Title: Public and private networks that sustain the aerospace sector.

Abstract:

This work addresses both the specific nature of the aerospace sector (design, production, marketing) and the work distribution dynamics on parts and components spread among different companies, countries and regions.

The paper attempts to elucidate on questions related to:

- How public policies applied in the main development centers of the sector (USA, EU Brazil) deal with the construction of an institutional support structure with emphasis on training and research.
- What instruments have been designed to consolidate a more comprehensive vision with public-private coordination.
- What progress is shown in Mexican designed instruments (at national and state, for Querétaro, level) on the integration of the regional innovation system and the construction of networks between the different agents.
- What type of private initiatives are emerging to facilitate the forming of networks and knowledge flows in the aerospace sector, which give leading companies the confidence to incorporate local suppliers into new levels of greater technological complexity.

Resumen:

En el desarrollo del trabajo se distinguen la especificidad de la producción del sector aeronáutico (diseño, producción, comercialización), así como la dinámica de distribución de trabajo en partes y componentes repartidas entre diferentes empresas, países y regiones.

Las interrogantes que se tratan de dilucidar se refieren a:

- Cómo las políticas públicas aplicadas en los principales centros de desarrollo del sector (EEUU, UE, Brasil) encaran la construcción de una estructura institucional de apoyo al sector enfatizando la formación y la investigación.
- Qué instrumentos se han diseñado para consolidar una visión más integral y coordinada pública-privada.
- Qué avances se manifiestan en los instrumentos diseñados en México (a nivel nacional y estatal el caso de Querétaro) a la integración del sistema regional de innovación y la construcción de redes entre los diferentes agentes.
- Qué tipo de iniciativas surgen a nivel privado para facilitar la formación de redes y flujos de conocimientos en el sector aeroespacial, que den confianza a las empresas líderes para incorporar a las empresas proveedoras locales en nuevos niveles de mayor complejidad tecnológica.

I. Structure of the paper.

This work addresses both the specific nature of the aviation sector (design, production, marketing) and the work distribution dynamics on parts and components spread among different companies, countries and regions.

The identification of the sector's working logic is essential for understanding the international nature of the industry and the ease with which its locations can be transferred to maintain costs or opportunities that ensure the development of the main original equipment manufacturers (OEM).

Since its beginnings, the aerospace industry (AI) has been considered strategic; the public sector has been present, directly or indirectly, in the development of an institutional structure designed to densify communications within the sector, and its positioning in the market. Different producing countries have created an institutional structure conducive to growth in the sector, aimed at improving the productivity of the workforce, and promoting specialized training and collaboration with research, whether academically or in partnership with other companies, in order to raise the level of competitiveness and safety in the aviation industry.

Public policies adopted internationally and recently in Mexico are shaping an institutional structure that supports innovation, specialized training and collaboration with research. The high level of design and manufacturing technology in the AI, as well as the complexity of manufacture and the multitude of disciplines and certifications that accompany the production process, establish a centralized management by OEMs, which also demand international and national regulatory controls that act as a barrier to innovation.

II. Differences and similarities between the aviation and aerospace industries.

In most international studies the aerospace industry is referred to as a whole (Niosi, J. and Zhegu, M. 2005; Sammarra, A. and Biggiero, L. 2008). In spite of the differences between and aerospace and aviation industries, there are also significant similarities (Broekel, T. and Boschma, R. 2010). One lies in the fact that companies (Boeing and EADS) participate in both sectors and share high risk activities subject to intense commercial competition in the case of aviation, and government and military control in the aerospace industry. The technological core of both is centered in aerodynamics, propulsion, electronics, navigation and materials. Both industries are located in a few regional clusters attracting the participation of multiple agents for the control of OEMs. The industrial structure in both sectors takes on a hub-and-spoke configuration with large companies in the center (Broekel, T. and Boschma, R. 2010). The variations between aviation and the aerospace industry are related to the series of a single product that are produced, which are much larger in aviation, and products are marketed more quickly in aviation than in the aerospace industry. The organization of the aerospace industry is dominated by the weight of government and military decision, while aviation starts out as a private sector with a clear identification with client needs, and a success-based business approach to reduce costs.

