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Coproduce or Codevelop Military Aircraft? Analysis of Models Applicable to USAN*

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The creation of the Union of South American Nations (USAN) aroused expectations about joint development and production of military aircraft in South America. However, political divergences, technological asymmetries and budgetary problems made projects canceled. Faced with the impasse, this article approaches features of two military aircraft development experiences and their links with the regionalization processes to extract elements that help to account for the problems faced by USAN. The processes of adoption of the F-104 and the Tornado in the 1950s and 1970s by countries that later joined the European Union are analyzed in a comparative perspective. The two projects are compared about the political and diplomatic implications (mutual trust, military capabilities and regionalization) and the economic implications (scale of production, value chains and industrial parks). We argue that both processes generated convergence, though countries involved already shared threat perceptions and a military alliance, which compelled them to cooperation. Thus, the successful joint development of military aircrafts within USAN would require a previous level of convergence not yet achieved.

Keywords: Military cooperation; aircraft development; USAN; UNASUR; UNASUL.

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The creation of the Union of South American Nations (USAN) has driven the debate on defense cooperation. Despite the advances in favor of a South American defense identity and the establishment of mutual trust (SOARES and MILANI, 2016), since the regional arrangement does not aim at integrating defense structures that still operate within the national framework, the cooperation becomes an alternative among the members. In this sense, the institution came to devise the development of defense products, whose production and common use foster cooperation and efforts of mutual trust among its members. Those were the main purposes of the development of a light military training aircraft, UNASUR-1, and the design of a regional unmanned aerial vehicle (UAV)[1].

However, the development of these products has been going through a succession of obstacles. Part of them is precisely on the divergences regarding the perception of threats among the bloc members, in the competition for regional leadership and in the asymmetric and limited technological and productive capacity of the South American aviation industry. Moreover, there is the presence of external actors in the region that can influence the decision-making process.

South America countries show several asymmetries in aircraft development and production capability, which are accentuated for military aircraft. Somewhat similarly, the post-Second World War in Western Europe, while countries as France had the cutting-edge technology, developing and improving their existing bases during the war, countries as Germany lost their ability to develop defense materials. However, Italy, which had limited capacity, still reduced its technology park, depending on the material supply from external sources. Technological gaps, asymmetries among the actors and the condition of relative subordination from Western Europe to the interests of the United States during the Cold War are relevant elements for thinking on models of cooperative arrangements for the USAN countries, since these countries were able to develop and produce military aircrafts based on cooperation.

During the second half of the 20th century, Western European countries undertook several cooperative production programs of military aircrafts. The well-known SEPECAT Jaguar and Eurofigther Typhoon are just two examples of such

[1] The KC-390, a military transport aircraft developed by Embraer with international partners, could be presented as a success case by USAN. However, its design predates the creation of USAN itself and, despite the purchase intentions signed by Chile and Colombia, only Argentina participated in the development and production of the aircraft in the region.

practice. In this study, it was chosen to approach two military aircraft development programs with different arrangements that generated impact products in the international scenario, both by their arrangement design and established links among members, as well as by the final product: the F-104 'Starfighter' and Panavia Tornado.

The differentiated architecture of each of these programs allows describing them as two distinct cooperation models; one vertical and based on the production licensing of an existing aircraft and the other horizontal and based on the codevelopment of a new aircraft. Each experience involved significant political, technical and economic externalities for the actors. The political aspects are related to the gains, both for the cooperation and by aircraft possession and its combat capacity. The technicians concern to the domain of technologies, industrial innovation and productive capacity. In economic terms, industrial capacity has resulted in the formation of value chains and work force specialization.

During the Cold War and its arms race, based on the incorporation of new technologies, the costs and risks of military aircraft production have made the development of complex systems for many countries almost unviable (CREVELD, 2000; STURGEON et al., 2014). Faced with a scenario of extreme competition, cooperation in the sector became a possible alternative among countries that had the perception of common enemies, since it divided costs and multiplied demand.

Although countries were ultimately seeking to secure their particular interests in an anarchic and competitive environment, cooperation proved to be an alternative to the high cost of acquiring cutting-edge technologies and combat capabilities. Thus, it was possible to create an environment where all participants won in some respect. After all, cooperation, when successful, operates as a process in which the involved actors obtain, besides something material (the product or the objective of cooperation), the creation of a subjective good: closer ties among the participants. Cooperation processes, in turn, face constraints and obstacles from a different nature and can be arranged in different ways, which makes the understanding of experiences relevant to thinking about the present challenges. In methodological terms, this research analyzed the political, diplomatic and economic variables of two different designs of cooperative production arrangements of military aircrafts. Since they are two cases investigated by the specialized literature, this research used secondary data extracted from the bibliography. The comparison purpose is to extract inferences applicable to USAN.

