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FOREWORD

This publication is the translation of a study conducted in 2008 and published in Italian in October 2008 in the "IAI Quaderni" series (no.31).
In the meantime, a number of events concerning Italian and European participation in the JSF program have taken place. These events largely confirm the validity of our policy analysis.

Italian industrial participation in the JSF project was confirmed in late 2008 by the first agreement between Alenia Aeronautica and Lockheed Martin (for a relatively small sum of 15 million dollars) aimed at developing Italy's capability for wing construction, making it a second source with a potential of 1200 pieces in the next 25 years for a value of 6 billion dollars.

Since the Italian Air Force, due to budgetary problems, had decided not to buy two Low Rate Initial Production (LRIP) aircraft as originally foreseen, the Italian Parliament eventually approved the JSF's acquisition in April 2009 in order for Italy to participate directly in the Initial Operational Test and Evaluation (IOT&E).

The Parliament approved funding for the construction of the Final Assembly and Check Out line (FACO/MROU) in Cameri, for a cost of 775 million dollars. The Cameri facility will assemble parts coming from the US, Britain and Italy for the Italian (131 planned to be bought), Dutch (85 planned) and potentially Norwegian (48) aircraft. Nevertheless, Parliament remains concerned about the industrial return for Italy (despite the fact that the value of contracts already signed by Italian companies is 188 million dollars), as the "best value" principle does not (luckily from our point of view) guarantee offsets or "juste retour" as in previous programs.

Italy is planning to purchase the first six (four conventional, two V/STOL) LRIP6 aircraft in 2014, in order to participate in the common fighter train-

ing school in Eglin, Florida. Currently, the procurement plan involves 74 conventional F-35A aircraft and 57 V/STOL F-35Bs, at a pace of 14 platforms per year in the 2014-18 period, 12 per year in 2019-22.

In the same period, the United Kingdom has ordered 3 test aircraft (the total operational aircraft order for UK would be 138 F-35s), while the Netherlands has confirmed the acquisition of two pre-series test aircraft, while postponing the final decision concerning procurement of 85 operational aircraft.
The cost per unit of each LRIP aircraft is around 110-120 million dollars.

These events confirm the relevance and topicality of the analysis conducted in 2008.

May 2009

INTRODUCTION

The F-35 Lightning II is an American supersonic, single-seat, single-engine fighter bomber which will equip Western air forces from the next decade onwards.
The F-35 sports the advanced features typical of 5th generation combat aircraft. It is a platform equipped with advanced sensor integration and processing in a net-centric perspective and very low observability (stealth) characteristics that set it apart from advanced fourth-generation aircraft (such as Eurofighter and Rafale).
The new integrated logistics system for platform and fleet, aimed at increasing aircraft availability and cut operating costs, together with its high survivability and interoperability, make it suitable for redeployment tasks in distant operating theaters, for deep ground attack missions and to support surface operations.
Designed and built by the US company Lockheed Martin, the Lightning II stems from the Pentagon requirement for a Joint Strike Fighter (Jsf), a common type of attack aircraft with which to replace the current Air Force, Marines and Navy types.

Three different variants are planned:

1. Conventional take-off and landing (CTOL, F-35A);
2. Short take-off and vertical landing (STOVL, F-35B), fitted with a unique propulsion system that allows it to operate from medium-sized ships and outside airports, drawing upon the experience gathered with the Harrier and AV-8B by the USMC, the Royal Navy and the Italian Navy;
3. Based on conventional aircraft carriers (CV, F-35C) for the US Navy.

In addition to an estimated 2,400 aircraft to be ordered by the United States, the program also involves eight partner countries potentially worth 700 aircraft. Unit cost has grown over time and is now set at about USD 50-60 million, with a potential market which over the next 30 to 40 years will exceed USD 200 billion. Lockheed Martin avails itself of a large number of partners in both the United States and participating countries,

including BAE Systems, Rolls-Royce and Alenia Aeronautica.
The Italian participation, at both government and industry level, in the American-led F-35 Joint Strike Fighter has been accompanied in recent years by criticism and distinctions, occasionally based on prejudice and on a widespread habit that prefers an *a priori* ideological approach to the serious analysis of issues and the realistic focusing on possible alternatives. The acquisition of a particularly significant and long-term defense system should not be based on idealistic models; rather, it should revolve around choosing between possible alternatives, and in particular with those consistent with budget realities. In theory the following could have provided alternatives to the current industrial participation in the Jsf:

1. Developing a European ground attack aircraft program, following in the wake of the Tornado and Eurofighter programs, bringing together the industrial and financial resources of the main European countries.
   This course of action would have required a decision in the latter half of the 1990s, when European countries were busy cutting defense budgets and creating single-nation programs or grappling with the difficult Eurofighter management issues.
   In theory this approach would have afforded the highest levels of operational sovereignty, technological and industrial fallout, subject to Europe proving able to overcome the national divisions that befell the previous Tornado and Eurofighter programs and to fund its high costs. This option, at any rate, became unavailable as a result of French and German unwillingness, albeit originated by different factors.
   It is also doubtful whether such a program could have reached results comparable to those achievable by JSF, particularly with regard to stealthiness, which are the fruit of a string of previous programs originating in the early 1980s and even earlier (particularly "Have Blue", F-117 Nighthawk, B-2 Spirit and F-22 Raptor). In any case, this would have led to difficulties when operating with US forces, whose front-line aircraft will become all-stealth in the 2020s.

2. Modify some Eurofighters in a ground-attack variant, or develop and build a dedicated variant. This solution would also have entailed non-recurring investments that are difficult to estimate – but certainly in the region of several billion Euro – to develop a dedicated version of an aircraft which was originally not designed to fulfill such a role. For

Eurofighter participants this approach would have had the advantage of a certain commonality between the fighter and attack fleets, provided of course that the hypothetical bomber Efa would have been common to the air superiority variant, which was not the case with the Ids and Adv variants of the Eurofighter), plus operational sovereignty and European industrial development, albeit without the technological advances deriving from the innovations introduced by Jsf and typical of fifth generation aircraft.
This hypothesis would have required the development of different capabilities, because Close Air Support and ground-attack missions dictate that the aircraft arrive comparatively close to the target and thus requires reliance on stealth technologies in order to survive. (The alternative would be to use solely stand-off guided armament, which is very expensive, has operational limitations and often is not allowed by the rules of engagement). In order to use it in a broader role spectrum, and particularly in the so-called "Urban Cas" environment, the aircraft would have had to achieve a combination of low observability, sensors and armament. Currently only the UK has developed a ground-attack capability for the Eurofighter. This is considered a secondary role until the aircraft line-up can be standardized on two types, the Eurofighter for air superiority and the F-35 for ground-attack and Cas.

3. Buy the Jsf "off the shelf", without participating in its development and industrialization. This would have allowed Italy to save the billion dollars it is currently investing in the development, as well as postponing procurement decisions, while still maintaining interoperability with the United States (albeit with a lower insight into the development and characteristics of the system). As to procurement costs, economies of scale in the production phase are expected to gradually lower the cost of the aircraft; specifically, F-35s should become less expensive from 2019-2020 onwards. For Italy purchasing aircraft "off the shelf" would have certainly been cheaper, in part because it is less expensive for all work to be performed by Lockheed Martin at Fort Worth rather than to establish a "Final Assembly and Check Out (Faco) and Maintenance, Repair, Overhaul and Upgrade (Mrou) line" in Europe, supplying European partner industries with the required technical assistance.
The Faco/Mro&u is a specialized industrial plant that performs the final assembly and performance verification of new aircraft, as well as

their maintenance, overhaul and upgrade in later stages of their service life. Italy has asked that such a facility be located at Cameri Air Force Base, investing in a dedicated site for Alenia Aeronautica which – on the basis of agreements which are open to other partners but have so far been signed only by Holland – would be in charge of the aircraft for these European partners, both during the initial production phase and the later operational support.
It is therefore considered that a relatively small increase in cost would allow an Italian (and European) industrial presence that would offer significant benefits in terms of operational sovereignty (through a better understanding of the aircraft and the ability to integrate other systems) and particularly of industrial and technological transfer and financial return for the country-system.
In fact, an "off the shelf" purchase would have been the opposite of the Faco concept supported by the Italian Air Force itself, i.e. industrializing the program to contribute to achieving operational sovereignty over the aircraft. Without considering the potential business-industrial returns in the cutting-edge aerospace and defense businesses, returns largely connected to the presence of a production and maintenance site in Europe.

4. Continue using the Tornado by extending their operational life as long as possible, waiting for unmanned Uav/Ucav systems to become sufficiently mature. This is the avenue pursued so far by Germany and, in concept, by France (with the Dassault Rafale, an entirely French-built aircraft).
This is an interesting, but also dangerous approach. There are no elements supporting the massive use of Uav/Ucav systems as early as 2025-2030 and, particularly in the German case, this implies the risk of "suspending", and thus losing, industrial and technological capabilities, leaving the production lines empty for too long with the related loss of skills.
In addition, this solution could prove at least as expensive than participating in the Jsf, if not more. This is because aircraft size is largely dictated by the desired operational range and the presence of systems, and although the Ucav saves some space by eliminating the systems required for the pilot, building an unmanned aircraft with certain capabilities is still very expensive. In addition, Ucavs also require stealth

technology to reduce the risk of losing a platform. The combination of these reasons explains why at present the US Air Force looks at 2030 with a mixed Ucav and manned Jsf fleet; ultimately, some mission require a manned aircraft.
Seeking national sovereignty and the protection of its industry, France remains the main sponsor of the Ucav option and also tries to turn it into a "European". Many Jsf participants are answering by investing in Uav technologies that are complementary rather than alternative to Jsf.