A significant difference between both sectors (Broekel, T. and Boschma, R. 2010) is the structure of the knowledge networks that prevail in each: aerospace is more tied to science-based knowledge, while aviation is more oriented towards engineering knowledge and new

materials, due to the need for technology production and cost reduction, where innovation emerges from the application and recombination of existing knowledge with a clear intent to solve problems (Wolfe et al. 2005).

In this work we refer to the sector as aerospace following the example set in many diagnostic studies performed by Mexican public and intermediary organizations.

III. Policies, institutions and international collaboration agreements to ensure the international competitiveness of the sector.

1. Development of institutional structure in the US.

The United States, specifically, has not developed a comprehensive policy for the aerospace industry, but it has consolidated an institutional structure of departments and agencies with broad investment programs responsible for guiding strategies and creating regulations for the sector. However, R&D is where federal policy becomes unified. After much lobbying and a number of studies aimed at exposing this absence of national policy, in 2006 the National Aeronautics Science and Technology Subcommittee emerged (Flight Plan 2008; Analysis of the US Aerospace Industry, 2007, Massachusetts Office of International Trade and Investment, 2007).

Table I.- Institutions Involved in Guiding Policy in the US:

INSTITUTIONS	*FUNCTIONS*
Federal Aviation Administration (FAA)	Regulates civil aviation in order to ensure efficiency and safety in the air traffic control and navigation system for military and civil use. The FAA designs and supervises noise control and environmental impact programs. It handles many funds for research projects in the sector, aimed at developing anti-collision equipment, night navigation equipment and communications.
NEXT Generation Air Transport System (NGATS or NextGen)	Represents an evolution in air traffic control based on the satellite system. With positive effects on safety enhancement, the reduction of delays and a substantial improvement in environmental conditions.
National Aeronautics and Space Administration (NASA)	Organization responsible for space exploration, with a number of R&D programs to create new technologies in the industry. NASA focuses its AI research in the Aeronautics Research Mission Directorate.

Department of Defense (DoD)	Maintains the supervision of military space, infrastructure and equipment, and has a fundamental role in the funding of basic research.
National Science Foundation (NSF)	Federal agency which contributes to the development of basic science and engineering research, with specific research in aerospace.
The National Science and Technology Council (NSTC)	Coordinates ICT policy and specific developments for the sector.
Regional Research Centers Connecticut Center for Advanced Technology	Created with federal support, it helps diverse industries: aerospace and defense suppliers to improve technological capacities and their efficiency in organizations.
Center for Integrated Manufacturing Studies	Belonging to the Rochester Technology Institute, it contributes to the development of various manufacturing industries, for the application of new technologies, business strategies and in organizational management approaches based on applied research.
Florida Center for Advanced Aero-Propulsion Universidad de Florida	Founded by aerospace companies: it raises and improves the quality of the workforce through the design and development of new technologies.
Advanced Materials in Transport Aircraft Structures (Universidad de Washington y Wichita State University.	Founded by the Federal Aviation Administration, it researches advanced materials for commercial use and defense aviation.
Laboratory for Surface Science and technologies organized by the University of Engineering of Maine	With federal and industrial support it has a successful trajectory of basic and applied research in coatings and paint, as well as supporting manufacturers in marketing.

Source: Compiled by the Author.

In spite of institutional and financial efforts, the Commission on the Future of the Aerospace Industry diagnosed the workforce situation in the sector as serious, especially the reduced number of workers. Among the causes are: *i)* foreign outsourcing trends, *ii)* the shortage of young workers attracted to the AI, *iii)* the need to increase learning in sciences, especially mathematics, physics and engineering which are vital to the industry, *iv)* the aging of the workforce. The average age of workers in the sector is 44 in civil aviation and even higher in NASA.

The Aerospace Industry Association (AIA) confirmed the downward trend in employment in its diagnosis, a product of mergers, down-sizing and the location of activities abroad, as well as high wage costs.