Therefore, the present study was structured as follows: in the first and second parts, we present an analysis of the arrangements for the adoption of the fighter aircrafts F-104 and Tornado by the involved European countries. We focused on political and diplomatic aspects, such as mutual trust, expertise development, and regionalization. We also paid attention to economic implications, including scale, value chains, industrial parks, and technology. In the third part, features of these programs are discussed, whose understanding can be useful for a better design on the aviation cooperation programs of the USAN countries. In the final section we present our conclusions and some brief recommendations.

Coproduction arrangement of the F-104

The aircraft design that would originate the F-104 was devised as an American response to the performance of the Soviet Mig-15 used in the Korean War. A simple, lightweight and cheap fighter aircraft was sought and should be faster than any other of that time (FERNÁNDEZ, 2007, p. 07). For this study, more relevant than technical innovations of the F-104 are the political and industrial arrangements adopted for its production. In this respect, the United States, mainly through Lockheed, developed and produced the first versions and then scaled partners in allied countries for regionalized production, with a view to providing North Atlantic Treaty Organization (NATO) with greater levels of rationalization, standardization and interoperability of weapon systems. Among the main partners of Lockheed were the Italian Fiat, which also produced for Taiwan, Netherlands and Federal Republic of Germany (FRG); the German Messerschmitt[2], which after supplying to the FRG Air Force and Navy, forwarded fighter aircrafts to Turkey; the Dutch Fokker, which also supplied to the FRG; the Belgian SABCA, which produced versions for Denmark, and finally the Canadian Canadair, which manufactured units for Canada, Norway and Spain (BOWMAN, 2000). Mitsubshi also produced, under license, F-104 fighters for the Japanese defense forces.

The initiative was part of a shift in the US arms transfer pattern to its European allies in which donations were gradually being replaced by sales (MOTT IV, 2002; TAYLOR, 1982). In the early 1960s, besides the F-104, the United States produced the missiles Hawk, Sidewinder and Bullpup, the Mark-47 torpedo, and the M-72 anti-tank weapon jointly with European countries. These programs made it possible to

[2] In the 1960s, the Messerschmitt was renamed Messerschmitt-Bölkow-Blohm (MBB).

Washington reduce the resources intended to arm European allies (which would then be redirected to the Third World) and secured important contracts for US defense industries, albeit with a significant technology transfer (KAPSTEIN, 1992). The training of partners in the parts manufacturing for the F-104 aircraft and the development of future fighter aircrafts with structural parts common to Starfighter intended to produce aircrafts at a lower cost, with greater scale, and to meet all NATO members.

Partnerships were established with Lockheed providing assistance, primarily by training and licensing parts manufacturing, and after the production of a limited number of aircrafts (MILLER, 1995, p. 68). This policy, which aimed at standardization, assisted the formation of a network productive capacity and cooperation networks, both in technical and economic/logistical terms. In economic terms, there was a consolidation of a logistics system that showed greater demand, by the number of users, as well as by geographical proximity, in the European case.

It is important to point out that France and the United Kingdom produced jet fighters autonomously and were able to consolidate their industries from domestic demand or exports, besides competing with US products. However, other NATO members with more limited capabilities perceived in the F-104's vertical production model an opportunity to implement nationally produced systems, even dealing with an American design.

With the option of a fighter aircraft that meet the interests and with acquisition facilities due to the low cost, the F-104 became the standard NATO fighter operated by most members. The adoption of production licensed by the FRG also contributed to the resolution of tensions within the coalition. After FRG decided to buy and produce the model, it paved the way for other local purchases and productions, especially in the late 1960s with the policy so-called "autonomous and indigenous defense". In this respect, for the United States, the F-104 production by its allies converged with what would later be the 'Nixon doctrine', which sought to transfer to the Allies the main costs of conventional defense while the United States would keep the commitment to provide nuclear deterrence (MEIERTÖNS, 2010, p. 143).