5. Not equip its forces with ground attack aircraft, arguing that it does not believe it will be called to perform such types of operations. This is an ideological point of view, often imbued with an unrealistic isolationism and contradicted by facts. No prudent political or military decision-maker could make such a choice on the basis of what is known about the possible evolutions of the international scenario.
This would entail accepting an extremely high risk and the inability to rebuild such a capacity within a meaningful timeframe should an urgent need arise and should the Italian government decide to use such a component at short warning, as in the past. Furthermore, the immediate economic savings would be followed by the loss of considerable industrial and technological capabilities, with associated high costs for the country-system. It should not be forgotten that even training requires adequate specific long-term preparation.
As a matter of fact, the main opponents to the choice of the F-35 come from this "peace" front and particularly from the extreme left, also in a strongly "anti-American" perspective. The true goal is therefore the reduction of military strength and force projection capability, transatlantic cohesion, as well as the downsizing of the defense industry based on the assumption that wars are brought about by weapons and that there are "defensive" and "offensive" weapons.
It would also be wrong to conclude that – since the participation of Italy and of several European countries in the research, development and industrialization phase has already been agreed – there are no other important decisions to be taken. In truth, the governments of Italy and of participating countries, as well as of some countries not involved in Jsf such as Germany, are called to make over the coming years a number of decisive choices for the future of the program or, at the very least, of the European role in it.

The purpose of this study is to identify, through the analysis of the current status of the program and of its foreseeable future evolution, those problems which are still open and to suggest some options aimed at improving the Italian and European participation by developing the industrial, technological and operational sovereignty returns in a framework of increasing the "Europeanization" of the program.
This study comprises four parts. The first chapter analyzes the operational and procurement aspects which will characterize the future of ground attack aircraft in the various European aircraft, focusing specifically to the development perspectives of the national air fleets and of the Italian air fleet in particular. The second part offers a quick overview of the situation of the European defense aircraft industry and of its current international cooperative ventures. The third chapter summarizes the current situation and prospects of the F-35 program in Italy, analyzing the decision to operate a mixed F-35 and Efa fleet, but also the elements of industrial and technical innovation and the related problems of transferring sensitive technologies from the USA. This is currently subject to political administrative and industrial property restrictions that it is hoped to overcome gradually.
The final chapter focuses around the currently limited cooperation between some European Jsf partner countries, underlining the consequences of this approach and the opportunities to improve it, strengthening and increasing participation in the European initiatives that are already under way.

There is a final issue of methodology. The analysis is necessarily based on the (unclassified) documents, information and forecasts available at this moment with regard to program phases, size of F-35 purchases, cost and times related to the development and production of the weapon system. Should there be substantial changes on any, or several, of these aspects, this would obviously impact the elements to be considered and therefore the conclusions we have reached today.
The possible changes include, in the first place, and also in consideration of what has happened in recent years, a possible further increase in the over-

[1] M. Sullivan, "JSF Impact of recent decision on program risks", Gao, 11 March 2008, p. 2.
[2] Idem.

all costs of the F-35 program. According to a recent Government Accountability Office (Gao) report, "the prime contractor and program office are readying a new estimate, which is expected to be much larger than what is now budgeted."[1] In the second place, also according to the GAO, "there is continued degradation in the schedule"[2] caused by the overall delays in the various F-35 development phases. The cost increases do not translate directly into greater contributions from partner governments, because the international agreements exclude this explicitly, but could in part have an impact on the cost of individual aircraft and thus influence the size of national orders. At the same time, delays from the original timing could easily postpone the delivery of the first fully operational aircraft to the armed forces of the United States and/or partner countries. Should this occur, the Italian government and Air Force would need to reassess the national procurement timetable and adopt those measures required to ensure full Air Force capabilities also in the pre-F-35 acquisition timeframe. Spiraling costs could push the Us Department of Defense (Dod) to decide to save money by cutting off its commitment to a second engine source, a much-debated issue in recent years. In the event of a considerable worsening in the timing and overall costs, or should there arise some insurmountable technical obstacles, it cannot be ruled out altogether (as unlikely as it may be) that the Dod might decide to cancel the more complex variants of the aircraft (such as the Stovl, which poses the greatest technical challenges and thus contributes greatly to cost increases and schedule slippage). Should this, rather remote,[3] event come to pass, countries such as Italy and the United Kingdom would need to completely rethink the extent of their orders and, to some extent, their very participation in the F-35 program. Italy would have to face the problem of what to do with its new Cavour aircraft carrier, which dictates the use of Stovl aircraft.

Setting aside the analysis of scenarios which at this point appear possible, but not likely, we feel that here it is best to reflect on those conditions that are either certain or conceivable in which Italy and Europe will have to move in coming years.

[3] Together with the funding to procure 6 F-35A CTOL aircraft, in May 2008 the Pentagon granted preliminary approval to purchase the first 6 aircraft of the F-35B STOVL variant. See "Lockheed Martin receives funding F-35 lot 2 production", in www.spacewar.com, 28 May 2008. The STOVL variant prototype had already run its vertical take-off engines in late April and the first flight test was expected for the second quarter of 2008. The program thus appears to be headed for a stage advanced enough to make significant downsizing unlikely.

1. THE F-35 AND EUROPEAN AIR FORCES

1.1 The Need for Expeditionary and Interoperable Aircraft Fleets

In evaluating the perspectives for European air forces it is necessary to consider in the first place the changing geo-strategic context in which armed forces – and air power specifically – are used. In fact these changes dictate the need for new kinds of missions and operational doctrines, which in turn will demand a corresponding new generation of combat aircraft.

On one hand, in Europe the need to defend domestic territories from conventional threats – such as an air attack from a hostile sovereign country – has lessened somewhat. The need has not disappeared altogether, for two reasons. In the first place, air defenses cannot be improvised at short notice, and it follows that it must be available and operating before a threat which is now considered only possible actually materializes; in the second place, at a time of overall international instability significant national air defenses can dissuade other countries from the possible ambition to launch arms races by making them excessively expensive for their available resources.

On the other hand, European countries have a growing need for armed forces capable of operating outside their homeland, and with increasing frequency even outside the Old Continent, in order to confront in a flexible way any rising threats to the security or vital European interests. The 2003 European Security Strategy sets a goal "To transform our militaries into more flexible, mobile forces, and to enable them to address the new

threats."[4] Air Forces are specifically asked to be capable of carrying out a series of tasks that, in addition to airlifting towards and within the theatre of operations, range from reconnaissance to combat and direct support to contingents deployed in international operations for peace-keeping or other purposes.

Already today operations in Afghanistan are carried out already with an air cover prevalently geared to the needs of surface operations. By their very nature, such operations require a fleet with "expeditionary" characteristics. For the Jsf Stovl this translates into the ability to operate in areas in which the runways available for take-off and landing could be inadequate for traditional combat operations, dictating the use of less complete facilities with limited logistic support infrastructure.

The two tendencies are also reflected in the active participation of Italy in international organizations such as Nato and the Eu, and in the roles they play in ensuring the security of member states and promoting international stability. In the first place, Nato is experiencing a gradual transformation that has led it to an increasing use of its military assets in operations which are "out of area", meaning beyond the borders of its own members – such as Bosnia or Afghanistan. At the same time, the Eu has launched its own European Security and Defense Policy (Pesd), which in recent years has also involved sending civilian and military missions to the Balkans, Africa and the Middle East.

The combined outcome of this double evolution and of the renewed Nato and Eu activism – the analysis of which lies beyond this paper – has resulted in the Italian armed forces, including therefore the ITAF, being committed to a growing number of international deployments authorized by the Un Security Council. Italy presently has over 2,700 troops in the Balkans (Bosnia, Kosovo, Albania, FYRoM) and as many in Lebanon, some 2,500 in Afghanistan, and several hundred in missions in other Middle Eastern and African countries.[5] It is clear that the ITAF, together with other European air forces, is increasingly engaged in operations within areas that are simultaneously a source of threats to national security and a crucial element for both national interests and international stability.

From the new strategic context, which is only barely sketched out here,

[4] EU, European Security Strategy, "A secure Europe in a better world", December 2003, p. 12.
[5] G. Gasparini, L. Marta, "Economia e industria della difesa: tabelle e grafici", IAI, April 2008, p. 17.

there stem further considerations on the use of airpower. In the first place, because of its specific characteristics, this military tool can "achieve political objectives directly with speed, flexibility and broad freedom of action; it ensures a constant 'virtual presence' because it can be deployed anywhere in very short time."[6] Taking this point of view, the Chiefs of Staff of European air forces have identified several "convergence criteria" to make the best use of the characteristics of airpower in the new strategic context: "fast use at long range, mobility and flexibility, in order to allow political decision-makers to quickly intervene to circumscribe crisis situations and possible international consequences."[7]

Secondly, for European democracies that are accountable to domestic public opinion for human losses in operational theaters far from home, airpower offers the advantage of using military force with fewer soldiers exposed to danger. This helps the authorities to obtain and retain the necessary support for operations that, politically speaking, are not considered worth deploying a military contingent on the ground, with all the associated costs and risks. This characteristic therefore also needs to be strengthened, aiming at a "high cost/effectiveness ratio based on a decisive technological supremacy, capable of guaranteeing the quick achievement of political goals while reducing the costs associated with the continuing military action and avoiding the unacceptable loss of human lives."[8]

The sum of these considerations obviously influences the associated defense procurement decisions. On the other hand, these decisions are also strongly influenced by the objective situation of aircraft fleets and national defense budgets.

In this respect, by shifting our attention to the current state of European air forces and in particular to the age of the aircraft in use it is possible to garner some useful indications of the size of the related anticipated procurement in the next decade, and on the aircraft types and programs it will be aimed at. It must be said that this study considers as relevant only those national fleet renewal programs planned up to 2025, because planning the replacement of tens of military aircraft within this timeframe requires gov-

[6] "La trasformazione 2007", *Rivista Aeronautica*, n. 6, 2007, p. 96. The Italian Air Force published the "Transformation 2007" based on a direct input of its then Chief of Staff General Vincenzo Camporini in order to assemble and disseminate the outlook of an armed force in a period of significant change.

[7] "La trasformazione 2007", *Rivista Aeronautica*, n. 6/2007, p. 96.

