinforce its representation, together with the group of SMEs belonging to AECMA (AeroSME) and the main national actors (OGMA and TAP).

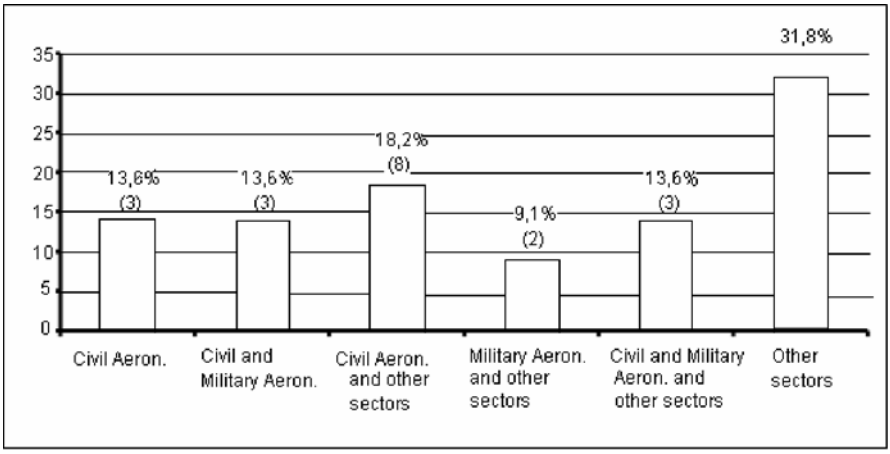
Table 6.3. PEMA member firms and institutions

FIRM	ACTIVITY SECTOR
Almadesign	Project of design
Couro Azul	Tanned Skins
Critical software	Software development
Iberomoldes	Molds for plastics
Mistral	Assembly of structural components and modules
Manuel Pousada Herdeiros	Specialized Machinery of precision (metal cut)
Moldit	Molds for plastics
Motoravia	Manufacture of light airplanes
Plasdan	Plastics
Skysoft	Software development
TeanMD	Technical coatings
INSTITUTION	-
IN+ - Centro para a Inovação, Tecnologia e Política Industrial	-
INTELI – Inteligência em Inovação	-
PIEP – Inovação e Engenharia de Polímeros	-

Implemented and coordinated by INTELI - *Inteligência em Inovação* (*think-tank* that operates in the field of industrial public policy), the main competencies of PEMA are those concern with manufacture and design of production equipment; conception and manufacture of aeronautical sets and final aviation products; conception and manufacture of certified leather coatings and technical coatings of surfaces; conception and assembling of structural modules; testing and certification of software and solutions in electronics and information technologies; and the manufacture of basic components, such as plastic compounds and materials, and mechanical components.

PEMA, as a whole, collects an estimated business volume of 70 million euros and holds 900 specialists with advanced technical and scientific training.

Table 6.4. Portuguese AEROSME member firms and institutions



BOX 2. AEROSME

AeroSME is an organization of SMEs and institutions of the aeronautical industry that emerged as the merger between the European Association of Aerospace and Defense Industry and the European Commission.

It was initially created to support the participation of SMEs in projects of R+D in the aeronautical and space fields fitted in the *Frame Work* of the European Union. AeroSME triggers cooperation between SMEs and big firms world-widely responsible of aeronautical activity, and between firms and institutions of R+D that directly or indirectly carry out their activity in the aeronautical and space fields.

AeriSME has elaborated a membership database. Taking into consideration both, enterprise and institutional agents, more than 700 associates are already registered. AeroSME aims for associated SMEs to participate in international projects and get involved in great international suppliers networks.

32 countries take part in this association, that is, all 25 Members of the EU, together with Bulgaria, Iceland, Israel, Norway, Romania, Switzerland and Turkey.

6.4 Synthesis of the Territory

Development Potential of an Aeronautical Mega-Cluster

The scientific community unanimously realize that *cluster* formation brings about a set of sector advantages. These advantages achieve greater interest in sectors of high technological content being very much linked to the activity of innovation networks.

The development of the Portuguese aeronautical sector must be approached through a *cluster* perspective in order to ease relations between sector firms. Firms that do not yet belong to the sector may be incorporated through jumping in the value chain and through better technological products in association with research institutions.

The launching of an aeronautical c*luster* turns into an important challenge in a country whose main competitiveness factors are non-qualified labor, natural resources and scale economies. Its subsistence relies on an industrial policy that may assure consistent structural conditions and explore agglomeration economies. On the other hand, this trusty attitude towards a *cluster* formation demands international strategic associations, taking into account that this type of procedure has been recently favored by world-wide aeronautical tendencies. Main national aeronautical actors cannot distance themselves from these tendencies. They should accomplish new forms of association.

Due to piled up competition in some activity sectors, the development of an aeronautical *cluster* in Portugal must be handled from an ampler *mega-cluster*[5] perspective rather than from the conventional industrial or regional *cluster* approach. The Portuguese aeronautical *mega-cluster* will have to be constituted by different activity types (see figure 6.26), such as:

- Activities responsible of airship construction or of components directly related to their production, essentially airship integration and assembly;
- Activities related to product or subsystem manufacture, necessary for airship production;

[5] Concept proposed in 1999 by the Focus Group on Cluster Mapping and Cluster Policy of the OECD. It refers to a set of activities whose goods or services satisfy the demand of a same great "functional area of the final demand" and it operates through basic complementary competencies, exploring the advantages of network articulation of firm actors, state or research institutions.