On the other hand, the joint production of the F-104 was an United States' offset to demonstrate to the partners its efforts to build mutual trust beyond the simple arms transference programs. It should be considered that the fighter aircraft would comprise not only the defense of the operated country, but also assist the joint defense of the

other bloc members. The F-104 operators had an element that aligned the shared production system, logistics structure, human resources (pilots, mechanics, technicians with standardized training) and, if necessary, the aircrafts themselves.

Although the United States was largely responsible for the arrangement and strategically and economically benefited, the activation of the European partners' aviation industry and the resumption of the capacity to produce high-tech weapons in the region had significant economic and political impacts. This cooperative arrangement is highlighted as the means by which the bases of defense industry began to act not only for the domestic favoring of each involved nation, but in the regional set, building what is now called global value chain, adding new technologies and capabilities to partner industries, such as the production of wing kits and air intake by German industries, which was lost at the end of World War II. The integration of networks and supply chains, facilitated by the common use of the aircraft, drove the activation of European defense industries, which reached another level from the partnerships for the model production. On the other hand, its adoption was a serious setback to the French industry, which produced military aircraft independently and intended to export them precisely to European neighbors that joined to the F-104 coproduction (KAPSTEIN, 1992).

For the United States, the adoption of the F-104, according to the shared production model (under manufacturer's license), meet both its cost-sharing objectives and the widen economies of scale and thus the aircraft availability. For the involved European countries, the creation of institutions for management of the F-104 program began to consolidate cooperation channels that facilitated both the development of later cooperative experiences and what would become a self-defense identity for the region. Such an identity included the construction of some level of regional autonomy before the transatlantic ally, while seeking simultaneously to assert itself as a bloc, with the development of complementarity and the community of its policies. Based on the F-104 circumstances, the referred European countries depended on a strong partner to provide their defense, since their industrial base depended on support due to the lack of resources (TAYLOR, 1982).

It is important to note that the effort to reduce dependence on the United States had already been evident since the creation of the Western European Union (WEU) in 1954, in which European countries began to develop a concept of

autonomous defense forces in relation to the US, seeking, in parallel with NATO, the reestablishment of its industrial base and the development of domestic supply chains, mobilizing its entire industrial complex. To this end, parallel institutions were created in each of the security aegis: NATO created the NATO Maintenance and Supply Organization (NAMSO), with the objective of maintaining the supply chain within the organization under the command of the Allied Force in Europe; and the WEU created the Independent European Program Group (IEPG) with the aim of developing common European defense materials in the near future (RÜHL, 1999, p. 25).

The F-104's coproduction arrangement made it possible to Europe qualifying its industrial base, even though a production system ordered by a power outside the region, which also allowed the USA reducing the financial contribution for the European defense upkeep (MOTT IV, 2002). At this point, based on economic rationality from a supply chain with common fighter aircraft, Europe has regionally experimented the positive economic impact of shared defense systems as an alternative to escalating defense costs. The size of the production scale can be observed in the table below, which presents the number of aircrafts produced by each partner.

Table 01. F-104 aircrafts produced in each country

Country	Produced aircrafts
West Germany	283
Belgium	198
Canada	340
United States	737
Netherlands	354
Italy	417
Japan	207
Total	2,536

Source: Adapted from Bowman, 2000.

The option for a common fighter aircraft, or even standard defense means, has its advantages; however, there are also relevant obstacles. One of them is the very limit of the standardization of a combat aircraft, since different national requirements and operational concepts, industrial objectives and budgetary considerations generally lead to divergent configurations and tough synchronization (LORELL and PITA, 2016, p. 07). Another important element is the very definition of the national interest of European partners that, after completed the post-war

reconstruction process, have been devoted to seek a greater autonomy from the United States. In this sense, according to Lorell and Pita (2016), "once European national industries fully recovered from the destruction of World War II, the leading European powers rejected licensed production of U.S. systems and sought to collaboratively develop indigenous systems" (LORELL and PITA, 2016, p. 34). This was the scenario that led to a new joint production model, now with development, that came to be adopted with the Panavia Tornado.

Codevelopment arrangement of the Tornado

In 1968, the FRG, Netherlands, Belgium, Canada and Italy formed a working group within NATO in order to develop an aircraft to replace F-104; the project was named MRA-75 (Multi-Role Aircraft - 1975). At the end of the same year, England also joined the project, which was then called MRCA (Multi-Role Combat Aircraft) (GUNSTON, 1980, p. 14; LUCCHESI, 2007, p. 46). Inasmuch as studies and definitions of the new fighter aircraft were developed, some partners gave up, remaining only FRG in the group (with intentions for both the Air Force and the Navy, as with the F-104), England and Italy. Some countries that abandoned the MRCA project adopted the US F-16 in terms similar to the F-104 with respect to the coproduction arrangement (BURIGANA, 2011, p. 91).