[8] Idem.

ernments to launch and fund the associated procurement programs now. In general terms, the alternative to such a government and industrial commitment is the direct purchase of aircraft entirely developed abroad, which are later difficult to manage autonomously by an air force which has not participated in the definition of the operational requirements leading to their development and built without the least contribution by the domestic defense industry.

Studying the armed forces of the main European members of Nato, and extending the analysis to encompass both air forces and ship borne naval air assets, there emerges a widespread need to replace third-generation combat aircraft that entered service in the 1970s-1980s. The United Kingdom has an urgent need to introduce the replacement of the vertical take-off Harrier jet in use for over four decades. In coming years Germany will need to replace Phantoms with over 35 years of flying on their wings, followed by Tornados around 2020. Turkey also foresees replacing its Phantoms around 2015, while Spain needs replacements for its AV-8B (Harriers), of 40 year-old Mirages and more recent Hornets. Belgium, Denmark, Norway, the Netherlands and Portugal face the same need with their F-16s. Greece needs to replace as soon as possible its Phantoms and A/TA-7E/Hs dating to the early 1970s.

Only two European countries have a less urgent need to launch a substantial renewal of their combat aircraft fleets. These are France, which does not plan to replace the eldest part of its Mirage fleet before 2025, and Finland, which foresees a long service period for the Hornets introduced in the mid-1990s.

Italy does not escape the overall necessity for a marked renewal of aircraft fleets because, as it will be shown later, over the next 10-15 years it will require to replace its entire AV-8B (Harrier), AM-X and Tornado fleets.

Facing this massive demand for combat aircraft, and setting aside the French decision for the Rafale and a certain number of Gripen sales, the largest European customers are leaning towards two main products: the F-35 Lightning II, previously known as Joint Strike Fighter (Jsf), and the Eurofighter 2000 Typhoon (Efa).

The first program is led by the United States with the participation, in Europe, of the United Kingdom, Italy, the Netherlands, Denmark, Norway and Turkey, while the other comprises Germany, United Kingdom, Italy and Spain. The international membership in the two programs exerts a certain influence over individual national defense procurement choices, in terms of favoring aircraft which a country has contributed to develop (in terms of

both operational requirements and domestic industrial participation). It should be noted, however, that the United Kingdom and Italy, two of the European countries involved in the Efa, are planning to purchase several hundred F-35s for their air forces.

In general individual countries retain a measure of discretionary choice in navigating national procurement among the various options available.

The United Kingdom has decided to participate in both the transatlantic and the exclusively European cooperation, confirming once again its traditional stance towards Europe and the United States. This choice is reflected in its intention of purchasing for the Royal Air Force and Royal Navy a fleet of F-35 and Efa.

Other European countries will also have a fleet comprising several types of combat aircraft called to perform different missions: air defense, air-to-air or air-to-surface air attack, interdiction, suppression of enemy air defenses, offensive air support, tactical air support to maritime operations. For instance, Turkey will operate a mix of F-35 and F-16, while Greece will use Mirage and F-16.[9]

Such a choice obviously entails a certain increase in costs for the national defense budget, as a direct consequence of the setting up of two different maintenance and logistics lines attuned to the specific requirements of the various aircraft. It is no accident that until now the air forces of Denmark, Norway and the Netherlands have chosen all-F-16 fleets and are now leaning towards all-F-35 fleets to spare their defense budgets the additional cost. This option is made viable by the multi-role nature of the F-35, which can fulfill in a satisfactory way the various primary missions listed above, even though its greatest capabilities are in the ground attack role.

In this scenario, it should not be forgotten that in countries like Spain the debate is still open as to the make-up of the national fleet in coming decades. In Spain there are in fact two different positions on the issue of the successor to the F-18 Hornet, with some wishing to continue purchasing Efa's to build a combat fleet substantially around a single aircraft type, and others arguing for an additional F-35 component to be bought "off the shelf" at the end of the development phase. The overall evaluation is also impacted by the Spanish Navy's requirement for a vertical take-off aircraft capable of operating from carriers, and particularly its own Principe de

[9] See Table 1.

Asturias. Unlike the Efa, the F-35 offers a variant with the desired capability. Dropping the mixed fleet option in favor of an exclusively Eurofighter procurement would entail a de facto withdrawal of the Spanish carrier or its partial use with either old aircraft or helicopters. Spain has recently asked the F-35 program office for information on aircraft performance and the terms for a possible purchase.

Germany is also pondering its choices. The massive planned Efa purchase, some 180 aircraft in all, would allow replacing all of the current Phantom fleet together with about two-thirds of the Tornados. But completing the total renewal of its fleet with the Efa alone raises doubts about the possibility of carrying out air-to-surface missions with an aircraft with a specific air-to-air vocation. It should also be underscored that such a choice would leave the German Air Force and Navy without a vertical take-off aircraft that will be widely used by allies such as the United States, United Kingdom and Italy. In addition, should Germany elect to stretch the use of its Tornados as far as possible, in such a way as to supplement the Efa until the new Unmanned Combat Air Vehicle (Ucav) technologies become mature and usable, the German government alone would have to bear the full cost of further Tornado upgrades which are currently capped in part by sharing them with Italy which also must upgrade its own Tornado fleet.

A different analysis applies to France. Having exited the Eurofighter program almost immediately, since the 1980s France has developed the Rafale on a purely national basis as a Mirage replacement, without any cooperation with other European countries at either the government or industrial level. The outcome of this choice is that in coming decades France will be the only European country, together with Greece, that does not use either of the aircraft used by the overwhelming majority of Nato countries, i.e. the F-35 and Efa. The negative consequences in terms of interoperability of the French armed forces with allied countries are self-evident.

Europe wants to have the means to take up future challenges by having an aircraft capable of performing its duties effectively in coming years, to reduce or cancel own losses, to be deployable and sustainable in distant theaters and to be reasonably affordable in terms of cost.

On the basis of the situation described above it is possible to draw some useful conclusions to be used in the debate on the coming choices that Italy will have to make for its Air Force.

In the first place, European countries appear to attribute a growing importance to the interoperability – if not commonality, with the important

exception of France – of its fleet with those of a reasonable number of allied countries. When considering the above-mentioned changes in the geo-strategic context, the possibility of sharing with partners in multinational missions similar employment doctrines and common logistics, if not even the same aircraft, constitutes an undisputed operational and economic advantage.
In the second place, European countries seem to point to a greater homogeneity of their respective national combat aircraft fleets, aiming either at a single multi-role aircraft or a mix of two types. The cost of maintaining in use increasingly technologically complex and advanced weapon systems make a fleet composed of too many different combat aircraft less and less viable financially.

Table 1 – *Major European Air Forces*

Country	Aircraft in service	Introduced in	Remaining life	Planned F-35 Acquisitions	Other Acquisitions Planned
Italy	**85 Tornado** including **18** already with 1st upgrade **15** being upgraded to basic MLU **30/35** planned upgrade to full MLU from 2010	1982	2015-2025	131 F-35A/B	121 Efa (including 28 already in service)
	103 AM-X including **70** in use **33** awaiting WFU	1989	2018		
	28 EF 2000	2004	2030		
	18 AV-8B Harrier	1990	2020		
	29 F-16 A/B	2003 Leasing	2010		
Belgium	**71 F-16**	1980	2020-2025	–	–
Denmark	**63 F-16 A/F-16 B**	1980	2015-2020	48 F-35A (competition under way)	
Finland	**63 F-18 C/DHornet**	1995	2025	–	–
France	**64 Mirage 2000C**	1984	2025		
	78 Mirage 2000D	1986			
	67 Mirage 2000N	1986	2025		
	37 Mirage 2000-5F	1997	2025		
	50 Mirage F-1CT	1992	2025		
	48 Mirage F-1CR/CR200	1980	2025		
	47 Rafale B/C	2000	2025		
	38 Rafale M	1999			
	48 Super Etendard	1978			
Germany	**38 EF2000**	2004			180 Efa (including 38 already in service)
	76 F 4F Phantom II	1973	2007/8		
	193 Tornado IDS	1982	2020		
	36 Tornado ECR	1993	2020		

Greece	**31 Mirage 2000 EGM**	1988		–	30 F-16
	10 Mirage 2000-5	2007			
	61 F-16CG	1989, 1/2			
	40 F-16C	1997			
	50 F-16D	1989, 1/2			
	56 F-4E Phantom II	1997	2015		
	78 A/TA – 7E/H	1989, 1/2	2015		
	23 RF-4E Phantom II	1997 1972 1975 1972	2015		
Norway	**45 F-16 A/B**	1980	2015-2020	48 F-35A (competition under way)	–
Netherlands	**113 F-16 A**	1979	2010-2020	85 F-35A (competition under way)	
Portugal	**40 F-16 A/B**	1980	2020		–
United Kingdom	**54 Harrier GR.7/7A**	1969	2010-2025	138 F-35 B	144 Efa (including 50 already in service)
	61 Harrier GR.9/9A	1969	2010-2025		
	10 Harrier GR.7/7A/9	1969	2010-2025		
	50 EF2000	2004			
	94 Tornado F3	1985	2010-2025		
	140 Tornado GR.4/4A	1982			
Spain	**18 EF2000**	2004		–	87 Efa (including 18 already in service)
	83 F-18 Hornet	1986	2015-2020		
	45 Mirage F1	1975	2012-2015		
	20 Harrier II	1977	2015-2020		
Turkey	**185 F-16C**	1987	2030	100 F-35A	30 F-16
	42 F-16D	1987	2030		
	195 F-4E/NF-4E Phantom II	1973	2015-2025		

Source: IAI estimate on IISS "The Military Balance" 2008.