To breathe new life into the manufacturing sector and capture part of the added value growth, a broad strategy has been designed that involves changes to taxes, regulations and the social system. The creation of the National Advanced Manufacturing Program is part of the plan, since manufacturing plays a critical role in the economy and the contribution to innovation, employment and the importance of including SMBs. This strategy is broken down into different levels, including: *i)* the control of competitive advantages in Asian countries, with incentive-based tax systems to reduce costs for US producers. *ii)* A revision of standards and regulatory systems that affect productivity levels and discourage foreign investment in the country's manufacturing sector. *iii)* The increased volume and quality of spending on research and development in the manufacturing sector. Fifty percent of the increased investment is directed towards high-tech manufacturing activities and the emerging, increasingly important technology services sector due to its cross impact throughout the manufacturing sector. In parallel to the increased investment, there was an attempt to adjust the composition of research and development spending to emphasize long-term plans, disruptive technologies and the diversification of the portfolio for emerging technologies. *iv)* The spread of a growing number of technology clusters that not only provide a common physical space for ventures, but also a research and management portfolio that facilitates the face-to-face contact essential in the initial stages of the innovation process. *v)* The changes in business strategy against Asian countries, through the removal of tariff barriers and price manipulations that elevate competitiveness, especially that of China.

2. National and supranational networks created at European levels for sector development.

In the last ten years, a policy of partnerships, mergers and acquisitions has totally reshaped the European aerospace industry. In turn, financing for the sector has increased, both from the European Community (EC) and from the states to confront the challenges of global competitiveness (Hualde, A. and Carrillo, J. 2007).

The most important alliance was the creation of the EADS (2000) consortium which occupies second place in production and sales worldwide, and includes major aerospace companies from France, Germany, Great Britain and Spain. The aerospace industry plays an important role in each of the member states with specific government support for the development of clusters that concentrate the advantages for manufacturing and investment in R&D, generating synergies between large companies, SMBs and research centers. The

EU member countries have joined productive, financial research and training efforts to develop a competitive strategy in the aerospace sector. Among the goals pursued are high technology products, whose synergies can be leveraged by other industries. Growth poles are a response that concentrate supplier liaison programs, incubation support and territorial incentives. Despite efforts to accentuate inter-country coordination between different aerospace producers, their own national strategies persist.

Table II: Initiatives Adopted by the EU to Energize the Sector:

INSTITUTIONS	FUNCTIONS
European Aerospace Cluster Partnerships (EACP)	Platform to strengthen communications, initiatives, create networks, make projections and diagnoses on the needs of engineers and industry specialists from member states.
ERA-NET	Complements the EACP with the participation of companies and researchers. There are several funds for fuel research and improvement such as Alpha Bird and SWAFEA aimed at obtaining the best alternative fuel options, including biofuels, and environmental sustainability where it works in conjunction with the **US** COMMERCIAL ALTERNATIVE AVIATION FUEL INITIATIVE (CAAFI) to develop new aircraft fuels.
Hamburg Qualification Initiative	Redirects the recruitment of labor, cooperation in infrastructure for the learning and qualification of the AI workforce. Its purpose is forward thinking and providing highly skilled labor to the industry in the short, medium and long term. Among its activities are: *i)* The generation of university level courses in cooperation with AI sector companies. *ii)* The creation of new courses for technical and professional training in the sector. *iii)* The revision and modification of organizational structures of technical and vocational schools to update their courses and demand levels of quality in their results. *iv)* The organization of university courses for the business demands of the sector. *v)* The development of

	transnational information and learning. *vi)* The promotion of science education programs for children, fundamentally directed towards girls through summer courses.
European Qualification Framework (EQF)	Fulfills a role in the harmonization of technical education policies and the development of skills for the sector.
EU FRAMEWORK PROGRAMMES (VI andVII)	Support a number of research projects directed towards the aerospace sector under the category "Strengthening Competitiveness."
CleanSky Joint Technology	With a public-private collaboration between the European Union Commission and the AI it is directed at the protection of the environment in order to reduce the impact of aviation.
CREATE	Emerged from the 7th Framework Programme with the aim of studying and adopting innovative proposals in air transport.
Advisory Council for Aeronautics Research in Europe (ACARE)	Developed the 2020 Vision for the AI. Among its objectives is the competitiveness of the European AI as a comprehensive strategy creating a research agenda to address the impact caused by emissions and noise, and increase security and efficiency in transport.

Source: Compiled by the Author.

Despite the existence of supranational policies for the sector aimed at coordination between different producer countries, differences persist due the political weight of national strategies that respond to the needs of conserving jobs and the competitiveness of regional clusters. This situation causes the duplication of efforts in research and development activities because of the national, regional and supranational programs whose incoordination is seen as inefficient (European Economic and Social Committee, 2009).

The mobility of the workforce in Europe is lower than in the United States in spite of the incentive policy; to this are added language and education barriers. Hence, the importance of the EACP to develop transnational education and training programs.