The Tornado project was developed within a convergent sphere of interests shared by NATO European member countries that sought a greater level of autonomy (within the alliance) and the development of productive capacities, which was performed cooperatively. The choice to develop and produce jointly the aircraft was due to the increasing cost of developing high-tech weapons systems, such as supersonic fighter, and the constraints of each partner's domestic markets that hindered large-scale production gains. In this respect, they differed from France, which even having greater capacity, opted to maintain the autonomous production of combat aircrafts by scaling through exports[3].

Tornado was the product resulting from the largest military aircraft development program in Europe until the 1990s. The program involved tri-state cooperation both in developing a high-complex arms system and in integrating part

[3] Aircrafts like the Dassault Mirage III fighter were widely exported in several versions to countries as Australia, Israel, South Africa, Argentina, and Brazil.

of the supply chain and association among industries, creating two new consortium companies: Panavia Tornado, responsible for the aircraft development and manufacturing and Turbo-Union, responsible for turbine production. The consortium has joined capabilities with British Aerospace (currently BAE Systems), Messerschmitt-Bölkow-Blohm (currently Airbus Group) and Alenia Aeronautica (currently a division of Leonardo) from the United Kingdom, Germany and Italy, respectively. The tri-national aspects of the program were managed by a special agency created for this function, the NATO Multirole Combat Aircraft Development and Production Management Agency (NAMMA).

In the fixed arrangement, each nation defined its pre-established aircraft demand, ensuring project sustainability. Considering the enterprise complexity, the varied demands from each partner and the asymmetry of their capabilities, it is important to highlight two aspects of this arrangement: the definition of a joint management structure, in which the Panavia Consortium was created, and management of capabilities, which allowed taking advantage of expertises that each project member already had, so that their participation represented gains in relation to value and capability aggregation, besides representing the actor in the project.

Thus, British Aerospace was responsible for the front section (nose cone, cockpit and part of the avionics) and the tail section (tail cone and empennage). The MBB produced the central section (wing pivoting mechanism, wing box and engine bay). Finally, Alenia was responsible for the wings and simpler components. The distribution of coproduced aircraft according to operators and versions can be observed in Table 02.

The development and production arrangement of the Tornado differs from previous experiences in Europe by creating two companies and a project management agency, thus contributing to increased integration in a particularly sensitive sector and in a region with a long history not only of mistrust, but also of conflicts. The existence of a shared perception of a security threat from the Soviet Union and competition with the United States aviation industry were important forces in favor of cooperation and for overcoming divergences and asymmetries.

Table 02. Versions produced, operators and quantities of the Tornado

Model	United Kingdom	FRG	Italy	Total
Tornado IDS[1]	228	322	99	745
Tornado ECR[2]	-	35	16	51
Tornado ADV[3]	170	-	-	194
Total produced	398	357	115	990

Source: Adapted from EVANS (2009, p. 62) and http://www.panavia.de/aircraft/overview/variants/.
Notes: 01. Variant intended for interdiction and strike; 02. Variant for recognition and suppression of enemy defenses (Electronic Combat/Reconnaissance); 03. Variant intended to hold air superiority (Air Defense Variant).

It should be noted that there was considerable asymmetry among partners regarding expertise and capabilities in the aerospace and defense industry. England was the most advanced, having already developed missiles, bombs, training jet aircrafts and high performance fighter aircrafts, besides civil and military transport and helicopters. Italy already produced light jets, medium-lift military transport aircrafts and helicopters. FRG had industrial capacity, but only assembled licensed models and passenger jet aircraft.

By looking at the industrial park and the production capacity of countries involved in the Tornado program, it can be noted that there was increases, both in quality and in size and capacity for the development and production of military equipment, mainly due to the decrease in dependence on US origin material and the development of follow-on projects by partners. This can be observed in the production of sophisticated weaponry, such as the Skyflash air-to-air missile, the JP233 submunition dispenser, and improved launch vehicle systems for use in the Tornado. The gained expertise influenced several other aircraft projects, including with other partners, such as the AMX developed by Italy together with Brazil in the 1980s.