1.2 The Evolution of the Italian Air Force and of the Italian Navy Air Service

Within this European context, there is an ongoing discussion within the Italian armed forces regarding the ITAF organizational model and employment doctrine. The discussion must necessarily start with the goals set by the political authorities for the military, and by the types of missions that can be realistically anticipated in the short and medium term, proceeding then to evaluate the assets required to achieve the stated goals.
Considering the range of duties assigned to the ITAF, it is necessary to look at its multi-role, meaning the ability for the ITAF to perform different functions with the same aircraft. This characteristic is of increasing importance because the need to defend the home territory has been joined by the need to have an expeditionary potential, in itself capable of being implemented through a broad range of missions, and with limited resources ruling out the doubling of current force structures. This problem applies particularly to aircraft fleets. "The Air force is multirole in nature, despite relying traditionally on specialized platforms",[10] meaning weapon systems engineered to perform a specific mission – e.g. air-to-air combat - in an optimal way but less capable in others. Currently the ITAF fleet is made up of some 71 AM-X, 85 Tornado, 29 F-16 and 28 Efa, while the Navy relies on 17 AV-8B Harriers capable of ship-borne operations. There are therefore 230 aircraft total. Following a European trend, the ITAF is also thinking of reorganizing its fleet around a smaller number of types with intrinsically multirole characteristics, in order to be able to cut costs while performing adequately the various missions: "to make the capabilities of Air power credible in this respect it is necessary to leverage available and future weapon systems with a multirole approach. This approach should be considered comprehensive, i.e. applicable to every level of the armed force and to personnel training methods." [11] Such an approach, unthinkable for air forces in the recent past, is currently made possible by the technological and industrial steps forward in the field of combat aircraft, which are now almost mandatorily multi-role: "Today the so-called swing role capability represents an essential feature of any aircraft which aims to succeed in the world market. [12]
In keeping with the need to play an active part in international military missions agreed in a Euro-Atlantic context, the ITAF must have "a line-up

[10] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 102.
[11] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 106.
[12] A. Cucurachi, "Tecnologie future per i caccia di oggi", *Rivista Aeronautica*, n. 2/2007, p. 80.

with strong expeditionary capabilities." [13] In a situation in which the national budget only has limited resources available, this priority must be pursued tenaciously by making any required savings on the non-expeditionary component. Some maintain that "it must be possible to project 100% of the Armed Forces: it is possible to do without non-projectable forces, which can therefore be cut." [14] In general there is now an unquestionable need to "form a force with high readiness and expeditionary warfare capability, from which to draw the national contribution to the Nato Response Force (Nrf) and the Eu." [15] Again in order to operate effectively in multinational operations, the other side of the expeditionary requirement is that fleets be fully interoperable with those of allied countries: it is therefore necessary to aim at having an air force which can be "integrated in coalition frameworks, capable of handling crises either autonomously or within a broader multinational force." [16]

Taking this approach, and looking at the use of ITAF aircraft in combined operations with military contingent deployed on the ground, there is a need for aircraft that can first and foremost perform surveillance and air cover, as well as providing timely and adequate fire support when necessary. This entails "greater precision, speed of execution, longer range and mission with a high level of stand-off/all-weather capability."[17] As for an adequate range, this is increasingly becoming a pre-requisite for actions in certain theaters in the Middle East or in the Mediterranean area, relatively distant from both Italian territory and the main Nato bases which the ITAF can rely upon. Precision and speed are, instead, increasingly important for effective action considering that the "mobile and elusive targets typical of the new threat identities require special care and special abilities." [18] Since a majority of today's conflicts takes place within a single country and involves groups that resort to forms of urban guerrilla, it could be that the ITAF might find itself to have to hit military targets that have been deliberately placed amidst civilian targets, as during previous air campaigns in the Balkans.

In a context in which technological and scientific progress has greatly increased its pace, the ITAF additionally feels the need to keep "in step with

[13] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 97.
[14] G. Gasparini, "Per una nuova politica di difesa", *AffarInternazionali*, 21 April 2008.
[15] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 110.
[16] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 110.
[17] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 97.
[18] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 9.

technology development particularly in the areas of communications, precision munitions and expeditionary warfare." [19] This need is increasingly pressing both to offer soldiers the best possible tools with which to face the opposition (particularly considering that today it is difficult to deny states and armed groups the access to relatively sophisticated weapon systems), and because important allies – the United States in the first place – demand that all participants in joint operations observe predefined technological standards. The leading-edge technological characteristics of the aircraft are also important if the aircraft is to be examined with an eye to the element of time. The basic technology, indeed, is "the parameter on which the technical feasibility, operational-cost validity and operational usefulness of any upgrade program must be evaluated. The end of the past century was marked, in terms of aeronautical technologies, by a sequence of advances in certain fundamental areas in which Jsf, Gripen, Rafale and Typhoon will clash to conquer market share", while for the time being the F-22 remains not available on the market. [20] From this point of view, the technologies at the basis of an aircraft must not only be advanced, but also potentially capable of being modified and improved in order to keep the pace with technological evolution: "factors such as the basic technology and ability to evolve faster than potential enem will represent for strategists the key to success and for pilots the difference between surviving or being shot down." [21]
Finally, like the similar vintage fleets of other European countries, the ITAF must also take into account the age of the aircraft currently in use. "The current capabilities and make-up of the Italian Air Force are still able to face traditional and emerging threats in an acceptable way, but (...) will be less and less so in the immediate future." [22] If the goal is to preserve a military establishment capable of fulfilling the tasks given it by political authorities, "the unavoidable and progressive technical and operational obsolescence, the unbearable increase in maintenance costs and the exhaustion of the structural fatigue life thus dictate the replacement of the current fleet starting from 2014-2015." [23]
Faced with all needs and evaluations, the ITAF has chosen to equip with a mixed F-35 fleet including a number of conventional take-off aircraft and short/vertical take-off variant. The primary missions of this fleet would be

[19] "La trasformazione 2007", *Rivista Aeronautica*, *op. cit.*, p. 100.
[20] A. Cucurachi, "Tecnologie future per i caccia di oggi", *Rivista Aeronautica*, n. 2/2007, p. 81.
[21] Idem.
[22] F. Giunchi, "L'aeronautica militare e il JSF", *Rivista Aeronautica*, n. 1/2006, p. 44.
[23] Idem.

in the air-ground realm, complementing the Efa component seen as an air superiority aircraft. This would lead to the withdrawal of all the Tornado and AM-X variants currently in use to build a service based upon two great pillars, both at the state of the art and with complementary functions.
From this point of view, the F-35 appears to provide positive answers to the main requirements emerging from the above analysis: multirole nature, small logistic footprint, expeditionary and interoperable, full ability to support troops on the ground, leading-edge basic technology predisposed for upgrades because of its open architecture.
The F-35 is "a single-seat, single-engine aircraft, capable of supersonic speeds, and stealth characteristics that make it difficult to spot on radar. With a maximum take-off weight of 30 tons, it can carry loads in internal bays and has an operating radius greater than that of an F-16 with three external tanks." [24] One of the new features of the F-35 is that the aircraft has been designed with three variants sharing a vast majority of components but differing on key points such as the take-off and landing system. These differences have been conceived to meet the needs of the various US armed forces interested in the F-35 – air force, navy and marine corps – and should also be carefully considered by partner country governments when considering national procurement. The Conventional Take Off and Landing (Ctol) variant features the standard take-off and landing mode and will have an operating radius between 450-600 nautical miles and the ability to carry over 4,000 pounds of bombs internally. The Carrier Version (CV) for the Usn also has conventional take-off and landing, but with a number of changes to withstand the stresses of landing and taking off from aircraft carriers. The Short Take Off and Vertical Landing (Stovl) variant has an engine that can pivot up to 90° around three axis and a powerful dorsal fan, which together allow the aircraft to hover off the ground.
The presence of the parts required for the latter engine affects significantly the design and performance of the Stovl variant in comparison to the Ctol. The F-35 Stovl will have reduced flying range compared to other variants, between 450 and 500 nautical miles, because part of the internal volume available for fuel has been used for the vertical jet of the Stovl propulsion system. The internal bomb carriage capability will be over 2,000 pounds, and the fighter will have a retractable air-to-air refueling probe. In any case the three variants will share "the same mission system, with benefits for both operating

[24] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *Quaderno IAI*, n. 30, June 2008.

costs and the standardization of tactics and procedures," [25] as well as the same systems for avionics, operating software, communications, ammunition, radar and the main airframe structural modules starting with the cockpit. The logistics system will also be common to the three variants.
With regard to the multirole capability of the aircraft, aeronautical experts consider both F-35 variants to be able to perform all the tactical missions called for by Italian and Nato authorities: air defense, air-to-air and air-to-ground attack, interdiction, suppression of enemy defenses, Combat Search and Rescue (Csar), tactical air support to maritime operations. According to the vast majority of experts in the field, "Jsf is the first supersonic short take-off aircraft, highly maneuverable, capable of covering most effectively the typical missions of the light attack aircraft currently in service." [26] The fact that its multirole characteristics allow the F-35 to perform such tasks without modifications or additional equipment evidently ensures greater flexibility for ITAF operations when compared to the current fleet of different aircraft conceived for different missions. Replacing different aircraft with a single type appears not to be a problem for the Air Force because the majority of the infrastructures, doctrines and training techniques currently in use can be rapidly adapted to the F-35. Obviously pilot training will have to be modified to cover the entire range of missions that the F-35 can perform, and to exploit in full the potential sorties which the aircraft can perform, and to this end it can certainly be useful to look at standard Nato training and tactical doctrines.
With the regard to aircraft expeditionary warfare, the F-35 has been specifically and structurally conceived by the United States to have the greatest expeditionary capabilities, particularly in the Stovl variant that can land on runways unavailable to current conventional take-off fighters due to insufficient length. In many cases such expeditionary capabilities are a pre-requisite to participate in international missions in theatres devoid of the Main Operating Bases (Mob) required for traditional operations. "An independent study has shown that in hypothetical theatres of operation in areas of national interest the availability of 1,000 meter runways is three to five times greater than that of standard 3,000 meter Nato runways." The great expeditionary capability is one of the key reasons for countries like Israel to negotiate the purchase of a significant F-35 fleet, including part in the Stovl variant. [27]

[25] F. Giunchi, "L'aeronautica militare e il JSF", *Rivista Aeronautica*, n. 1/2006, p. 44.
[26] Idem.
[27] B. Opalll Rome, "Israel may switch JSF order to STOVL", *Defence News*, 10 March 2008.