3. A successful emerging country in the sector: Brazil.

Brazil is one of the first emerging countries where the AI has strengthened in production, technology development and strategic partnerships in order to position in new markets. It is currently the first emerging country to have manufactured a complete aircraft. In 1941, it established the Ministry of Aviation to provide the air force and civil aviation with the right conditions for technology development. In 1954, the Aerospace Technical Center (Centro Técnico Aeroespacial, CTA) emerged in the state of San Pablo under the auspices of the Ministry of Aviation. The creation of Embraer (Empresa Brasilera de Aeronáutica S. A.) in 1969 emerged with the mandate of producing the Bandeirante aircraft. Embraer is the backbone of the aerospace industry in Brazil; in two decades it has become an important producer of commercial aircraft and a market leader for regional planes. In 1996, Embraer began a steady growth positioning in European, north American and recently the emerging Chinese markets, where it has operated since 2000 (Hualde, A. and Carrillo, J. 2007; Massachusetts Office of International Trade and Investment, Brazil A.I. 2007).

Technology development and research activities for the sector are shared between the Ministry of Defense, which is responsible for aviation programs through the CTA, and the Ministries of Science and Technology, which direct many R&D programs for the sector.

The importance acquired by Embraer was sustained by the coordinated support of government agencies, especially BNDES (National Development Bank) and FINEP (Financial Funds for Studies and Projects), a member of the S&T Ministry whose support covered a large part of the development costs of the ERJ-145/135. The Industrial Technology and Development Program (PDTI) derived funds for the development of Embrear by supporting tax liberalization. Support funding diminished with Embraer's privatization, replaced by indirect support such as PROEX (Export Promotion Programs). These support programs were the reason behind the dispute with Bombardier, which accused Brazil of unfair practices.

Table III: Institutional Structure Supporting the Sector:

INSTITUTIONS	FUNCTIONS
Advanced Studies Institute (Instituto para Estudios Avanzados, IEA)	Development of basic research.

Aviation and Space Institute (Instituto de Aeronáutico y Espacial, IAE)	Research and development.
Aviation Technology Institute (Instituto de Tecnología Aeronáutica, ITA)	Performs training and research in AI-related sciences and technologies.

Source: Compiled by the Author.

IV. Opportunity for the aerospace sector to develop production clusters in Mexico.

Since the mid-90s, programs and tools have been introduced in Mexico to help create industrial clusters in different sectors (automotive, electronics, later biotechnology, ICT, aerospace) and regions (Guadalajara, Baja California, Chihuahua, Querétaro, Aguascalientes). The aim was to facilitate external economies, integrate SMBs either in partnerships among themselves or with anchor companies to strengthen regional economies through improved business and production performance and the creation of new work skills. But the majority of these government-created policies and tools, which have also attracted private support, fail to take into account the assessment of the strategic sectoral scope and specificity that its development requires. This sectoral scope implies identifying the structure and evolution of the productive organization, and the methods adopted in the different locations to assess the impacts on the productive environment and on the development of new knowledge absorption capacities of the companies that form part of the production. These aspects are crucial for designing feasible production chain policies which include benefits and incentives to attract anchor or locomotive companies, identifying which kinds of transnationals are those with suitable conditions (depending on their trajectory) for the development of emerging economies, especially the development of skills to assimilate and enhance knowledge, promote R&D training, and boost the creation of mixed national and foreign companies in priority areas associated with the latest technologies (Casalet, M. 2011).

The aerospace sector is strategic for its contribution to the technological development of the country and the feasibility of mainstreaming intangibles (distribution and marketing) whose cost often represents a large portion of the final price of a good. Information flows that are built with suppliers (especially SMBs) introduce companies to the modalities and requirements which enable their participation in global markets. In 2003, the Ministry of Economy made the decision to develop the space sector in Mexico, launching a strategy to attract leading international companies in order to facilitate their localization in regions with productive and business maturity. However, the strategic sectoral scope remains unclear, in particular the coordination to decide what is produced and how. The integration of a complex system like the aerospace industry is difficult, since it is governed by the logic of large international companies; hierarchical production chains demand a framework of clear incentives to obtain a local supply of inputs and services. In addition to these demands are certification and quality assurance processes which are an industry constant in manufacturing processes, maintenance and auxiliary services.