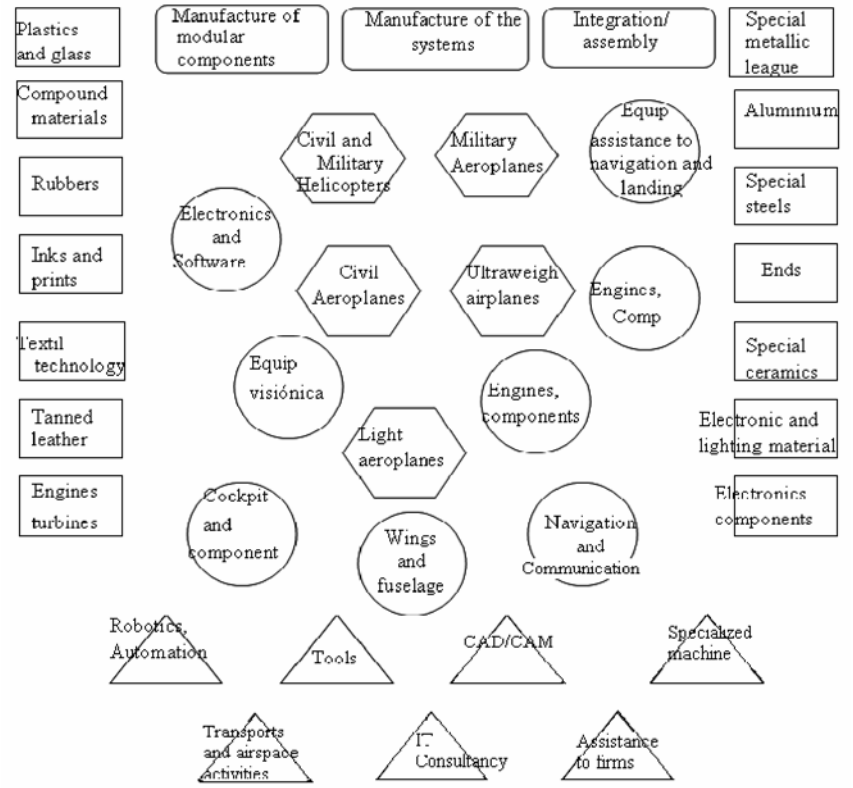


Fig. 6.26. Aeronautical *mega-cluster*

- Production activities of raw materials or intermediate goods in the *mega-cluster*, physically incorporated or not in the product;
- Activities of shared services related to final production or to firm operation.

From the interaction between these activities, the *mega-cluster*'s final production is obtained.

The Portuguese aeronautical *mega-cluster* must hold the following interdependent dimension and complementary activities: maintenance reinforcement of traditional constructed airplanes; subcontracting of firms belonging to other sectors that have achieved magnitude in the value chain; and attraction of other constructors of niche markets (business, sports or non-piloted airplanes) for their installment in Portugal. Thus, the *mega-cluster* will rely on the establishment of synergies between the main actors belonging to the aeronautical maintenance (OGMA and TAPME), on the interaction between enterprise and institutional agents and complementary

sectors (automobile, molds), and on the development of structural projects, taking advantage of infrastructures such as Beja's and Évora's and the attraction of market niches.

6.4.1 Exploration of Synergies between Ogma and Tapme

The exploration of Synergies between the competencies of OGMA and the maintenance and engineering unit of TAP is crucial in the creation of a national aeronautical *mega-cluster*. There are two cooperation agreements between these two firms, one for Airbus aircraft maintenance and the other in which any surplus maintenance in TAPME will be subcontracted to OGMA. Fusion or change of participation between TAP and OGMA was a likely setting considered by EMBRAER in the last years, after the recent privatization of Alverca's firm. OGMA and TAPME share similar capacity and equipment levels dealing with all aeronautical maintenance stages. While OGMA achieved its competencies through light and military airships (belonging to FAP), TAPME focused on great civil aviation airships (Boeing, Lockheed and Airbus).

OGMA's recent privatization, TAP's restructuring process and the future transference of the Lisbon Airport manifest a deeper bilateral cooperation. The departure of TAPME's maintenance infrastructures from La Portela (the current Airport of Lisbon) implies its delocation to a new place which must have a runway and several maintenance and airport infrastructures.

6.4.2 Interaction among Related Sectors

In this section, automobile components and plastic molds are stress. In Portugal we may find interesting *clusters* belonging to these particular sectors (see Box 3).

Since many of the processes and methods used in the production of automobile components are identical to those in the aeronautical sector, new opportunities are opened to explore the integration of automobile firms in aeronautical provision chains. Institutions such as INTELI and the *Gabinete de Apoio à Participação da Indústria Nacional* (GAPIN) carry out efforts in this particular implication.

Certification requirements, which suppliers of the automobile industry must fulfill in the aeronautical sector, are realistically achievable in the production of components such as batteries, glass, seats, navigation instruments, metals and plastic components. An aeronautical *mega-cluster*

formation would allow firms of automobile components to react towards diversification, avoiding excessive mono-sectorial dependency.

The same happens with plastic mold *clusters*, extended to compound materials. Its reinforcement depends on the firm's capacity in supplying the aeronautical sector, which becomes an opportunity to incorporate greater technological inputs. Cabin interiors offer great opportunities, in some cases in automobile sector competencies such as material compounds, molds and plastic pieces. These segments represent between 10% and 20% of a commercial airplane final price and, moreover, these interiors are renewed every 5 years, average. From a technological point of view, cabin interiors are pioneer of Information Technologies, Communication and Electronics (TICE), materials, ergonomics and design.

Contacts established between a few Portuguese firms and BOEING in the *7E7* manufacture involvement, not only at the production level of plastic components for the cabin interior and outer panels, but also in the product engineering itself, are significant. CENTIMFE, as the leader of Eurotooling, an integrated project for SMEs that includes technological centers and firms from European countries, and organizer of masters specialized in polymer engineering and molds, is carrying out an important role.

Iberomoldes is the main Portuguese group of firms in the mold industry that accumulated experience in the supply of automobile components. It associated with OGMA, creating LISTRAL, responsible of assembling the succesful *turboprop Pilatos PC12* in the U.S.A.

BOX 3. THE AUTOMOBILE CLUSTER

Foreign Direct Investment became crucial for the development of an automobile *cluster* in Portugal, especially through investments coming from Renault (1980) and Ford-Volkswagen (AutoEuropa - 1992). The Renault project was essential for the components industry, while AutoEuropa was decisive in the consolidation of the supplier fabric and in the creation of the c*luster* centered around the assembly unit of the Volkswagen group.

According to Ann Markusen's *hub-and-spoke industrial district* definition, Auto-Europe is a good example of this type of area as it developes a polarized space through a firm which promoted a network of suppliers.

In relation to location, areas such as Metropolitan Lisbon, specially the Setúbal Peninsula (lAutoEuropa is located in Palmela), Porto's Metropolitan Area (metals, textile, rubber and plastics), the Leiria-Marinha Grande-Figueira da Foz axis (molds for plastics) and the Abrantes-Ponte de Sôr axis (automobile electronics) are important. The firm network is constituted by SMEs of components, particularly providers of second and third lines, and by some assemblage firms such as AutoEuropa, Salvador Cae-

tano, Citröen Lusitânia, Opel Portugal and Mitsubishi Trucks Europe. This *cluster* has nearly 400 firms and more than 20,000 workers. It also leads the Portuguese economy in terms of exports (one fifth of national exports).

To its reinforcement contributed the creation of institutions of R&D and training, together with recent development efforts in the *Pininfarina Project* and in the integration in the Iberian automobile *cluster* through synergies exploration between the northern regions of Portugal and Galicia.

The automobile *Cluster* needs a fast growth in its added value to develop new products and share knowledge with equally advanced sectors, especially the aeronautical sector.

THE CLUSTER OF MOLDS FOR PLASTIC

The Portuguese industry of molds arose in 1925 with the necessity to manufacture metallic molds for the glass industry. This fact conditioned the current location of the mold industry and encouraged the creation of *clusters* in the Marinha Grande and in the Oliveira de Azeméis. The glass industry moved gradually towards the plastic molds. In 1946, a new technical process arose based on the manufacture of molds by injection, which greatly expanded after the 2nd World War.