In general, the short take-off variant offers greater ease of force deployment and of mission execution, because "with minimal aerodynamic and range penalties it can operate from short or damaged runways, from austere bases or small aircraft carriers, enormously expanding deployment flexibility." [28] While it is true that regular Stovl operations require laying a special material, similar to concrete, to protect the surfaces from the erosion caused by the strong take-off airflow, but the spreading of such an "island" is a relatively simple and cheap operation. It must also be recalled that expeditionary operations are not limited to the Stovl variant, but is also very much present in the Ctol model, albeit in a slightly inferior way for the obvious reason that it takes off conventionally. Compared to the Stovl, the F-35 Ctol enjoys "greater range and reduced logistic requirements particularly in out of area scenarios." [29]

The expeditionary capabilities of the F-35 also entail a number of not inconsiderable operational advantages. In the first place, using a smaller base located closer to the mission theater increases *de facto* the operating range of the aircraft, compensating for the 100-150 nautical mile gap which separates the Stovl variant from the Ctol. Secondly, the chance of survival is increased by allowing aircraft to be dispersed over a greater number of sites, which reduces the impact of missile, air or terrorist attacks against aircraft on the ground compared to the possible results of such attacks against a Mob. The logistics required for an expeditionary capability certainly present additional difficulties compared to traditional logistics, because necessary resupply and repairs are more difficult and require setting up and protecting more supply lines on the ground. But in any case the greater precision of the F-35 would require bringing in fewer ammunitions, while component commonality and durability would diminish the need for spares, thus contributing to alleviate the logistics requirements for expeditionary missions.

In terms of aircraft interoperability, the fact that the F-35 will be in service with the United States and six European Nato members (in addition to Italy, Denmark, United Kingdom, Netherlands, Norway and Turkey) will make it one of the most widely used – if not the most used – in international missions within the Euro-Atlantic framework. To the list of F-35 users there should be added Australia and Canada as program partners, and possibly countries like Israel, Japan and Singapore which have opened bilateral negotiations with the United States. The commonality of the weapon sys-

[28] F. Giunchi, "L'aeronautica militare e il JSF", *Rivista Aeronautica*, n. 1/2006, p. 45.
[29] Idem.

tem used will thus be, from the very start, the best possible guarantee for the interoperability of the Italian armed forces with those of the main allies. With regard to its ability to support troops on the ground, the F-35 characteristics are believed to provide adequate surveillance, air cover and fire support for such missions.

In the early phases of a crisis, air forces play a decisive role in "allowing coalitions to deploy its ground forces securely (...) in this context, the conventional Jsf, thanks to its superior aerodynamic performance, low observability, significant radius, precision armament and on-board sensors, can operate in depth and at significant distance from its point of take-off" [30]. Furthermore a Stovl F-35 can return directly to replenish its armament and fuel in small bases near the theater of its mission, performing a new mission immediately thereafter. This increases the generation of sorties, a very important consideration when supporting troops on the ground which might suddenly require strong air support."

Finally, the reduced logistics required for the aircraft helps achieve a sustainable low intensity constant air support activity through the long time span required by land missions, which are usually measured in months when not years.

Turning to the basic technology, it is worth looking at protection from attacks carried out with Weapons of Mass Destruction (Wmd) as an example of an F-35 mission and a parameter of its technology. Should political authorities consider an attack to be imminent, the ITAF would need to be able to go destroy the WMD before they might hit Italian forces or home territory. This capability requires the use of an aircraft able to penetrate deep into enemy territory without being shot down, to identify WMD sites and to conduct a lethal attack against concealed and well-protected structures. The combination of characteristics such as stealth technology, a sophisticated sensor suite, a wide radius and an adequate payload would allow the F-35 to carry out this kind of mission perfectly.

If the reasoning illustrated thus far is mainly centered around ITAF needs, it is also necessary to consider that the Italian navy also has a vested interest in the F-35 Stovl, "specifically indicated by the Italian Navy for use aboard the Cavour aircraft carrier." [31] This need, in turn, makes it more sensible for the ITAF to purchase a mix of Ctol and Stovl variants. If several tens of short

[30] F. Giunchi, "L'aeronautica militare e il JSF", *Rivista Aeronautica*, *op. cit.*, p. 46.
[31] F. Maurelli, "JSF, la rivoluzione nei cieli", *Rivista Aeronautica*, *op. cit.*, p. 108.

landing aircraft must in any case be operated from carriers, purchasing others for the ITAF allows maintenance, weapon systems and training to be shared, with a resulting greater synergy between the armed forces. Such cooperation between ITAF and Navy means that "the 'specialist' conventional or short take-off element could be used 'individually' or 'synergically' (Air Force-Navy) depending on the required time and mode of intervention, as well as the geo-strategic characteristics of the operational scenarios (specifically land or mixed)." [32] In terms of logistics and maintenance, such a choice also affords considerable savings on aircraft life-cycle costs.

In the light of the analysis carried out, it can be said that in terms of the strategic needs of the Italian armed forces the F-35, with its unique characteristics, provides an adequate complement to the Efa to allow the ITAF to perform the full spectrum of its required tasks.

The official position taken by the Air Force Staff in 2002 states that "indeed the Eurofighter would not in itself cover the entire aero-tactical need because its configuration, optimized for the air superiority role (...) will never, anyway, be able to acquire the stealthiness relied upon by current first day of war employment doctrines in enemy territory." [33] In strategic terms today there is no "credible European alternative to the Jsf to replace the aircraft which will be withdrawn from service in coming years." [34] It must be underscored that the two aircraft can complement each other within the same fleet, but not in the same mission when this consists in Close Air Support or suppression of enemy air defenses: because of its low observability, the F-35 can penetrate deeper into the enemy defenses. Thus although the actual use of the two aircraft will depend in part upon tactics adopted at the national level, in general terms it can be said that the F-35 and Efa are different assets for different circumstances.

In consequence Italy has adopted the same position as the United Kingdom, planning to provide its armed forces with both F-35 and Efa aircraft, their combined number totaling some 200 aircraft against almost twice as many at the beginning of the past decade. On this point Undersecretary Forcieri has stated that "the choice of our Armed Forces and of our Government to procure both such aircraft is shared by other coun-

[32] F. Giunchi, "L'aeronautica militare e il JSF", *Rivista Aeronautica*, *op. cit.*, p. 46.
[33] Chamber of Deputies, Research Service, "Programma pluriennale di R/S n. Sma 002/2002", 22 May 2002, p. 21.
[34] M. Nones, "Nell'aerospazio l'Italia gioca da protagonista", *Il Sole 24Ore*, 19 July 2006, p. 19.

tries, such as England, because they fulfill two different needs. While the Efa is geared to the air defense of the nation's territory, the Jsf is aimed at replacing types which are about to become obsolete." [35] With regard to this, in September 2007 General Vincenzo Camporini, then Chief of the Air Staff, stated in an interview that he did not believe that "the Typhoon are fully adequate to meet the national air defense requirements and offer expeditionary potential. We cannot therefore also use them as fighter bombers. For this role we have instead chosen the F-35. We will therefore have aircraft specialized in specific roles." [36]

While the decision to operate a mixed fleet is now well-established, the number of F-35 to be acquired for each of the two variants remains to be determined. From the point of view of the needs of the armed forces, defining the quantities to be procured means the simultaneous examination of factors such as the "level of national ambition, the principle of the sustainability of the effort and therefore of the rotation of forces, and of the greater operational effectiveness of the Jsf, of the anticipated levels of efficiency and reliability." [37] The government will obviously have to balance this evaluation with considerations regarding the cost of acquisition and the situation of the defense budget, without forgetting that should the F-35 fleet be too small it might negate the advantages described thus far and would threaten the very possibility of the ITAF fully playing its role in military missions outside Italy, with all the related anticipated negative consequences.

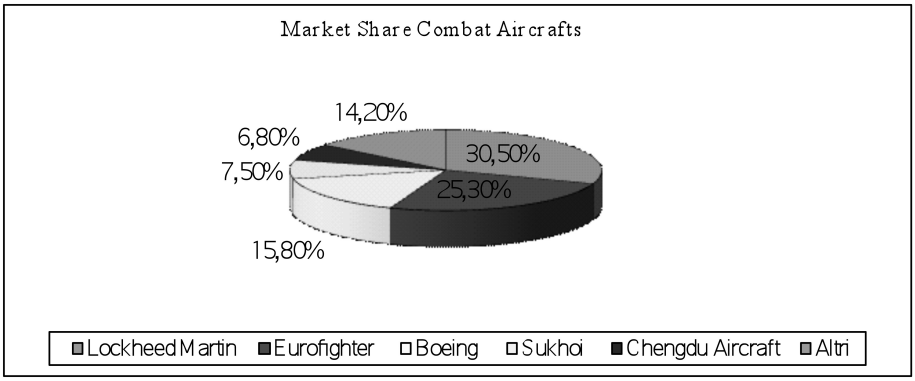
[35] Chamber of Deputies, Defense Committee IV, transcript of meeting of 16 January 2007, p. 3.
[36] A. Nativi, "Realtà e prospettive dell'Aeronautica Militare", interview with Gen. Camporini, *Rid*, September 2007, p. 27.
[37] F. Giunchi, "L'aeronautica militare e il JSF", *Rivista Aeronautica*, *op. cit.*, p. 47.

2. THE DEFENSE INDUSTRY AND INTERNATIONAL COOPERATION

The renewal of the European combat aircraft fleets comes within a broader world context that also sees the United States and various Asian countries undertake a substantial upgrading of their air forces. This is also driven by the accelerated development of technology in recent decades. "Advancements in weapons, sensors, cockpit and performance have made the newer aircraft more effective than older models, while their systems are more reliable, require less maintenance and are easier to upgrade throughout their life cycles than the aircraft they are replacing."[1]
This tendency does not impact only the Euro-Atlantic area. Russia and China have also entrusted their respective national industries, Sukhoi and Chengdu Aircraft, with substantial programs to upgrade their air forces, while significant orders are anticipated from India, Pakistan, Saudi Arabia and other regional powers. Over the next four years the world's main combat aircraft makers will increase their production volume while keeping their respective market shares stable in terms of value of production.