The arrival of investments from Canada, France and Spain hastened opportunities to move up the production chain, encouraging the entry of Mexican companies into the sector's value chain, achieving two-digit growth in export values in recent years.

The strategic development hubs for the country's aerospace sector, according to the same source, are the states of Baja California, Chihuahua, Nuevo León, Querétaro, Sonora, Tamaulipas and Mexico. The differences between the concentrations of the AI are related to the industrial development of the states, and the existence of an adequate environment to strengthen training and infrastructure capacities, such as the development of competitive factors (promotion of supplier development).

i. Main public and private agents which contribute to strengthening the aerospace sector in Mexico.

The interaction between different international institutions from the public and private sectors has enabled them to form agreements, projects and incentives to encourage interagency collaboration that consolidates: the formation of new skills, the development of technology capacities in sector suppliers, especially the integration of SMBs into production chains, as well as collaboration in research projects involving companies, suppliers, higher education institutions and research centers.

Table IV:
Institutional Framework for Strengthening the National Aerospace Sector

Intermediary organizations with national and state action	*Programs*	*Main actions*
Ministry of Economy	Sectoral program 2007-2012	Formation of production chains; business association; creation of supply; sector export and technological restructuring; boosting businesses; factors

	SMB Fund.	Financing. Business management. Technological innovation. Training. Marketing. Strengthening value chains in Mexico. Linking suppliers to inputs in global chains. Increasing national supply and exports.
ProMéxico.	Production chain program. National Program of Locomotive Companies. Transnational Accompaniment Model (ACT)	Applied in many automotive and aviation companies. Initiatives to generate prospective studies of industrial sectors
Directorate General of Civil Aviation (Dirección General de Aviación Civil, DGAC), under the Ministry of Communications and Transport (Secretaría de Comunicaciones y Transportes).	Aviation authority. 1950 first civil aviation regulations, Aeronautical Telecommunications and Radio Aid Regulations, Search and Rescue regulations. 1952 Mexico signed agreement with the ICAO. Supervises the everyday functioning of the sector.	Checks aviation and airport security measures (Safety y Security). Airport surveillance, issue of permits, authorizations, licenses and certificates to air transport companies. Compiles information and statistics on air transport.
Conacyt.	Innova SMB programs. Pro Innova. Innovatec.	Financial support programs for large companies, SMBs and public research centers to generate innovation-related jobs. Support for the aerospace and aviation sectors.
	Strategic Alliances and Innovation Networks Program for competitiveness (AERIs).	Interinstitutional coordination to encourage innovation networks. Prospective and market studies.
	Strategic Alliances and Innovation Networks Program (Alianzas	Exchange platform between researchers, business owners and the public sector.

	estratégicas de redes de innovación, AERIs)	
	Thematic Network of Space Technology Knowledge (Red Temática de Conocimientos Tecnológicos Espaciales, RTCTE).	Competitiveness of the Mexican aerospace industry UNAM, IPN, Ciateq, Cicese, UABC, INAOE, Global Star México, Satmex, AMC, Cinvestav (Guadalajara).
Mexican Aerospace Agency.	Created in 2009.	Holding forums and construction of a working agenda for the sector with public, private, and academic actors to develop a state policy on space.
Mexican Counsel of Aerospace Education (Consejo Mexicano de Educación Aeroespacial, Comea), independent, academic body, created in 2007.	First national academic research network related to the aerospace sector.	Diagnosis of the aerospace industry. Identification of professional skills. Education program, joint updating and training (Comea and Femia).
International bodies (PNUD Mexico).	Supplier development program.	Approach to reduce the learning curve and generate greater impact on the education of human resources.
	Certification program for special processes.	Integration of SMBs to the aerospace, automotive, electric and electronic sectors.
	Mexico-EU Collaboration agreement with the Integral Support Program for SMBs (Piapyme).	Collaboration between Mexican SMBs and European companies, aerospace sector, jointly with Femia. Certification of space processes for SMBs. Nadcap standards, SAE, AS9100.
Business organisms with public/private action.	Establish a national strategic aerospace plan.	Jointly with Comea. Development of training programs.
Mexican Federation of the Aerospace Industry (Femia), non-profit	Help the integration of the national aerospace industry. Obtain incentives and tariffs for aerospace products.	Maintenance and manufacturing products. Analysis of relevant legislative trends.