Through a gradually reinforcement of synergies, the mold industry originated one of the most important *clusters* in today's Portuguese economy, with nearly 300 firms that employ more than 7500 workers.

Despite its small economic magnitude, Portugal occupies the tenth place in the world-wide mold manufacturer scale and the sixth place in the mold industry for plastics. Production is almost exclusively based on exports, especially to the United States market.

6.4.3 Exploitation of Market Niches

OGMA's privatization provides optimism towards this *mega-cluster* development, particularly due to the new Airholding international projects. There are additionally other great international projects to be considered:

- *A350 Airbus* and *7E7 Boeing* – the participation in both programs is likely to happen, as in the case of Italy's ALENIA. It would allow access to a total market of 3000 airplanes in 20 years;
- *A400M Airbus* - European military transport plane with already solid contracts and great export potential;
- *NH90 Helicopter* - with a great amount of orders and the best export potential of the sector;

- *JSF Fighter* or *Eurofighter* – nearly four hundred orders of *Eurofighters*.

Also, in addition to these international projects, there are other opportunities in other market niches such as the *Advanced Training Jets* and the *Unmanned Aerial Vehicles* (UAV). There exist potential in the participation in development consortiums and in the manufacture of training airplanes, being the latter of particular interest to Eurotraining's purpose (AEJPT). A good example of this is the *M-346 Aermacchi* project, in which OGMA would help through the development and manufacture of its structural parts and through interventions in areas of greater added value like marketing. On the other hand, the niche belonging to the UAV has registered a great growth and displays less entrance expenses. Here is where a product associated to Portuguese necessities exists, such as forest and coastal vigilance, integrated in a pilot project of development and association that would gradually replace the usual acquisition "key in hand" to outsiders.

Projects aiming to explore market niches in interior regions such as Alentejo (Beja and Évora) or Beira Litoral (Covilhã) have arisen in the last years. These projects plan to establish new capacities in the existing airport infrastructures or to develop the production of new segments like business or sport ultra light airplanes. Alentejo benefits from a number of factors that assure an excellent aerial visibility, such as its high average of sun exposure and its ideal orography. These favorable conditions are perfect for aeronautical activities. The base of Beja[6] (German military base until the beginning of the 90's) has similar conditions. Fitted with an advantaged location, being relatively near to Lisbon (180 km), Sines (100 km) and the aeronautical grounds of Seville (220 km) and Madrid (590 km), it is also suitable for aeronautical activities.

In Évora, projects like the creation of the Aeronautical Academy and the dynamism carried out by the City Council attracted investment for an strategic sector. It is the case of AIR LUXOR, which belongs to LOURO AERONAVES and SKY GECI, interested in settling in Portugal a mixed aircraft factory of small size[7]. Toulouse's SKY GECI will also establish, next to the municipal aerodrome, the Skylander production unit, a great versatile twin-engine airplane with turboprop that is able to land in any type of runway and may transport up to 3.3 tons of goods or 19 passengers. Level one twin-engine supply, to be commercialized in 2007, together with the

[6] LOCKHEED MARTIN displayed a proposal for the development in this infrastructure of a training European school for pilots of F-16 Fighters.

[7] The city initially thought to take in this project was Tarbes (France).

conception and engineering works are going to be provided by a Portuguese set of SMEs.

In the Alentejan city of Ponte de Sôr other SMEs have been settled in the last years that will aim to explore light or ultra-light airplanes. Such is the case of the Portuguese firm MOTORAVIA or the French DYN'AERO.

Investments have also been generated due to the *know-how* of the Aerospace Science Department of Beira Interior's University and of the Municipal Aerodrome of Covilhã. The South African firm JUPITER AIRCRAFT, producer of a type of light airplanes, is to a great extent responsible if this prosperous situation. Its Portuguese representative is MOTORAVIA. Since 2004, the light airplanes niche is also found in Sintra, with the manufacture carried out by a Portuguese SME of the *Land Africa* Ultralight.

6.4.4 Line of Action of a Portuguese Aeronautical Mega-Cluster

The potentialities to constitute a *mega-cluster* in Portugal depend on speeding up of the relations between actors and their reaction to an increasing demand of aeronautical constructors. Constitution of firm networks or groups is specially important for Portuguese firms at a time when the global aeronautical sector is going through a period of consolidation. The state should design an industrial policy based on *clusters* following three main lines: taking advantage of the potentialities of market niches; selection of strategic collaborators for the participation of Portuguese firms in structural projects; and internationalization of national firms.

The efforts to create a tecnopole for aeronautics, possible due to its geographic location, the emergence of a unique official interlocutor for the *mega-cluster* and the creation of a risk capital fund are also circumstances of great relevance. Beja is an ideal location mainly due to its available space, its existing infrastructures and its proximity to the Spanish market. This last characteristic promotes collaboration with the peninsular aeronautical activities of Seville and Cadiz. The creation of an Aeronautical Technology and Engineering Center will centralize and coordinate sector support.

Finally, the Portuguese sector aims to participate in all processes of aircraft production, design, development assembly, etc.

7 Comparative Analysis of the Territories Studied

7.1 Descriptive Analysis of the Territories

We are going to expose the characteristics of the different territories studied, although we must remark on the field work carried out by the Lisbon team, since, as we have mentioned in chapter six, we cannot speak today, in its strict sense, of a Portuguese aeronautical sector that fulfills the economic requirements to catalogue it as *cluster* or *industrial district*. These requirements are space agglomeration and, in addition, the need of this agglomeration to be configured as a set of firms specialized in an specific industrial sector (see third chapter).

For the rest of the territories studied, the statistical tables expressing its respective characteristics may be perfectly accepted as representations of the studied *clusters*. We must also mention that tables are displayed grouped in two (French and Spanish) to have a clearer and more intuitive vision about the average value of each of the variables in each of the territories and countries.

The variables chosen provide the most explicit information over each of the respective territories. They refer to the volume of sales and the number of qualified employees in each firm, together with other variables related to research effort carried out by each firm, the number of employees that participate in R&D or the number of patents achieved (tables nº 7.1., 7.2. and 7.3.).

The tables exposed reflect the situation in which each of the studied aeronautical fields are. Thus, if we compared Toulouse and Bordeaux (table 7.2.), the average values show a clear advantage of Toulouse over Bordeaux in sales and employees, whereas in those values referring to managers, advanced, qualified or administrative technicians, as well as full time employees in R&D or number of patents achieved, Bordeaux maintains a clearly advantage over Toulouse. What interpretation should be given to these values for both French *clusters*?