Lockheed Martin and the Eurofighter consortium, the latter comprising BAE Systems, Eads and Alenia Aeronautica, will see the US and European markets drive their combat aircraft production. Specifically, many experts in this field predict that the F-35 program "is likely to account for a large portion of world-

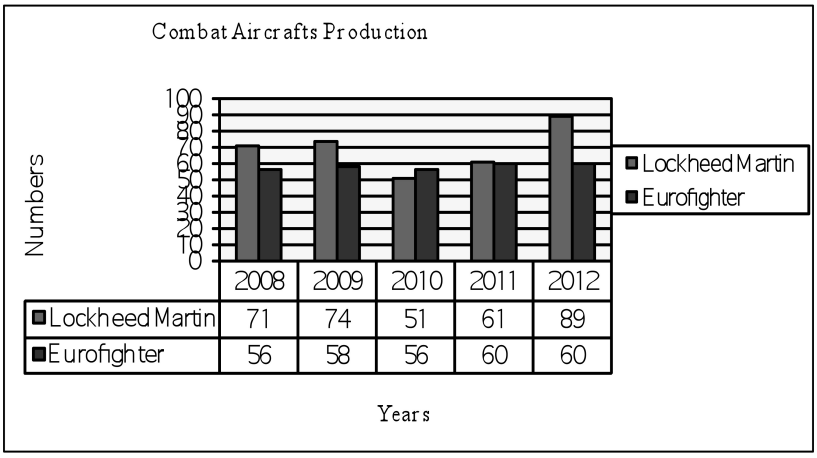
[1] "Fighters in front", in *Aviation Week and Space Technology – Aerospace Source Book 2008*, January 2008, p. 20.



Source: *Aviation Week and Space Technology , Aerospace Source Book 2008*, 2008-2012 forecast.

wide annual fighter production," [2] not just because of the massive orders anticipated from the United States – about 2,700 aircraft – and its European allies – at least 730 aircraft – but also through the likely sales to other countries such as Israel.

With regard to companies capable of developing complete platforms, there are at least eight major European and North American players that can be said to have fathered a specific combat aircraft currently in production or in use with Euro-Atlantic air forces.



Source: *Aviation Week and Space Technology*, *Aerospace Source Book* 2008.

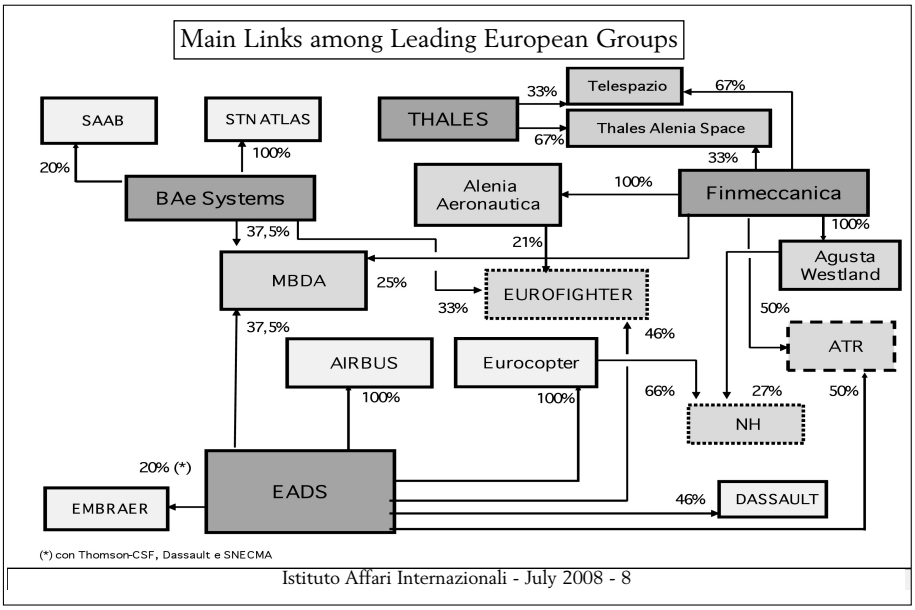
[2] Idem.

Manufacturer	Country	Combat aircraft
Alenia Aeronautica (Finmeccanica)	IT	AMX, Tornado, Efa Typhoon
BAE Systems	UK	Harrier, Sea Harrier, Tornado, Efa Typhoon
Boeing	USA	AV-8B, F/A 18 Hornet, F/A 18 Super Hornet, F-15 Eagle
Dassault	FR	Mirage, Rafale
EADS	FR-GER-SP	Tornado, Efa Typhoon
Lockheed Martin	USA	F-117, F-16, F-22, F-35
Northrop Grumman Integrated	USA	F-5
Saab	SW	JAS, Gripen

By including the propulsion and avionics sub-sectors, the scenario is further broadened to other major national or trans-national companies that are present at various levels in one or more fields. Some of these players are also involved in the manufacture of non-combat military aircraft (transport, reconnaissance, etc.) or of commercial aircraft, as well as of other weapon systems (missiles, naval etc.). Although the figures tabled in Appendix I for turnover and headcount refer to the complete entities, our analysis only deals with those areas of specialization with industrial and technological capabilities directly related to combat aircraft.[3] It should also be borne in mind that the scenario of the major European industries active in the aerospace and defense sector should not be viewed as a field of stand-alone monoliths. It is more properly depicted as a network of players who often agree to pool resources and assets to develop a given military program. The result is a number of variable geometry consortia or international joint ven-

[3] Appendix I, "Main Euro-Atlantic industrial capabilities in the combat aircraft business", lists the 12 main players active in this field in the Euro-Atlantic area: Avio, BAE Systems, Boeing, Dassault, EADS, Finmeccanica, General Electric Aviation, Lockheed Martin, Northrop Grumman, Rolls-Royce, Saab, Thales.

tures involving all the main European industries, starting from BAE Systems, Eads, Finmeccanica and Thales. It must also be remembered that even "national" companies such as Dassault of France and Saab of Sweden may include non-national players among its shareholders – in this case respectively the Franco-German group Eads (46%) and Britain's BAE Systems (20%).



Source: G. Gasparini, L. Marta, "*Economia e industria della difesa: tabelle e grafici*", www.iai.it, 2008, p. 18.

Turning to the Italian context, the largest industrial player in the aeronautics business is Alenia Aeronautica (AA), a Finmeccanica company. Alenia has about 11,000 staff and defines its activity as the "design, manufacture, conversion and support of a broad range of aircraft and aeronautical systems, both commercial and military."[4] Specifically, in the field covered by this study it designs and builds – whether directly or through international cooperative programs – the Efa, Amx and Tornado combat aircraft.
With regard to the Efa, Alenia is partnered with BAE Systems and Eads with a 19.5% work share comprising the "left wing, rear fuselage, wing

[4] Aiad, "Repertorio aziende associate 2007", p. 41.

pylons, secondary power systems. Alenia also participates in the development of the navigation, armament, landing gear, propulsion and utility control" systems." [5] The aircraft entered series production in 1998, with 620 aircraft expected to be delivered by 2014. Alenia had previously built the Tornado with the same industrial partners. Its role comprised the production of "variable-geometry wings for the entire production run and assembl[ing] 99 machines for Italy, some of which later upgraded to Ecr standard." [6] The 900 Tornados built under the program were assembled at three national final lines, each managed by the corresponding partner manufacturer. Through the Panavia consortium Alenia still supports the Italian Air Force Tornado fleet, including the mid-life update.

Unlike the other two programs the Amx is controlled largely by Alenia Aeronautica and its Aermacchi subsidiary, with a minority participation of Brazil's Embraer (29.7%). The specific Alenia contribution was to build "all fuselage center-sections and manage the Italian assembly lines." [7] Italy and Brazil ordered 182 Amx in total.

In addition to manufacturing components and complete platforms, Alenia also provides the Italian armed forces and international industrial partners with logistic support and maintenance and overhaul services for military and commercial aircraft, obviously beginning with its own products. It also offers a number of technological services through some state of the art infrastructures such as its shielded anechoic chamber, the simulation center, the new structures and systems lab and the Sky Light Simulator.

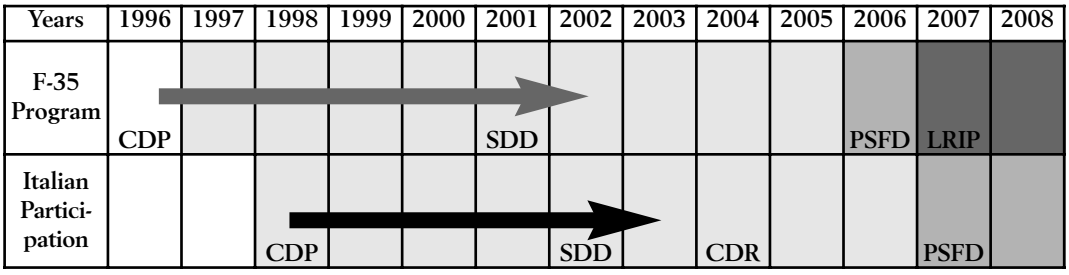
[5] www.alenia-aeronautica.it
[6] Idem.
[7] Idem.

3. ITALY IN THE F-35 PROGRAM

3.1 The Italian Role

The original Italian involvement in the F-35 program was decided in 1998 by the D'Alema administration with a 10 million dollar contribution to the Concept Demonstration Phase (Cdp). With the launching of the System Design & Development (Sdd) during the Berlusconi administration, on 22 June 2002 the Italian Ministry of Defense (MoD IT) signed with the US Department of Defense (DoD) the Italy/USA bilateral supplement to the general Framework MoU.