The program reinforced mutual trust and defense identity between partners, particularly with regard to doctrine, training and standardization, since the employment tactics of the versions were common to operators. The Tornado development was based on the asymmetry of the industrial base of partners and sought to overcome this fragility by establishing a complex interdependence structure in defense industries and the relative conformation of a basis for mutual trust.

When the operational requirements of the MRCA were planned, an aircraft was defined that would fly very low and fast, in order to prevent a possible Soviet advance, which resulted in the larger volume of Tornado jets produced in the versions IDS and

ECR. However, the English insisted on an intercepting variant ADV. These operational definitions also affected the European partners' relationship with the US. Prior to the MRCA development, within the F-104 replacement-working group, Germany and England analyzed the US F-111 for the in-depth attack task. The model was supported by the US, interested in being present in the European market and expanding the scale of its production lines, but as the F-111 did not meet the British requirement of interception capability, joint development opted for a new fighter aircraft (BENNELL, 2002, p. 18). An independent European defense market was beginning to consolidate, with institutions facilitating the development of the regional community and the defense identity. Besides qualifying and integrating the industrial defense base, the Tornado also consisted of a platform for new technologies, which was partly innovative for the period. Even currently, after updates, the fighter aircraft remains operational.

Another important aspect related to the arrangement adopted with the Tornado concerns the relationship between States and companies. The practice of maintaining subsidized 'strategic' national companies was replaced by the establishment of two tri-national consortia (Panavia and Turbo-Union) and a demand level capable of keeping these companies and their suppliers sustainable, primarily with regional demand and then with the export to Saudi Arabia in the 1980s.

One of the greatest difficulties of the Tornado program was the definition of the final model. The uncertainties and demands of partners led to the creation of several versions of the aircraft, including the national participation requirements of each major partner, thus increasing the number of companies involved in the project. This differentiation generated losses in terms of economies of scale and, with the increase in the number of involved suppliers, increased transaction costs. However, this was compensated because the involved companies started to act as pools, i.e., bringing together other smaller companies with specific capabilities as system integrators, resulting in the current big European conglomerates. Thus, programs as the Eurofighter, the A-400 and the EADS/Airbus aerospace and defense conglomerate can be considered among the unfolding of accumulated experiences and developed capabilities.

Lessons for USAN

South America has a strategic environment characterized by the low frequency of interstate conflicts over the last century, modest defense budgets and a recent effort

to build mutual trust and defense identity within USAN, expressed in the coordinated action in regional crises and jointly with the UN Stabilization Mission in Haiti. However, the region's armed forces operate almost exclusively in the traditional national framework, with little cooperation and almost without integration. Another important characteristic of the regional panorama is the presence of the United States, the main supplier of defense materials in most countries that, during the Cold War, sought to standardize the armed forces of Latin America (PACH, 1991). Since then, the United States has sought to influence the regional defense agenda by promoting issues of their interest, such as combating 'new threats', focused on securitization of the drug problem (SVARTMAN, 2014).

This is complemented by the fact that the countries of the region are technologically dependent, being their economies very much focused on primary-export and with sharply unequal societies. When observing the productive capacity of the aviation defense industry of the South American region, there are large asymmetries, but comparable to those observed in Europe between the years 1950 and 1970, the period of the analyzed programs. The main aviation industries installed in South America have the following capabilities: Colombia has CIAC (Corporación de la Indústria Aeronáutica de Colômbia) as the main aviation company, focused on maintenance of military aircrafts and production of parts in several supply chains. Argentina has one of the oldest aircraft development and production structures of South America, whose main industry currently is FAdeA (Fábrica Argentina de Aviones); originally state-owned, it was privatized in the 1990s and nationalized again in 2009. Currently, it operates in Embraer's supply chain and other companies. Chile has a state-owned company ENAER (Empresa Nacional de Aeronáutica), responsible for the maintenance of civil and military aircrafts and aviation turbines, besides producing parts in several supply chains). The Brazilian park is largest and most diverse, housing companies as AVIBRAS (manufacturing of parts and systems for other companies), Helibras (specialized in licensed helicopter manufacturing, currently is a subsidiary of Airbus Group), Mectron (develops missile systems), AEL (the Israeli subsidiary of Elbit, develops avionics and onboard systems), Aeromot and Novaer (manufacturers of glider and light aircrafts), and Embraer (4th largest aviation industry worldwide). This overview can be summarized in the Table below.