Table 7.1. Madrid and Seville

Descriptive Statistics	Madrid			Seville		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Volume of 2002 sales	26,00	16,7 (M)	45,6 (M)	26,00	3,1 (M)	4,7 (M)
Total firm employees/2002	26,00	131,31	359,25	29,00	88,45	132,57
Total managers/2002	26,00	5,92	15,28	27,00	2,26	1,32
Total advanced technicians/2002	26,00	14,92	22,79	27,00	5,89	16,95
Total qualified technicians or Assimilates/2002	26,00	14,92	22,56	27,00	10,00	16,40
Total Administrative employees/2002	26,00	9,50	17,02	27,00	6,44	14,31
Total Skilled workers/2002	26,00	28,19	27,43	27,00	43,85	83,49
Total Unskilled workers/2002	26,00	41,50	201,27	27,00	15,33	30,78
% invested in R&D of the firm/total costs	26,00	9,00	7,76	16,00	0,00	0,00
Full time employees in R&D	26,00	18,77	61,69	20,00	1,60	4,04
How many patents has your firm developed in the last 5 years?	26,00	0,88	2,47	29,00	0,03	0,19

Table 7.2. Bordeaux and Toulouse

Descriptive Statistics	Bordeau			Toulouse		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Volume of 2002 sales	33,00	4,1 (M)	0,8 (mil)	43,00	28,0 (M)	89,7 (M)
Total firm employees/2002	33,00	93,52	240,63	41,00	128,32	181,48
Total managers/2002	33,00	69,70	241,01	39,00	21,41	47,64
Total advanced technicians/2002	33,00	97,85	290,00	26,00	22,00	39,27
Total qualified technicians or Assimilates/2002	33,00	92,06	291,26	28,00	17,75	26,19
Total Administrative employees/2002	33,00	94,42	290,56	33,00	17,36	37,01
Total Skilled workers/2002	33,00	68,30	240,35	34,00	55,21	92,15
Total Unskilled workers/2002	33,00	94,58	290,78	20,00	14,35	23,21
% invested in R&D of the firm/total costs	33,00	186,94	388,86	18,00	7,99	9,69
Full time employees in R&D	33,00	184,09	390,14	16,00	20,47	52,93
How many patents has your firm developed in the last 5 years?	33,00	91,24	291,51	12,00	2,42	2,87

Table 7.3. Lisbon

Descriptive Statistics	Lisbon		
	N	Mean	Std. Deviation
Volume of 2002 sales	22,0	13,2 (M)	29,0 (M)
Total firm employees/2002	22,0	216,4	557,8
Total managers/2002	22,0	4,3	9,5
Total advanced technicians/2002	22,0	13,6	46,2
Total qualified technicians or Assimilates/2002	22,0	29,6	105,9
Total Administrative employees/2002	22,0	14,0	56,4
Total Skilled workers/2002	22,0	61,5	203,7
Total Unskilled workers/2002	22,0	7,0	14,9
% invested in R&D of the firm/total costs	22,0	5,7	14,4
Full time employees in R&D	22,0	3,0	8,0
How many patents has your firm developed in the last 5 years?	22,0	0,9	2,5

French investigation teams have repeatedly remarked (see chapter four) that Toulouse holds the best *cluster* adapted to the new aeronautical worldwide configuration, mainly in its civil branch. As a consequence, Toulouse has become more dynamic and less dependent on the state. It has therefore achieved a greater growth in sales, benefits and employment for its firms, while Bordeaux, excessively attached to the military and aerospace sector, has had difficulties in moving away from the protective role of the state. Consequently, and along with the crisis over the satellite launching industry in the last years, Bordeaux's prospects, in contrast to Toulouse's, have become gradually deteriorated. At the same time, Bordeaux upholds values over Toulouse in the remaining variables, including those related to technology and patents. The greater necessity of qualified employees in the industrial profile of Bordeaux, together with an over-employment, probably due to government interference, is likely to be the cause of this contrast. That is, Bordeaux still manifests some of the weaknesses carried out in the aeronautical industry back in the 80's, before the fall of the Berlin wall, when the sector was still rigidly regulated (see chapters 2.4 and 5).

The contrast between Madrid and Seville can be established by looking at table 7.1. where, as we have mentioned early, we have not considered neither the industrial activities of Eads nor those of Airbus in both territories, so that comparison would be more balanced. In these circumstances, we see that practically all given variables averagely provide higher values for Madrid. We may conclude that, although precaution is needed to correctly analyze the statistics given, due to a probable financial dependency between firms existing in both places but imputing their activity to the social headquarter, the differences could perfectly assume any margin of error that could rise. Noteworthy are the values obtained from the variable of total employment and from those related to R&D. If we have frequently shown throughout the analysis the necessity of European aeronautical SMEs to grow in size, due to the strong correlation noticed in all studied territories between size and research activity, the compared statistics between Madrid and Seville clearly support this same characteristic. Conscious of their situation, Seville as much as Madrid should seek to continue the way which they have already undertaken towards a territorial specification as a process of aeronautical fortification.

Considering the four territories together, the positions among them provide us with a particular arrangement in preference of Toulouse, from a more gradual global market point of view. Although it may seem paradoxical, from a point of view closer to the public administration (traditional in the sector), Bordeaux would be at the top with regard to human capital and results, such as patents. Madrid would be behind Toulouse un-

der market criteria, which is, after all, the criterion that prevails in a globalized world.

7.2 Factorial Analysis

7.2.1 Empirical Analysis

Factorial analysis is a statistic technique used to identify, through a small amount of factors, the complex relation that may exist between a set of registered variables. It aims to find a group of factors, with common but not obvious dimensions, that may exist among an ample number of variables. Factorial analysis does not distinguish between dependent or independent variables. Its main purpose is not the analysis of causal relations, but the grouping of variables based on their shared features.

7.2.2 Factorial Analysis

Factorial analysis is based upon four fundamental steps which are: computation of the matrix that expresses the common variability of all variables employed in the research; extraction of the optimal number of factors; rotation of the solution to facilitate its interpretation; and estimation of each subjects' scores in the new dimensions.
In the first place we proceed to represent the variables we are going to apply, their values accomplished on the basis of field work and their more elementary statistical features. We should not forget that the range of our work extents to 153 samples (firms), for four of the five territories studied, that is, Bordeaux, Madrid, Toulouse and Seville. From this data we can see in table 7.4. the basic Descriptive Statistic (average, and standard deviation) of the studied variables.