Italian participation in the F-35 program



Abbreviations:
CDP = Concept Demonstration Phase
SDD = System Design & Development
PSFD = Production Preparation, Sustainment & Follow-on Development
LRIP = Low Rate Initial Production

The Italian contribution to the Sdd phase amounts to about 1,000 million dollars spread over 11 years from 2002 onwards.[1] Since then the overall cost of the F-35 program has continued to grow over the years, from 233 billion dollars in 2001 to 300 in 2006.[2] This problem is not, by the way, specific to this program because the same has happened and happens in every major civil and military program, whether aeronautical, space or naval. There is an inescapable objective difficulty in estimating the costs of programs that are very complex, very large and very long. This difficulty is increased by the cost of technological innovation, whether developed directly or made available thanks to other programs. There is, however, a subjective component linked to a certain tendency to limit cost estimates for any program as much as possible in order to win the required approval from political decision makers.

F-35 Program Costs

Estimate made in	2001	2003	2005	2006
Cost in USD billion	233	244,8	276,5	299,8

Source: M. Sullivan, "Jsf Impact of recent decision on program risks", *Gao*, 11 March 2008.

With regard to the program cost increase over the past years, during the Prodi administration Undersecretary Lorenzo Forcieri confirmed to the Italian Parliament that "the agreement provides for different and greater costs to be absorbed by the United States and not by the other partners. Our participation is therefore limited to that which was indicated in 2002 and that is not a contribution that can escalate."[3]

According to the latest Dod estimate of April 2008, the average stabilized cost (i.e. obtainable in full production and not in the initial Lrip of the program) Urf (Unit Recurring Flyaway cost, including *airframe*, *mission system*, *vehicle system* and *propulsion system*) runs to 49.5 million dollars for the Ctol and to 61 million dollars for the Stovl.

[1] The rate of exchange is set at about 1.16 Euro per US Dollar, which translates into an overall cost of about 1,190 million Euros for the Italian government.
[2] M. Sullivan, "JSF Impact of recent decision on program risks", Gao, 11 March 2008, p. 6.
[3] Chamber of Deputies, Defense Committee IV, *op. cit.*, p. 13.

In accordance with the provisions of the production Memorandum of Understanding (Psfd MoU) signed by the US government and by the eight countries participating in the program, the cost of the partners' aircraft will be exactly the same as that of the American aircraft purchased in the same production lot. Cost differences are only envisaged in case of particular changes being requested by individual countries.
The MoU for the Sdd regulates in detail the participation in the program. In particular, as a Level II partner Italy:[4]

- has the opportunity to influence aircraft requirements, albeit in a limited way;
- places its personnel in the Jsf Program Office for a better access to information and to ensure adequate technical, planning and financial visibility;
- accrues profits on exports beyond the initial partners, proportionally to the investments made in the development phase;
- purchases aircraft at a lower cost than either lower level partners or external purchasers;
- is guaranteed a priority in aircraft deliveries over Level III partners.

According to the official position expressed by the Italian Air Force Staff on the choice between a direct purchase and participating in the program, "adopting a Us system without adequate visibility of the systems it comprises would not offer the operational and operating independence levels fundamental for national Armed Forces. This is guaranteed only through an adequate presence in the Program Office that cannot be achieved at lower levels of participation and/or contribution."[5]
At present the international cooperation in the F-35 program can be summarized in the following broad scheme. Each partner country formulates its requests to the Jsf Program Office (Jpo), with regard to both aircraft requirements (obviously within limits) and to the quantity and model of F-35s it intends to purchase. The Jpo examines the national requests, discusses them with partner countries and formulates an overall request to Lockheed Martin indicating the number of aircraft to build for each variant, the basic aircraft requirements and if applicable the specific integrations to the basic configuration requested by individual countries and

[4] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit*.
[5] Chamber of Deputies, Study Service, "Programma pluriennale di R/S n. Sma 002/2002", 22 May 2002, p. 18.

financed by them in addition to the basic configuration. Lockheed Martin and Pratt & Whitney manage independently the sub contracts with European and American suppliers, which provide their products or services to the prime contractors responsible for delivering the aircraft and engines under the terms provided by the Jpo contract.
By participating in the F-35 program, the Italian industrial system has had to accept its basic "best value for money" philosophy. Companies in partner countries participate in the supplier competitions managed by the American prime contractors on an equal access basis, and bids are selected based on the best price/quality ratio. Although this approach forsakes the balancing of cost-share and work-share typical of previous international cooperations, according to Undersecretary Forcieri the new best value criteria is not "an absolute principle, but [rather one] tempered by the agreements that have been signed at both government and industrial level."[6] From the outset of the negotiation process the Ministry of Defense succeeded in introducing the concept of the "just return" for industry, in terms of both quantity and quality of the subcontracts awarded to Italian industry.
To this end an additional agreement was negotiated in 2002 through a Side Letter, precisely to introduce a greater degree of protection for national interests in both the operational and industrial field. The Side Letter specifically "protects the exchange of information required to operate and manage the Jsf fleet on a national basis, and seeks and confirms the support of the Us government to Italy in obtaining a level of industrial return coherent with Italian participation in the program."[7] As General Bernardis, then head of the 4th Department of the National Secretariat of Defense/National Directorate of Armaments (Sgd/Dna), stated in a parliamentary hearing in 2004, together with the supply of the equipment required by the armed forces the goal was to assure "an adequate return for the Italian industrial sector, not in merely quantitative financial terms but rather in terms of technologies and competitive opportunities for domestic industry on a worldwide scale."[8]
Lockheed Martin has certain management latitude in applying the best value principle to individual contracts. In general there can be identified

[6] Chamber of Deputies, Defense Committee IV, t*op. cit.*, p. 5.
[7] Chamber of Deputies, Study Service, "Programma pluriennale di R/S n. Sma 002/2002", 22 May 2002, p. 18.
[8] Chamber of Deputies, Defense Committee IV, transcript of meeting of 20 July 2004, p. 6.

three modes by which the prime contractors handle contractual relationships with European and American suppliers.
Particularly during the development phase, it can happen that Lockheed Martin sets a maximum level of expenditure for a given component, system or service, and the supplier chosen initially keeps the contract as long as he remains within that ceiling.
Lockheed Martin can also open, for a given supply, the bidding to all industry players, assigning the contract to the company providing the best value in terms of cost and quality.
Finally there are the "strategic second sources". Lockheed Martin believes that the strategic requirements of the program require having more than a source to provide certain capabilities and therefore signs agreements with two different suppliers of a given product. For instance Alenia Aeronautica, a Finmeccanica company, has strategic second source status for the F-35 wings, after Lockheed Martin itself. Italian industry will continue to provide wings as long as it can keep their price lower or equal to that of the units produced by Lockheed Martin at Fort Worth.
Should the "second source" price become greater than that of the first source, Lockheed Martin could resort to a competition to seek on the market another supplier offering best value for that specific product. Most supplier agreements with Lockheed Martin currently have a one-year term, but they are expected to become five-year contracts with the start of full production. In any case Lockheed Martin will check from time to time whether its supplier continues to offer the best value available on the market for that specific product or service.
Confirming the policies of previous administrations, on 7 February 2007 the Prodi government signed with the United States the MoU for the Production, Sustainment & Follow-on Development (Psfd) phase. The Italian contribution runs to 903 million dollars, the second largest of all European partners, without considering the possible purchase of an as yet undecided number of aircraft. The Psfd phase is linked to non–ecurring costs (industrialization and operational support phases), including for example the tooling required for production, development of common follow-on requirements and organization of aircraft sustainment.
On that occasion Undersecretary Forcieri again stated that "the project will have considerable industrial and employment returns. In economic and financial terms the purchase of aircraft will translate for Italy into a commitment estimated to be about 11 billion dollars, in exchange for

which we seek 100% industrial returns and increased employment proportional to such volumes." [9] In a longer term prospective, by deciding to join the Pfsd phase "on the industrial level we have sided with the importance of the experience that will accrue by participating in the largest military aviation program in modern history, based upon a logic of efficiency and competition that forces participating industries to constantly seek the greatest competitiveness." [10]

Together with the signing of the MoU for the Psfd phase the United States granted their approval for the building of the Final Assembly and Check-Out (Faco) and Maintenance, Repair, Overhaul and Upgrade (Mro&u) center within Cameri Air Force Base, in Novara province and currently the seat of the Italian Air Force's 1st Aircraft Maintenance Unit. The cost for Italy of the work necessary to build the facility remains to be defined, and Lockheed Martin will entrust the industrial operation to Alenia Aeronautica.[11] From a military point of view the ability to perform autonomous maintenance and support operations for the F-35, on national territory, is a fundamental condition in order to fully master the weapon system and the technologies within it, with all the evident fallout in strategic terms.

The presence of such a center would also offer greater opportunities for the transfer of sensitive technologies from the United States to Italy, something indispensable for the Faco/Mro&u activities themselves.

The F-35 program initially envisaged the Lockheed Martin facility in Fort Worth, in Texas, as the only Faco, and "the second center in Italy would have been the only one in Europe and thus *naturaliter* destined in the near future to support, as the cheapest and most practical solution, also the Jsf fleets of the European program partners, of the American fleet deployed in the Old Continent as well as those aircraft purchased by other countries in the Mediterranean." [12] In addition to bringing about the acquisition of leading-edge technologies and positive employment benefits, opening a Faco in Italy sets the foundation for industry to present itself to prime contractors as the best value supplier for Pfsd phase contracts. Having already borne the non-recurring costs to build the Cameri infrastructure, it would be possible

[9] Ansa newswire, 7 February 2007.
[10] M. Nones, "La scelta sofferta dell'Italia", in *AffarInternazionali*, 8 February 2007.
[11] Defense Industry Daily, "F-35 Joint Strike Fighter: Events & Contracts 2007", 15 November 2007.
[12] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit.*

to make Lockheed Martin the most attractive – and thus competitive – financial bid for many of the Pfsd activities. In addition, the Faco workforce would also have acquired important knowledge and capabilities, making it easier for staff to acquire the additional "bit" of knowledge required to perform any activities that Lockheed Martin may wish to carry out in Europe. It is evident that this would entail a volume of work much greater than that necessary for the Italian fleet alone, making Cameri a candidate for a multimode European maintenance center of excellence for the most advanced military aircraft, with important industrial fallout and workforce protection for the next 40 years.