Table 03. Main aviation military industries in South America

Country	Company	Employees	Revenues (million US$/year)	Products/services	Customers
Argentina	FAdeA	1,700	100	Maintenance Modernization Manufacturing of parts and components	Argentine Air Force Embraer
Chile	ENAER	875	47	Maintenance Manufacturing of parts	Chilean Air Force Embraer EADS
Colombia	CIAC	280	3.8	Maintenance Modernization Manufacturing of parts and components	National Police Colombian Air Force
Brazil	AEL Sistemas	270	39	Avionics Communication systems VANT	Brazilian Air Force Embraer
	Avibras	1,815	447	Guided rockets Control and shooting systems VANT	Embraer Brazilian Air Force Brazilian Army
	Embraer	19,000	5,900	Aircraft manufacturing Modernization Maintenance Control systems	Brazilian Air Force United States Colombia Chile Indonesia Egypt United Kingdom
	Helibras	540	140	Aircraft manufacturing Maintenance	FAB Brazilian Navy Brazilian Army

Sources: (FERREIRA, 2016); MILITARY BALANCE, 2013; www.globalsecurity.org; www.sipri.org; reports of the respective companies available on their websites.

Table 03 clearly shows the asymmetry when comparing the number of employees and annual revenue of companies. Although in the past FAdeA and ENAER have manufactured (and even developed) military aircrafts, currently only Embraer and Helibrás produce manned military aircrafts. Consequently, most of the installed plant is dedicated to the manufacturing of parts and components of aircraft and/or the execution of maintenance and modernization services. It is important to emphasize that despite its size, only approximately 15% of Embraer's revenues come from the defense

sector (FERREIRA, 2016), which does not change its position as the largest company in the region. In any case, this company exerts a strong nucleus value chain not only in Brazil, but also in South America, since FAdeA and ENAER are suppliers and the CIAC provides maintenance of the Colombian Super Tucanos. Another important characteristic of the industry is that the main client of the companies are the armed forces of their countries, in which only Embraer has external clients.

Table 04. Exchanges of military aircrafts and air systems (2000-2016)

Exporter	Importer	Quantity	Designation
Argentina	Uruguay	1	IA-58A Pucará
Brazil	Argentina	1	Bell-212/UH-1N
	Bolivia	10	T-25 Universal; Bell-205/UH-1H
	Chile	16	AS365/AS565 Panther; EMB-314 Super Tucano
	Colombia	25	EMB-314 Super Tucano
	Ecuador	23	HS-748; EMB-314 Super Tucano
	Paraguay	9	T-25 Universal; EMB-312 Tucano
	Uruguay	2	AS-355/AS-555 Fennec; EMB-120 Brasilia
Chile	Ecuador	4	T-35 Pillan
Ecuador	Uruguay	3	A-37B Dragonfly
Uruguay	Bolivia	11	T-34 Mentor
Venezuela	Bolivia	13	T-34 Mentor; AS-532 Cougar/AS-332; SA-316B Alouette-3
	Ecuador	6	Mirage-50

Source: SIPRI arms transfers database.

Table 04 shows some characteristics of intra-regional exchanges of military aircrafts in the present century. According to data from the Stockholm International Peace Research Institute, since 2000 98 aircrafts have been marketed or donated among South American countries. From these, most consisted of training aircrafts, being some quite old, such as the T-25, made in Brazil, and the T-34s, originally from the United States during the Cold War. The aircrafts Tucano (training) and Super Tucano (light attack), dominated the transfers in the period, completing 64 units traded. Chile transferred four and Argentina only one domestically manufactured aircraft to one country in the region. The other transfers referred secondhand aircrafts, originally imported, which were replaced by new acquisitions, such as the case of the French Mirage-50s, which were transferred to Ecuador after Venezuela acquired Sukhoi Su-30 from Russia.

Despite the structural weaknesses of South American countries, the region comprises a relevant aviation market (240 million passengers in 2015[4]), housing one of the world's largest aircraft manufacturers and, in the first decade of the 21st century, increased defense budgets and provisions for intra-regional acquisition and cooperation (MILITARY BALANCE, 2013). Since the creation of USAN, cooperation in defense has been seen as a way to strengthen the mutual trust among member countries, the production of consensus and a defense identity that considers the specific characteristics of the region and, not least, the promotion of defense industries in the region (MEDEIROS FILHO, 2010). Given the expectations, potential and limitations of cooperation in the military aviation sector in South America, it is then necessary to assess which might be learned from the aforementioned European experiences.