civil association (2007).	Events and seminars.	Sector diagnosis at national and international level. Lobbying to organize a single government agency responsible for acquisitions in the sector.
Mexico-US Science Foundation (Fumec).	Programs in emerging, high potential niches.	Support to the aerospace sector: – Diagnosis of strengths and opportunities. – Financial assessment to connect companies to investments. – Basic consultancy to assess an international business – ICT, financial and manufacturing plans. – Connection with TechBa for business units in Seattle and Montreal.
	TechBa – Business accelerator program (ME).	TechBa is installed in highly competitive, strategic areas: Sillicon Valley, Austria, Montreal, Madrid, Michigan, Vancouver, Seattle.

Source: Compiled by the Author, based on interviews and analysis of documents from the institutions mentioned.

The table above indicates the institutional decision to establish programs that trigger collaboration and research networks, and basic training and investment to consolidate the aerospace sector. On one hand, the action of public policies sets new trends in motion aimed at creating productive clusters for the sector, where the focus of attention shifts to group intervention strategies that identify advantages and whose implementation is supported by public resources. Meeting the needs of a productive cluster provides a better framework for designing and organizing the provision of services and channeling support instruments, given that they are aimed at group demands and focus on interdependent requirements. On the other hand, productive coordination operates indirectly across local and territorial advantages since both sector and territorial dimensions function systemically and are interrelated.

Table IV shows the action of intermediary organizations and/or programs that act as such (especially AERIs and the thematic networks implemented by CONACYT and the Mexican Aerospace Agency). The importance played by regional and sectoral intermediary organizations grows as a negotiation and liaison structure to make an effective link between universities, technology centers, industry and the public sector. The new paradigms of knowledge and competition processes in production increase not only the macro, meso and micro complexity but the need for greater complementarities. Such aspects require the impulse of national and state public policies, such as transformations in the management structure of universities to adapt to the challenges of knowledge transfer.

V. Dynamics and agents that form the aerospace cluster in Querétaro.

The networks that are built in the regional sectoral cluster in Querétaro stimulate collective learning and tacit knowledge transfer processes; exchange relationships are informal, with frequent contact that opens reciprocal enrichment opportunities, especially for the mobility of the labor market. Proximity helps to facilitate absorption capacity, exchange and training since it reinforces more or less permanent relationships with universities, research centers, national and transnational companies, technology institutes, intermediary organizations and public sectors. Amid this institutional complexity, intermediary organizations emerge which act as a regional, sectoral and national negotiation and liaison structure to make an effective link between universities, technology centers, industry and the public sector. The construction of networks is fundamental to the knowledge transfer process to facilitate communication and exchange between the productive, academic and public agents whose interrelation expands the social capital of the region. Intermediary institutions may be universities, public research centers, business associations or functions that are fulfilled within an organization to operate on different macro, meso or micro scales; they help to create conditions to support the sector in the training needs of businesses. In the literature on knowledge transfer, the role of intermediary organizations is an emerging theme; previously it was widely covered in the explanatory literature of public policies related to production and business promotion (Casalet, M. 1995; Casalet, M. 2011).

The aerospace sector is a complex production model of industrial organization where the local supplier network is tied to an assembler that operates as the leader. Relationships with these locomotive companies are important because they play a central role in fostering the competitive progress of local companies through the transfer of skills and technologies. Industry products are manufactured in a modular process: the design is broken down into several modules connected by standard interfaces, which, once assembled, form a complex system, while the modules are allowed to evolve, improve and change according to the actions taken by the suppliers (Aviation Week, 2009). Standardized production over time in all countries was made possible by the use of common platforms and models. As a result, assemblers demand a globally competitive service from their suppliers, with nationally and internationally established standards. The presence of locomotive companies in regional clusters (Baja California, Chihuahua, Querétaro) creates room for the competitive development of local businesses in specific niches, in spite of the quasi-hierarchical organization of the production chain. The locomotive companies that operate in the cluster have finalized agreements and support for workforce training and the improvement of supplier companies. These efforts would indicate that the objective is not only to leverage lower labor costs, but to combine the knowledge capacities of their environment with those of the country where they are located to form new knowledge flows and increase productivity. International OEMs located in the country have greater productivity and more efficient work organization since they have the know-how, proven in many international crises and different countries. But there is a diversity in behavior; not all locomotives transmit technologies and create a beneficial effect, neither do all countries and regions have a threshold sufficient to absorb the processes and technologies demanded.