Table 7.4. Descriptive statistics

	Mean	Std Deviation[a]	Analysis N[a]
Sales volume 2002	1,30E+07	51253239,58	153
Total firm employees/2002	87,0851	156,25466	153
Total managers/2002	25,1739	115,95961	153
Have you established any cooperative relation with other firms or organisms for their innovation activities?	1,0588	2,26888	153
Cooperation for process innovation	1,3302	2,31903	153
Cooperation for market innovation	0,8029	2,31369	153
Full time employees in R&D	56,0437	194,46025	153
Total advanced technicians/2002	36,8140	141,22713	153
Total qualified technicians or Assimilates/2002	32,0376	138,48786	153
% invested in R&D of the firm/total costs	54,6047	192,35066	153
Has your firm patented in the last 5 years?	39,1818	137,54945	153
How many patents has your firm developed in the last 5 years?	36,5057	137,63533	153
Total Administrative employees/2002	30,4632	138,94532	153

In addition, table 7.5. provides another correlation test between variables, called *Kaiser-Meyer-Olkin*, which is an index to compare the magnitude of the recorded correlation coefficients with the magnitude of the partial correlation coefficients. Its mathematical expression is:

$$KMO = \sum_{j} r_{ij}^{2} \; / \; \sum_{i\,j} r_{ij}^{2} + \sum_{i\,j} r_{ij.m}^{2} \qquad (7.1)$$

where r_{ij} represents the simple correlation coefficient between variables i and j, and $r_{ij.m}$ represents the partial correlation between variables i and j, being removed the effect of the remaining m variables included in the analysis. Since partial correlation between two variables must be small when the factorial model is adequate, the denominator should increase slightly if data matches with a factorial structure. In that case, *KMO* will obtain a value near to 1.

The estimation of the *KMO* index for our research is of 0,710, which is interpreted as a correct digit. Additionally, of .000 and, consequently, it enables us to proceed with the analysis. Bartlett's test specifies that the data applied does not produce an identical matrix with a significance value.

Table 7.5. KMO and the Bartlett test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,733
Bartlett's Test of Sphericity	Approx. Chi-Square	1295,265
	df	78
	Sig.	,000

Factor extraction may take place once the linearity between the variables studied has been verified. We will, thus, proceed to look for the factors that explain the obtained correlation. Of all the existing statistical algorithms, we are going to work with the so-called **main component analysis**. Through it we will form linear combinations between the examined variables aiming to see which components of the variables explain a greater amount of their total variance, that is, which of them explain a greater dispersion with respect to the average of the group. Successively gathering the variables in groups with correlation among them, and without it in relation to the other groups, we may specify the amount of the total variance that explains each factor (group) of the total of the standardized variance to explain.

Table 7.6. Communalities

Communalities		
	Initial	Extraction
Volume of 2002 sales	1,000	0,919
Total firm employees/2002	1,000	0,843
Total managers/2002	1,000	0,821
Have you established any cooperative relation with other firms or organisms for their innovation activities?	1,000	0,955
Cooperation for process innovation	1,000	0,924
Cooperation for market innovation	1,000	0,977
Full time employees in R&D	1,000	0,689
Total advanced technicians/2002	1,000	0,95
Total qualified technicians or Assimilates/2002	1,000	0,953
% invested in R&D of the firm/total costs	1,000	0,698
Has your firm patented in the last 5 years?	1,000	0,901
How many patents has your firm developed in the last 5 years?	1,000	0,902
Total Administrative employees/2002	1,000	0,951

Extraction Method: Principal Component Analysis

Table 7.6. provides the communalities initially assigned to the variables (initial) and those reproduced by the factorial solution (extraction). The communality of a variable is the proportion of its variance explained by the achieved factorial model. The total proportion of the variance, specified by each variable, equals the sum of the variance proportions explained by each factor. Through the study of the extraction communalities the worst variables explained by the model can be detected and valued. In our model, these variables are the number of full time employees in R&D and the % invested in R&D of the firm/total costs. The model is only able to respectively reproduce 68,90% and 69,80% of its original variability.

In the table related to the total explained variation (table 7.7) the specification quota that carries out each factor of the total of the variance to ex-

plain, 13 at the most, is shown. The important factors are those that explain a greater value than 1, since if it explains less, its value would not be equivalent to none of the variables and, hence, it will not be relevant.

Table 7.7. Total explained variation

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,299	33,066	33,066	4,299	33,066	33,066
2	3,316	25,505	58,571	3,316	25,505	58,571
3	2,668	20,525	79,096	2,668	20,525	79,096
4	1,202	9,246	88,342	1,202	9,246	88,342
5	,454	3,493	91,835			
6	,422	3,246	95,081			
7	,340	2,614	97,695			
8	,119	,913	98,608			
9	,111	,856	99,464			
10	3,254E-02	,250	99,714			
11	2,572E-02	,198	99,912			
12	8,567E-03	6,590E-02	99,978			
13	2,834E-03	2,180E-02	100,000			

Extraction Method: Principal Component Analysis.

In table 7.7 there are 4 self-values greater than 1 and, thus, the procedure extracts 4 factors that explain the 88,342% of the original data variance. The first factor reaches a value of 33,0665, which is equivalent to 4.299 of the standardized total value. The table also indicates the saturation of the factors, that is, the factorial load. The first factor, with values corresponding to the initial self-values, is shown without rotating, while the second one is reflected with the extraction of rotated factors. Summing up, the 13 achieved variables we initiated our work with can be reduced to 4 factors that explain the 88,342% of the total of the variance, without losing significant information.

We already know that 4 factors are enough to reasonably explain the existing relation between the observed variables. We must estimate now the coefficients that relate this factors to each of the variables. Through the method of main components we estimate the coefficients between the original variables, or *saturations*, and each of the factors. But, when comparing the relative saturations of each variable in each of the four factors, it often happens that many of the variables appear in more than one factor and, therefore, an excess of variables may emerge. It is therefore necessary to reduce the number of the variables that hold a high factorial load (*saturation*) in some of the factors. This may be done by applying a method of orthogonal rotation known as *Varimax*, which diminish the number of

variables that hold a high saturation level in each factor. This method simplifies the factor interpretation optimizing the solution through columns. The matrix of the rotated factorial structure is shown in table 7.8., named as *matrix of rotated components*.

Table 7.8. Matrix of rotated components

	Component			
	1	2	3	4
Total Administrative employees/2002	0,975			
Total qualified technicians or Assimilates/2002	0,975			
Total advanced technicians/2002	0,974			
Total managers/2002	0,895			
Total firm employees/2002	0,689			0,600
How many patents has your firm developed in the last 5 years?		0,949		
Has your firm patented in the last 5 years?		0,948		
% invested in R&D of the firm/total costs		0,833		
Full time employees in R&D		0,827		
Cooperation for market innovation			0,987	
Have you established any cooperative relation with other firms or organisms for their innovation activities?			0,975	
Have you established any cooperative relation with other firms or organisms for their innovation activities?			0,975	
Cooperation for process innovation			0,957	
Sales volume 2002				0,958

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Comparing the values of this table with those of the non-rotated matrix (not shown here) we would observe that the saturations of the variables have regrouped between the four factors, that is, they have been placed where they have more explanatory power.