The vertically arranged coproduction model adopted in the 1950s for the production of the F-104 in Western Europe allowed expanding capabilities of countries that adopted it in several fields: 01. operational, having the own aircraft in number and cost relatively low; 02. tactical, having a platform shared by several countries, which also brings logistical gains; 03. human resources, trained in scale; 04. industrial, involving both licensed production and maintenance of aircraft throughout its useful life, and 05. political, by strengthening links among the involved partners. The coproduction of an existing aircraft still avoided costs and risks of developing a new aircraft. On the other hand, this arrangement maintained its dependence on the United States, which holds the license.

Once adopted this arrangement, the involved industries in the countries that started to coproduce the F-104, at least initially, began to orbit around the supplier. This is due to the partnership type, in which Lockheed developed the evolution matrix in the following stages: aircraft development and certification; development of expertise and tooling for production and use licenses; qualification and certification of industries for coproduction and production licenses; approval and certification of maintenance centers; monitoring of aircraft use and useful life (MILLER, 1995, p. 68). It should be noted that the company that developed the aircraft became the pivot of their capacity to use, since it should maintain the logistics supply capacity of the aircraft supplies, as well

[4] World Bank data. Available at <http://data.worldbank.org/indicator/IS.AIR.PSGR?end=2015&start=1970&view=map>. Accessed on May 02, 2017.

as maintenance, even being the production decentralized.

With regard to USAN members, considering technological dependence, asymmetry of manufacturing capacities and limited resources, coproduction (from relatively simple mills) is still a viable path, whereas the product and licensor are adequate to demands of the region. It is important to highlight that some countries have already produced licensed military aircraft in the past (FRANKO, 1992; GUPTA, 1997), albeit within the strictly domestic framework. The production of Pampa in Argentina and Xavante in Brazil, respectively, licensed by the Franco-German joint venture Dassault/Dornier and the Italian Aermachi, are examples on the feasibility of this route to obtain not only the aircraft, but the internalization of engineering, production and maintenance of military aircrafts. Currently, the coproduction arrangement has been replicated partially in South America with the Brazilian acquisition of helicopters EC 725 from Airbus Helicopters. The assembly and production of parts of the 50 aircrafts ordered for the Brazilian armed forces in 2008 are being made by Helibras (a subsidiary of Airbus) and its partners, in an arrangement establishing that aircrafts sold in Latin America in the future will be coproduced in Brazil[5]. The operational, industrial and technological gains that Brazil has obtained with this arrangement, however, did not unfold in the USAN scope. None of the other members participates in the value chain mobilized to produce the aircraft, and the only Latin American country to acquire the model was Mexico. This is, therefore, a limiting of licensed production restricted to a single country.

By assessing the capabilities of the military aviation industry in South America, it can be easily noted that, for most companies, only simple aircrafts could be coproduced in the region. In this respect, the choice of a basic training aircraft and a monitoring UAV to be vectors of a regional integration process of defense industrial base was quite sensible; since it would meet the demands of pilot training, border monitoring, labor force training, gains in economies of scale and expansion of the sector. However, USAN member countries simply did not subscribe to orders for the referred aircraft. This lack of interest may be associated, on one hand, with the budgetary constraints of most of the region's armed forces and, on the other, with the preference for direct purchase from other suppliers, such as Chile and Colombia, which tend to

[5] See <https://www.defenseindustrydaily.com/Brazil-Signs-1B-Production-Deal-for-Cougar-Helicopters-04959/>, last accessed on May 5, 2017.

acquire from United States and Venezuela, which made major purchases from Russia. The pressure and persuasion capacity of the extra-regional industry and its countries of origin on governments and air forces is quite significant and should not be disregarded when evaluating the acquisition options from countries of the region and even the profiles of their employment doctrines. Although there was a pronounced asymmetry of productive capacities among the European countries that adopted F-104, these countries shared the willingness to develop productive capacities in the military air sector and especially shared a common perception of threat that joined them into a military alliance. The South American countries still have distinct strategic visions (in some cases even opposing) and have never formalized a collective military alliance, so that USAN and its defense council are nothing similar to NATO. The F-104 experience suggests that the viability of a vertical production arrangement for coproduction of military aircrafts depends more on the political choice (arising from a perceived shared threat) than on the capabilities of the involved defense industries. Therefore, it is not the coproduction of aircrafts (or other defense material) that gives rise to the defense identity, but rather the identity and common defense objectives that enable shared production.