Federal and state governments have played an important role designing and rolling out programs to promote the aerospace cluster, especially to attract leading companies. The methods they use include the establishment of preferential import and export tariffs for

goods for aircraft, components, machinery and equipment. The creation of an incentives infrastructure for the location of anchor companies (industrial parks, import tariffs, adaptation of airport runways to receive high-tonnage aircraft, the construction of cargo and passenger terminals, inland clearance depots and bonded areas). Furthermore, it contemplates the incentive to put SMBs into conditions of solvency in terms of technology and certification. The Financial Solutions Program of the State of Querétaro was created in 2009 to support SMBs, complemented by the Productive Coordination and Development of Local Suppliers Program (El Programa Articulación Productiva y Desarrollo de Proveedores Locales) and the federal SMB Fund (Fondo PyME) to strengthen the state SMB Fund.

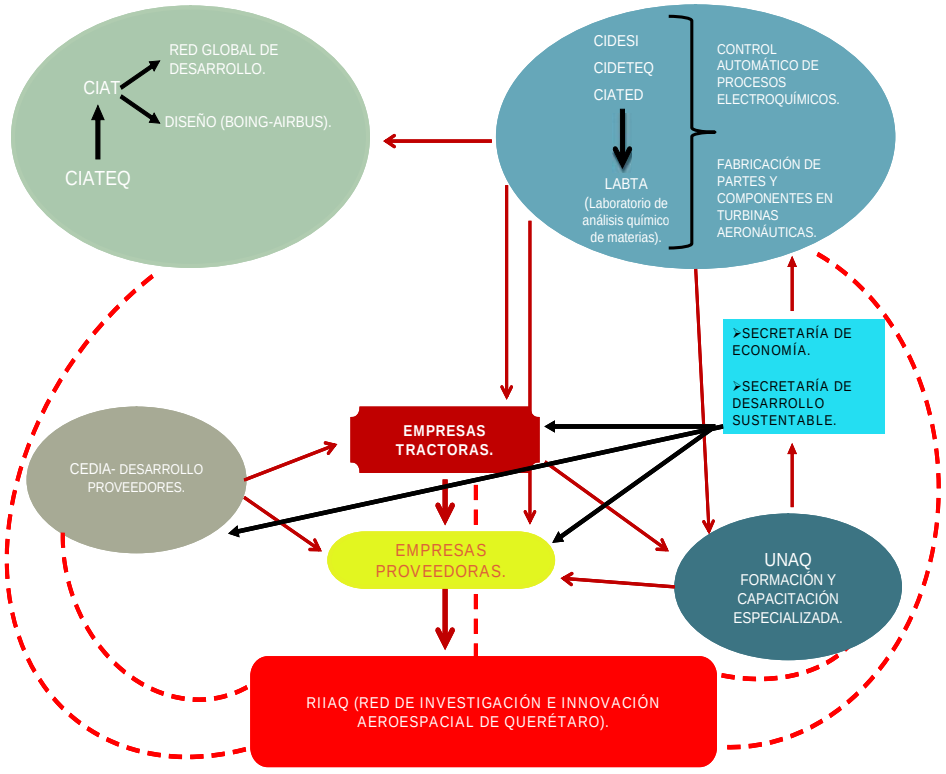
VI. Organizations associated with the creation of sector innovation networks in Querétaro.

The densification process of innovation networks generated fluid collaboration relationships between universities, Public Research Centers (PRC) and sector companies to develop new forms of collaboration, which gradually strengthen the bonds of trust - they build social capital and facilitate the acquisition and transfer of new knowledge. The use of different knowledge transfer channels presents peculiarities that depend on many factors, the most important of which include: *i)* the technological complexity of this production sector, *ii)* the opportunity to make use of financial, training, computer and marketing support, *iii)* the feasibility of integrating local suppliers into the regions of insertion of the sector, *iv)* the existence, or not, of a path linking institutions, especially research groups with experience in exchanges with the industry, in general started informally (out of the personal interest of the researchers) and which later give rise to the formalization of agreements to resolve incentives and generate new and longer exchanges.