INTERPRETATION OF THE FACTORIAL ANALYSIS

Being assigned the 13 variables to each of the 4 factors by the matrix of rotated components we may now "name" these factors in relation to the variables they contain. This particular stage is mostly conditioned by the theoretical scheme of the exposed statistical model since, from the interpretation obtained from the factors, we will reach the conclusions of the statistic model and will determine if it corroborates some of the main proposals that we have been formulating throughout the study.

The first factor contains the variables of Total Administrative Employees/2002, Total qualified Technicians or Assimilates/2002, Total advanced Technicians/2002, Total Managers/2002 and Total firm Employees/2002. Due to the relation they share between Administrative Employees, qualified or advanced Technicians and Total Firm Employees, we will call the first factor **Staff Dimension Factor**. This is how variables, grouped around factors, point at the *Dimension* as an important characteristic when judging the aeronautical sector in the territories studied. The second factor includes the following variables: full time Employees in R&D, % invested in R&D of the Firm/Total Costs, if the Firm has Patented in the last five Years and Patents developed by the Firm in the last five Years. This factor defines the level of knowledge in the firms in the specified period, and hence it will be called **Knowledge Factor**. The third factor includes the following variables: Cooperation for Market Innovation, Cooperation with other firms for process Innovation and, finally, Cooperative Relations with other firms or Organisms in innovative Activities. This factor will be called **Cooperation Factor** which is considered as a reality, although not always look-after, of the studied sector. Finally, the fourth factor is made up of the variables of Volume of Sales and Firm Employees. We will consequently name it **Financial Dimension Factor,** expressing through it the importance of firm dimension, defined not only on the basis of staff per function, but adding a new component that certainly enriches our factorial analysis when relating the number of employees with the business volume.

Which is, hence, the interpretation of the values reached by the statistical model of Factorial Analysis? A general conclusion based upon three determining forces that function and define the studied sector may be raised. That is to say:

The aeronautical sector is configured, firstly, around increasingly complex firm organizations where the existence of specialized workers is related to employment. This is shown by the existence, and the necessity, of practically all types of workers in the group as well as its correlation with the staff. Secondly, the aeronautical sector is based on an increasing participation of knowledge as much as in its current levels as in its growth rates. This is demonstrated by the direct relation between employees in R&D, the participation of research expenses over total expenses and the number of patents developed in the firm. Thirdly, the analysis shows an industrial sector where the number of employees is directly related to the volume of sales, suggesting a tendency towards size increase and firm concentration.

All what has been mentioned warns about the weaknesses of those *clusters* configured by micro-firms without enough size to face the increasing requirements of head firms, neither in staff, knowledge nor financial base. The final conclusion we obtain from the factorial analysis is that the enterprise size, in all its manifestations, is, and will mainly be, central in the aerospace and aeronautical sector.

8 Conclusions and Recommendations

The main conclusions that in our opinion define the current aeronautical sector are the following:

- In the territories studied, the sector has been developed under the *state shade* according to "state policy" tradition.
- Causes of this previous affirmation are to be found in the necessity of a national defence, as a public good for any country. Aviation, in its origins, tends towards military industry.
- Aeronautical firms were either public or closely regulated. Only since the 90's, and by obvious political reasons, the sector tends to distance itself from the state influence, although the bond is still important. Parallel, the pre-eminence in military activity yields to civil aviation, becoming the latter chief in the aeronautical field.
- Despite its origin and state development, that is, far away from the market, the sector has always maintained a high level of applied knowledge. It is a sector with high levels of human capital and technical development that, with access to a sufficient public financing, was able to obtain processes and products at the highest level of efficiency.
- The sector has been characterized by high quality and reliability levels in its products and component. Actually, the modern procedures of quality control in the industry in general are born and developed around the aeronautical sector. All firms involved in the sector must have the necessary qualification to provide products according to demanding specifications of quality. Quality certifications are an innovation guarantee.
- The aeronautical sector is probably the industrial sector that has developed in a greater way the financial and productive organization among firms belonging to it. Thus, it is frequent to see how firms involve themselves with financial risk in the airplane development. The final and manufacturing assembler seeks industrial partners with this same peculiarity of assuming financial risk in the project. Quite often the situation of a firm in the knowledge chain moves along with its acceptance of financial risk.
- Parallel, the manufacture of an airplane implies the use of different origin technologies, industrial or service, that are not usually strictly reflec-

ted in the aeronautical or space statistics. The combination of these technologies is carried out through complex processes of subcontracting or shared contracting. The industrial organization of the aeronautical sector has, thus, developed extremely flexible collaboration methods in contrast to other industrial branches. Together with the division of the product unit (airplane), in specific tasks between the participant firm network, and focused in a set of subcontracting relations (either contracted or achieved through the situation of the firm in the knowledge chain), other methods of enterprise participation are recurrent. Among them we can mention outsourcing, spin offs, start ups, gathering of firms in groups of knowledge management, mobility of human capital between firms, continuous formation inter-firms, etc. Together, they all carry out a common practice in the sector of airplane manufacture with excellent results in the fulfilment of objectives. The territories studied perform many of the methods exposed above.

- The greatest effort in the sector corresponds to design, industrial planning, creation of a suppliers network and advancing through the different production phases of the learning curve. Once the machine "has flown", its components and its basic industrial structure remain immutable throughout the rest of its existence. In those conditions, innovation in the sector takes place in manufacture and maintenance processes, in designing auxiliary machines to support the model and, mainly, in quality control of different airplane components.
- In general, the studied firms of the sector hold sufficient productive capabilities for its output to reach quality levels. This may happen even in those firms with small technological level.
- The restructuring necessity that reached the aeronautical sector at the beginning of the 90's speeded up the concentration in the sector and between countries. The launching of the firm model surrounding Airbus and, at the end of the decade, the emergence of Eads, which along Boeing becomes the greater world-wide airplane constructor, is accelerated.
- The consortium EADS is currently subordinated to a new and drastic process of rationalization in the relations with its suppliers. There exist an aim to promote the externalization of airplane production but, at the same time, a drastical reduction of suppliers is also sought. The purpose of the decision is to reduce both production and transaction costs in order to obtain a greater flexibility in the productive processes of the consortium.
- The decision of EADS to reduce the amount of suppliers represents a threat for current small and medium enterprises in the sector. A possible

solution may be grouping firms, under different contractual forms, to acquire size and position in order to face the consortium.