The development of a military aircraft as Tornado is a much more complex, costly and risky venture than coproduction. The process demands a high degree of coordination, convergence and integration of supply chains. Although it was a more advanced stage, the Tornado's horizontal coproduction arrangement faced a long way (with partner defections) until it was able to deliver the aircraft and other expected economic and strategic assets. Such model presents particularly to USAN the implementation of a tri-state project management agency and the creation of two consortium companies to execute it. These are companies whose capital composition is proportional to the contribution of each of the involved partners[6] and that are able to integrate their different productive capacities. Currently, this is an important characteristic of this model, since the aviation industry (civil and military) has advanced in the sense of horizontalizing the development and manufacturing of different systems that compose the aircraft. Whether to reduce costs, either to minimize risks or simply to

[6] Currently, the Panavia Tornado share capital is organized so that 42.5% is owned by Airbus Deustschalnd GmbH, 42.5% by BAE Systems and 15% by Leonardo Aircraft Division, respectively, in Germany, United Kingdom and Italy.

conquer markets via offset agreements, major aircraft manufacturers have been establishing horizontal alliances with smaller companies so that they can codevelop and produce the different aircraft systems that are lastly assembled in sophisticated 'integrating' aircraft units belonging to traditional manufacturers (GUERRA, 2011).

Embraer has also operated on this logic, accumulated experience in the codevelopment of the AMX ground attack aircraft in partnership with the Italians Alenia and Aermachi and currently codevelops the KC-390 transport aircraft and the Grippen NG fighter aircraft with external partners. In the same way, Embraer mobilizes other companies that compose the cluster that gravitate around itself to coproduce and manufacture its integrated systems into its military and civil aircrafts. One of the great challenges of the codevelopment model is the program management, which must equate political (government), operational (air forces) and manufacturing (industry) demands on a long time interval and in which the contribution of resources may vary according to the economic situation of the involved countries. In this regard, it can be stated that there is accumulated expertise in the region, in the private sector with Embraer and in the public sector with the Coordinating Committee of the Combat Aircraft Program (COPAC), an entity of the Brazilian Air Force that manages the development and acquisition programs of fighter aircrafts and their systems. The recent merger of air transport companies, the Chilean Lan and Brazilian Tam, reveals that there are possibilities in terms of capital concentration and nucleation in the region.

The challenge in the defense sector, however, is to produce convergence. The Brazilian Air Force does not intend to acquire the basic training aircraft that would be developed within the scope of USAN, which, given the order potential, practically made impossible any scale gains of the project. Despite Argentina's interest in the Gripen NG fighter, British vetoes and the Argentine Air Force's very low budget make the entry of regional partners into the ongoing codevelopment project between Brazil and Sweden a remote bet. Since the return to power of neoliberal governments in Argentina and Brazil, the challenge of convergence has become even greater, since USAN faces an emptying crisis (it has been for more than six months without a general secretary) and that Brazil, which accounted for half of the region's defense budget, adopted severe restrictions on public investment and reduced the relevance of the organization and the region in its new defense documents submitted to Congress in 2017. The potential and capabilities installed in the region are considerable, but they are not sufficient to accomplish

military aircraft codevelopment programs without continued political and strategic guidance in its favor.

Final considerations

The comparison of two different models of military aircraft production adopted by European countries in the years 1950/60 (F-104) and 1970 (Tornado) allowed us envisioning political, diplomatic and economic advantages and disadvantages. It is noteworthy that both licensed aircraft production and codevelopment have already been experienced by countries with the highest installed capacity in South America, although they were done predominantly with extra-regional partners with more advanced technologies. The analysis of the F-104 and Tornado cases emphasized that, while both processes generated greater convergence, mutual trust, diminished asymmetries and value chain integration, such developments were already based on a situation in which countries shared threat perceptions and were linked by a military alliance, which compelled them to cooperation in order to standardize and reduce the rising costs of military aircraft acquisition. Therefore, it is an important element for the modeling of defense policies of integrationist orientation within USAN. Although desirable, the process of integrating value chains of military aircraft industry from the joint production of aircraft faces domestic, external and economic constraints, whose solution depends on coordination, convergence and capabilities still to be developed in the region. By comparing both European experiences and considering the asymmetry among South American countries, it can be stated that coproduction would be a more viable arrangement for USAN. Nevertheless, faced with the absence of a military alliance or greater coordination of defense policies, unfolded in convergent profiles of aircraft acquisition, something more elementary must be sought, such as the sharing of maintenance centers and simpler components of the logistic chain.

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