The coordination structure between different players (public, private) is a field of mutual influence (Le Breton, R. 2004) to increase exchanges and knowledge transfer (university/businesses/public sector) (Cooke, P. and Leydesforff, L. 2006). But there are effective relationships such as in the acquisition of technology and in product marketing where exchanges with external agents, particularly foreign companies, gain importance. Also, as some authors suggest (Levy, R. and Talbot, D. 2010), proximity can induce the consolidation of control mechanisms, to imprint consistency between differential positions and interests. Where locomotive companies fulfill a central role due to the strategic management they develop in the integration of the production chain.

Figure 1

Institutional Support Network to the Sector in Querétaro



Developed by the Author.

The figure above suggests the coordination of an important support network created to respond to specialized training, research and knowledge transfer whose potential in exchanges and products helps to strengthen the aerospace sector in Querétaro.

VII. Final thoughts.

In the development of this work, we identified the efforts of different agents to incorporate and expand the aerospace cluster in the country. The nature of the aerospace industry and the organizational management determine the working structure and competitive progress achieved internationally, characterized by mergers, new acquisitions and a steady international expansion to maintain competitive advantages. In this industry, the business network of local suppliers is closely tied to an assembler who operates as the leader. We also identified the nature of the intervention of national and state policies aimed at installing the main equipment manufacturers, such as higher level supply companies.

The concentration of anchor companies has quickly become tied to the creation and/or restructuring of an organization to facilitate specialized training, infrastructure and incentive support, and the diffusion of specialized knowledge and information. This circulation of knowledge strengthened the informal knowledge exchange channels provided by the proximity of the Querétaro cluster. The creation of more formal channels (between PRC and companies) ensured access to the international certification and standards that govern the sector. The technical support, of credit and incentives, were designed to

incorporate local suppliers to improve their productive processes with the required quality and safety, and increase product delivery times.

The interventions of ProMéxico and the Ministry of Economy have played a significant role driving demand and promoting the insertion of anchor companies in a strategically important sector for the country. CONACYT, through different programs, has tried to strengthen the demand for knowledge, together with state institutions (UNAQ, CEDIA) and Public Research Centers (CIDESI, CIATEQ, CIDETEQ) that provide highly skilled personnel training for the aerospace sector, as well as initiating joint research projects. In turn, CONACYT programs such as INNOVATEC, InnovaPyme, ProInnova support companies and research centers directly by strengthening partnerships, reinforcing yet another way to consolidate a relational innovation culture. Although at this time, collaboration in joint projects is very much a commitment of large companies, it is essential to incorporate SMBs, especially those with the potential to evolve and be integrated into the supply chain.

The multiplication of the action of different organizations that play an intermediary role and contribute to the application of national public policies, not only provides a directory to integrate national suppliers and support to ensure their participation in international events of the sector, it also helps to establish networks with international suppliers and certification institutes: PNUD-Mexico focuses on the liaison and development of suppliers for different productive clusters and especially the aerospace sector; FUMEC makes a diagnostic and prospective contribution to the coordination of the aerospace sector in the State of Mexico and to the generation of linkage networks with companies in Canada through TechBa-Montreal (Arechavala, L., Marín, E. and Méndez, J. L. 2010), and FEMIA which as a business association in the sector plays a role of liaison between integrating and local companies. Changes in the design of public policies establish new strategies, some arising in the application of prospective studies (ProMéxico) which go beyond macroeconomics and encompass proactive programs and incentives to produce structural changes in institutions and in the behavior of companies and the scientific community. Given that the strategic decisions adopted are based on: *i)* establishing growth priorities in productive sectors; *ii)* promoting the multiplication of public-private collaboration networks at regional and sectoral level, encouraging the formation of industrial clusters, *iii)* fostering the mobility of graduate students and researchers in companies, *iv)* generating public support to increase the capacity of companies to develop innovation, improving productivity and quality, such strategies forge the re-engineering of new networks, which affect the transformation of educational institutions, Public Research Centers and technology institutes. A consequence of these initiatives would lead to the idea that horizontal public policies are insufficient and specific, selective policies and institutions are needed aimed at defining the profile of specialization. Selectivity appears as a central aspect considering the existence of specific, dynamic technologies with distinct techno-economic problems and different ways to solve them.

In spite of the improvements already made, in the creation of public programs and initiatives, there are still serious obstacles in the systematization of information concerning the results obtained, the evaluation of the scope and effect of transfer and collaboration methods started between companies and the supply of research.

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