- In addition, the creation of common computer science platforms between small platforms, through the introduction of Information Technologies, would provide opportunities to access work offers launched by the consortium, to collaborate with the rest of the firms in real time and, eventually, to reduce product delivery times. In some of the territories studied projects of the kind already exist.
- The consortium EADS (Airbus) arises in agreement among states, each with their respective contributions; *a priori*, activities carried out by the different national headquarters of the current incorporated firm would now determine their own capacities in the final product to achieve. We have, therefore, a tendency towards relative specialization of each of the national units which had to be considered by the consortium. Obviously, learning and new specializations could, and may arise in each of the divisions of the firm, but what is doubtless is the high inertia content in the technological and production trajectory of each of the production units in which new EADS would count on.
- The knowledge integrated in a civil airplane within the EADS consortium protocoles, synthetically, in the following way: centralized engineering design and progressively increasing innovation, but with the maximum level of existing pure and incorporated knowledge, so that once conceived and tested may be constructed and replicated, assigning the production of the different aircraft parts to those productive units belonging to the consortium that have more competitive advantages in each of the components of the aircraft. Obviously, the previous assertion marks a leaning path compatible with situations slanted by governmental policy.
- The production of airplane components may be generally manufacture by the title firm itself, as it happened once, or its manufacture may be subcontracted, as it is currently happening. However, in the end, all components will be subordinate to the final product which constitutes a narrow cooperation relationship (voluntary or not) between subcontracting firms, suppliers and the final client.
- In all territories studied, especially Madrid and Seville, the industrial organization of the sector suffered from a bureaucratic excess and from rigid labor relations, characteristic of the public sector. The consortium belonging to EADS facilitated the emergence of knowledge streams between the territories that constituted it and, hence, a tendency towards knowledge homogenization in the respective *clusters*.

- The type of assistance for the sector established by the protocol between the E.U. and the USA is based upon credits granted by governments, reimbursable through time. Obviously, without the mobilization of those huge financial amounts, the consolidation of EADS had not been possible, and neither the development and launching of Airbus civil airplanes.
- The studied territories and their firms have a great chance to consolidate in the world-wide aeronautical sector as a consequence of belonging to the financial structure of the title firm EADS. This opportunity must trigger an impulse for the creation and consolidation of firms in the sector. The different territories are well located to strengthen their respective aeronautical *clusters*.
- In relation to the degree of acquired knowledge, the firms studied may be classified in four different levels, although interrelated. The *cluster* organically operates in a vertical and hierarchical way between the different levels in the service of the final output, either belonging to EADS or Airbus. Parallel, knowledge also flows vertically between the different units of production determined by its position in the value chain. It is however common to find firms, mainly in the second level, that have in their activity the same capacity of pure knowledge, and greater capacity of applied knowledge, that final (title) firms them-selves. In these specific firms, knowledge does not flow vertically from head firms, but horizontally between them and owners of the final product.

The different specified levels are structured as the following:

- In the first level we find firms that own the brand of the final product and are as well promoters of the value chain. They are, therefore, creators, receivers and trustees of all the accumulated knowledge by the productive activity of the sector. We are referring to EADS and Airbus.
- In the second level there is a small number of multinational firms forming an oligopoly that operate in the global market and are crucial for the conception and realization of the airplane. They hold the greatest level of knowledge in its qualification and, although they functionally depend on a final assembler, they are financially and technologically independent.
- The third level is configured by firms, either producers and assemblers of highly significant components of the final product or engineering or software providers of high added value service, with great technological and product development capacity, that are key in the manufacture. These firms often participate in other sectors since the technologies employed are common in their application. This is the case of the auto-

mobile sector, the railway transport, etc. Demands on collaboration, with their engineering specifications, encourage subcontracting firms to look for new clients and diminish their dependency to a single sector. They are many in the territories studied and they all show high degrees of productive specialization.

- Finally, the fourth level is made up of the weakest firms, considering value and knowledge contribution, although good at tacit knowledge. These small firms, often of domestic character, are the most numerous and vulnerable of the system, and although many operate in other sectors, they show a high degree of specialization in the aeronautical sector. They usually operate on projects provided by the matrix house with little content in additional knowledge. Some of them have lately taken part in the design of the pieces that subcontracting firms wish to produce, from initially being mere receivers of projects. It is a qualitative change and a model to follow by the rest of the SMEs in the sector since it sets up a quality footpath.

EADS or Airbus definitely benefits from the pure knowledge originated by their own highly qualified human resources that, together with the tacit knowledge devoted to the trajectory of labor of their frames and workers, place them in the world-wide technological border of the sector. Another important advantage is the external knowledge provided by a relatively small number of multinational firms that operate in the global market and are usually independent of the final airplane assembler.

The productive structure of the aeronautical sector of Madrid and Seville, unlike Bordeaux and, above all, Toulouse, requires greater size firms (more than 250 employees). As the factorial analysis shows, the definite consolidation of the sector calls for it.

While the Toulouse industrial *Cluster* is already in a specification stage, the same does not happen with the other studied territories. Bordeaux and Madrid gradually tend to change from the specialization to the specification as territories, with their key actors, acquire a more active role in the union sector-territory. Seville, and by extension Cadiz in Andalusia, already holds a high degree of specialization, whereas Lisbon is behind.

As we advance in knowledge contribution in the value chain, firms tend to transform themselves and their surroundings from the specialization of their industrial activity towards territorial specification, together with the rest of the territory actors. The existence of high technology firms that operate for sectors different from the aeronautical sector leads to the development of specific territorial resources, specially when the sector in which they are greater applied undergoes a temporary fall in its activity. This de-

velopment is the territory's manifestation of having reached the state of specification.

Clusters need to surpass the current existing barriers of work load so that they may create expectations to generate critical industrial mass. Toulouse, and to a lesser extent Bordeaux, have a relative and global capacity of expansion. *A380* and *A400M* programs may represent an opportunity in all territories, specially in Spain, to provide greater size and production to current SMEs.

Leading industries of the sector existing in Madrid and Seville should undergo a redistribution in the composition of their work force. There is an excess of non-qualified workers with no apparent function in the degree of modernization reached by the sector. Parallel, employees with greater levels of qualification and with a qualified and advanced degree of training are needed. To increase the innovating capacity that the title firms encourage and make possible, an improve in the capacity of research should be carried out.

Current infrastructures of research are to be multiplied and oriented towards developments of component models and prototypes, moving hence away from excessive theoretical preoccupations. This research activity in prototypes is highly developed in Bordeaux and Toulouse, where collaboration between consortium and research institutes has been intense. It must, though, emerge in the remaining territories. Public policy should be considered from the knowledge we have of the organization model and of the sector, synthetically exposed above. Specifically, they should aim to:

Strengthen and develop the quality and capacity of aeronautical firms, specially the weakest as far as financial strength and technological capabilities. Firms that share an stable and recognized trajectory must also be considered, although the most vulnerable are the priority since they represent the basis of future industrial developments. Public policy will be based upon the technological capacity of the firm, avoiding as far as possible support to basic infrastructure investments (land, industrial space, etc.). Firms have other ways to face their infrastructure necessities.

Among all supports to increase firm knowledge and good practice, those related to the establishment of Information Technologies (I.T.), as an irreplaceable tool in aviation, are the most relevant. Assistance in R&D related to quality and I.T. will have to be a high-priority in the budgetary effort of the different Administrations, and firms.

Information Technologies and, precisely, the beginning and consolidation of a ¨Computer Science Common platform¨ for the small and medium firms of the sector, will shortly be essential for these firms to access awarding of work load with the titles firm (EADS or AIRBUS). The Common platform will facilitate relations between the different firms involved

in complementary projects for the final producer (Airbus), which will significantly help to improve production costs and reduce the number of manufacture delays. It will also diminish transaction costs making contractual necessities of certification and manufacture easier.

To access the I.T. Common platform, taking into account its high launching costs, firms will have to associate to contribute to the common project participating in their costs. Administrations, along with the matrix firms, will have to cooperate in order to guarantee the aim and viability of the project.

Trying to territorially parcel out the sector is unreasonable. It is necessary to find ways in order to combine regional public assistance with firm collaboration in projects that go beyond their own territory. To promote cooperation between firms, beyond where they are implanted should be a priority of Public Administrations facing the sector.

Although most businesses carried out by small and medium firms remain mainly in the aeronautical sector, it would be advisable for them to assign part of their productive activity to other sectors. This precaution would guarantee alternatives when faced with changes in the productive cycle of the aeronautical sector.

Productive diversification is not only beneficial for small and medium firms but it can also be very positive for the title firm since it can rely on collaborating partners in more than a single sector, but always within the industry. The possibilities to access knowledge, either tacit or pure, are clearly multiplied.

There is a necessity of more firms between 250 and 1000 employees to have a greater access to research and investment. In this study, we have found a clear statistic correlation between the firm's size and its predisposition to carry out more necessary labors of R&D. For this reason, new public policies should be developed to encourage and promote creation or association between firms to face the increasing requirements and necessities of Airbus. We are not talking about choosing "winners" between the already existing firms but to establish some kind of attraction so that firms, through their own initiative, value growth within the sector.

9 Annex

Table A: Typology of firms selected for study in the Andalusian Region

Level and Type	Firms	Location	
1º	Title firms or final assemblers	EADS-CASA San Pablo and EADS-CAS Tablada	Sevilla
		Airbus Puerto Santa María and Airbus Puerto Real	Cádiz
2º	Modular integrators or specialized firms	CONSUR GROUP (Airgrup SL)	Sevilla
		EASA del Sur S.A.	Sevilla
		Consortium Sevilla Control (Sevilla Control, AyG Sevilla, TECAER and Aeroestructuras Sevilla and Aeroestructuras Cádiz)	Sevilla and Cádiz
		GRUPO ALCOR (SK10 and SK3000-formerly TGA)	Cádiz
		Sociedad Andaluza de Componentes Especiales SA (SACESA)	Sevilla
3º	Manufacturers under specification of title firms and modular assemblers with some engineering and design capability.	Calderinox	Sevilla
		Aeronáutica del Sur SAL (Aerosur)	Sevilla
		ELIMCO Maintainance and Assembly	Sevilla
		GHESA Ingeniería y Tecnología, S.A. (Madrid)	Sevilla
		Industria Especializada Aeronáutica, SA (INESPASA)	Sevilla
		INTEC-AIR SL/ Intec-Fresado Químico S.A.	Cádiz
		Técnicas Aeronáuticas Defensa y Automoción S.A. (TADA)	Sevilla
		Tecnológica Componentes Electrónicos S.A. (TCE)	Sevilla
4º	Manufacturers under specification of title firms and	Aeroepoxy Composite Andalucía SL	Jaén
		Aertec SL	Málaga
		Auxinde SL	Sevilla

	modular assemblers. Auxiliary industry.	Beat Andalucía SL	Sevilla
		Cauchos Pedro Romero SL	Sevilla
		Easy Industrial Solution	Cádiz
		Emerge Ingeniería	Sevilla
		FEALTI SL (Talleres Parrales)	Sevilla
		Grupo MDU	Sevilla
		Grupo Simgi SL (Siderometalúrgica Gienense)	Sevilla
		INFASUR Aeronáutica	Cádiz
		MAVE Aeronáutica SL	Cádiz
		Mecanizados Calonge SL	Sevilla
		Mecanizados Eulogio Peña (MEUPE SL)	Sevilla
		Mecanizados Iñiguez SLL	Sevilla
		Mecanizados Navair	Sevilla
		Mecanizados Virtual SL	Sevilla
		MECAPREC SL	Cádiz
		MEINSUR	Sevilla
		MP Componentes Mecánicos SL	Sevilla
		PRODIPRO (Proyectos, Diseño y Programación SA)	Sevilla
		Qualitaire Consulting	Sevilla
		RESUR SAL	Sevilla
		REYPLAS SL	Sevilla
		SERVIMEC Mecanizados SL	Sevilla
		SOFITEC Ingeniería SL	Sevilla
		SURIMEX S.A.	Cádiz
		TACH	Sevilla
		TALLERES PAEZ S.A	Cádiz
		Talleres TAGONSA	Sevilla
		Tecnología, Diseño e Ingeniería SA (TEDINSA)	Sevilla
		TITALCHIP SL	Sevilla
		TRC SLL (Técnica de Recanteado de Composite)	Sevilla

Source: Authors

Table B: Typology of firms selected for study in the Community of Madrid

Level and Type	Firms	Location	
1º	Title firms or final assemblers	EADS-CASA	Madrid
		Airbus España, S.L.	Getafe
2º	Modular assemblers or specialized firms	CESA (Equipos y sistemas), S.A.	Getafe
		CRISA	Tres Cantos
		GAMESA Desarrollos Aeronáuticos	Madrid
		HEXCEL COMPOSITE, S.L.	Parla
		SENER/BOREAS, Ingeniería y Sistemas	Getafe
3º	Manufacturers under specification of title firms and modular assemblers with some design and engineering capacity.	ACATEC, S. L.	Arganda del Rey
		AERLYPER, S.A. Avionics System	Madrid
		COMPOSYSTEM, S.A.	Toledo
		TECNATOM	San Sebastián de los Reyes
		GRUPO TECNOBIT	Alcobendas
		TEGRAF INGENIERÍA, S.L.	Getafe
4º	Manufacturers under specification of title firms and modular assemblers. Auxiliary industry.	APM (Alta Precisión de Mecanizado)	Fuenlabrada
		APRIM (Alta Precisión Industrial Mecánica), S.L.	Getafe
		INDUSTRIAS CARMORA, S.L.	Fuenlabrada
		CONSUEGRA, S.COOP.LTDA.	Fuente del Saz
		HUERCAM, S.L.	Fuenlabrada
		JUPA, S.A.	Toledo
		MECANIZADOS ESCRIBANO	Coslada
		RAMEM	Madrid
		TALLERES DUMADI, S.L.	Getafe
		GRUPO TAM	Móstoles
		SAN JOSE VILA, S.L.	Getafe
		SMA, S.L.	Pinto

Source: Authors

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