3.2 The Relationship between the F-35 and Eurofighter Programs

The strategic choice to procure both the F-35 and Efa must however take into account the financial compatibility between the two programs in terms of the funding available in Italy to procure and upgrade such weapon systems. Setting aside the ideological clash between those who favor an exclusively European program such as Efa and those who prefer transatlantic cooperation on the F-35 (or consider it unavoidable), speaking on behalf of the Prodi administration Undersecretary Forcieri stated in Parliament that with regard to Efa "there is no competition with Jsf in budgetary terms particularly because neither of the two programs represents a duplicate of the other. The multirole Jsf is, indeed, a fifth and latest generation aircraft; thus not a competitor of the fourth generation Eurofighter, which has complementary technical and strategic characteristics." [13] The timeframe of the two programs should also be take into account, with specific reference to the fiscal years in which specific funding is anticipated and to the moment when the Italian armed forces will have available fully operational Efas and F-35s. With regard to the F-35, joining the Psfd phase entails a government expenditure of 903.2 million Euros, but the final installments of the Sdd expenditure decided in 2002 should also be taken into consideration.

[13] Chamber of Deputies, Defense Committee IV, *op. cit.*, p. 3.

Cost of program participation

Italian Contribution to the Sdd phase (Exchange rate set at 1,16 Euros per Dollar)	Italian Contribution to the Psfd phase in millions of Dollars
2002 - 85	
2003 - 104	
2004 - 126	
2005 - 152	
2006 - 171	> 2007 - 5,8
2007 - 154	> 2008 - 18,5
2008 - 98	> 2009 - 38,1
2009 - 68	> 2010 - 41,1
2010 - 41	> 2011 - 54,7
2011 - 27	> 2012/2046 - 745
2012 - 2	

Source: IAI estimate

With regard to the cost of acquiring the aircraft, not yet officially decided but very likely in the light of the analysis thus far carried out, it is possible to estimate some 100-130 aircraft spread out between 2014-2025, for a total cost of 5.2 billion dollars. Meanwhile, at least for the 2008-2018 decade, Italy will also bear the cost of the Efa fleet it has already contracted. The Eurofighter program agreements are very rigid, with stiff penalties for countries should they decide to cut their initial aircraft order. This makes a substantial reduction in the financial commitment for such procurement very unlikely, unless it should be replaced with third-party exports. From this point of view the F-35 offers greater flexibility in terms of the number of aircraft to purchase, the mix of Ctol and Stovl variants and the procurement timing.

Rather, the decision margin of the Italian government is circumscribed by the strategic needs of the armed forces. As described in Chapter 1, this means the specific need for an adequate expeditionary fleet as well as the urgency to replace the Amx fleet from 2014 and the AV-8B fleet around 2018, with the additional requirement to operate from Italian carriers. It will therefore be necessary to carefully harmonize the "phase down" of the Efa program, if pos-

sible by spreading the last tranche of purchases over several fiscal years, with the "phase up" of the F-35 program capable of ensuring that a Stovl squadron will be operational in time to replace the AV-8B being withdrawn from use. To this end it is necessary to consider that the three-year period 2015-2018 is likely to witness a peak in defense expenditures due to the simultaneous purchase of the final Efa aircraft and of the first F-35s.

3.3 Industrial and Technological Innovation

The defense industry is a "knowledge-intensive" field, in which the value of knowledge to companies is extremely important. Knowledge can be classified in three levels: technical, pertaining to the acquisition of new or specific techniques; systemic, covering the organizational systems and procedures; strategic, referring to the ability of company management to handle a complex military program.[14] An international cooperation such as the F-35 program is a means to increase the technical, system and strategic knowledge of participating companies. From an American perspective the goal is, firstly, to gain access to European technological innovation, such as vertical take-off technologies developed by Bae Systems and incorporated in the Stovl variant, or other technologies matured by the Efa program and even – as with some aspects of composite airframe materials – even in commercial programs. In addition to becoming the recipients of certain leading-edge technologies, European companies have the absolute need to continue to increase their system knowledge in order to preserve national industrial capabilities in a rapidly evolving field. The main factor in favor of learning by cooperating – cooperative learning –[15] is the common goal to forge a long-term alliance: for if partners believe they have basic interests in common, or at least compatible, that will lead them to a long cooperation, they will be strongly motivated to learn "from" their partner and "with" their partner, with a scope and intensity in direct proportion to the goals of the alliance. Instead, collaborations not placed within such a strategic alliance framework lead each partner to seek an opportunistic maximization of the advantages to be derived from the cooperation, with prejudice to the exchange of knowledge and giving rise to a process of competitive learn-

[14] D.W. Versalilles, V. Merindol, "Knowledge transfers and R&D management: an inquiry into the problem of transatlantic complementarities", *Defense and peace economy*, IISS, June 2006.
[15] Idem.

ing. With this in mind, leading world powers such as the United States "try to assess the technological positions of other countries in the general framework of strategic alliances,"[16] and the same is true on an industrial level, with the major American prime contractors preferring to consolidate their strategic partnerships with European suppliers.

Because of its unique size and nature, the F-35 program touches upon knowledge assets previously not open to international cooperation, and is generating process of both competitive and cooperative learning. On the one side, the strength ratio system is extremely favorable to the United States and has generated an asymmetry of learning that rewards the American side decisively. European partners are largely excluded from strategic knowledge and from part of the system knowledge, without access to either the general steering of the program or to its decision-making process. On the other hand, however, European industries acquire both a part of the system knowledge (thanks in part to international cooperation already in the F-35 Sdd phase) and in technical knowledge by way of the transfer of the information and technologies required to make the subcontracted components, and by working in groups with prime contractors in the overall production process. States play a crucial role in determining the quantity and quality of the transferred knowledge, because they influence both the weapon system parameters they will procure and the conditions for national industrial participation. In the F-35 program each phase of the international cooperation is marked by long negotiations and numerous agreements between European governments and the United States, and between American prime contractors and Old Continent companies, impacting the overall transfer of knowledge and sensitive technologies.

According to some analysts, however, "what seems at first glance to be a complex compartmentalization and therefore a source of tension among the various partners committed to the programs turns out to represent the best way to secure the knowledge assets and avoid the dispersion of competencies."[17]

Specifically, the initial phase of the program was particularly crucial because it determined the adjudication of contracts that would later follow the development of the weapon system. The difficulty in obtaining from American authorities and prime contractors the information necessary to compete ade-

[16] D.W. Versailles, V. Merindol, "Knowledge transfers and R&D management: an inquiry into the problem of transatlantic complementarities", *op. cit.*, p. 242.
[17] D.W. Versailles, V. Merindol, "Knowledge transfers and R&D management: an inquiry into the problem of transatlantic complementarities", *op. cit.*, p. 253.

quately in the bidding process, as well as the difficulty of Italian industry in responding to the new rules, weighed negatively against the ability of Italian firms to reap the opportunities offered them. In this difficult contest, the national industries that acted more effectively were those which, on account of existing relations with the American defense market, already had some knowledge of both their industrial counterparts and of the political-legal system that presides over United States defense procurement. Alenia Aeronautica is a case in point, for the experience from its previous industrial relationships with Boeing helped it become the second supplier of complete F-35 wings, with an estimated 1,200-unit production run. This is a single crucial part of the airframe, which includes both wings and the fuselage section linking them – in other words, a very complex assembly. Specifically, wing panels and nacelles will be built by Alenia in Foggia, then shipped to Turin for wing pre-assemble and finally sent to Fort Worth for final assembly; should the Italian Faco be built completely and quickly, the wings would also go to Cameri for installation on aircraft assembled there. While it is true that Italian industry has been able to gradually enter new high technology fields with considerable potential, it is also necessary to distinguish between the technical knowledge to transfer: for instance while "on the American side there is a barrier to share software reputed to be sensitive, such as electronic warfare systems, there is greater openness towards industrial collaboration on hardware components." [18] As to electronic warfare, for instance, it must be considered that the major operators add to their specific database those threats which are considered prioritary, data on specific national armaments integrated on the aircraft, and in general all that pertains to the specific use of the weapon system by their own air force. The databases of allied countries are thus partly non-overlapping precisely because of the specificity of national air forces, for instance because of the different value attributed to each threat to weigh it. Thus, while it is true that the United States do not want to share with F-35 program partners the algorithms upon which their electronic warfare system is based on, in fact major countries use their own algorithms built up over the years through their accumulated experience and the national strategic context.

In those areas that foresee a greater transfer of knowledge from the United States to its European allies, there can be found actual examples of innova-

[18] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit*.

tion – whether of product or process – introduced into the Italian industries involved in the program. With regard to production methods, for instance, Alenia personnel operating in the paint shops in the Cameri Faco will apply the special paint that contributes to the low radar signature of the F-35. Even after analyzing the product, the formula of the paint cannot be duplicated because even an understanding of its basic elements will yield neither their individual percentages nor the action of the additives used by their American makers. Still, the fact that Italian technicians will work in the finishing phase, in close contact with American engineers, will make Alenia the only European industry able to work on this specific technology of increasing importance in the military – not merely aeronautical – field.
Another element that contributes to low observability is the design of the aircraft, and a transfer of knowledge by osmosis occurs in a sense even here. For instance, engineers will be able to study at close quarter the design of the curves that smooth the sharp edges to reduce radar signature. In addition to low observability, Alenia also works on the other great technological advance of the F-35 over the previous generation of aircraft: vertical take-off. The Stovl variant is extremely more advanced than the AV-8B with which Italian industry is already familiar. The Stovl variant will also need to have low radar observability, and this represents a completely new aspect in engine terms. Alenia assembled the AV-8B in Turin and still supports the aircraft, an experience that has proved very useful to understand the innovations of the Stovl variant, for instance in terms of mission system software.
To build the wings Alenia Aeronautica will use a new "fiber placement" technology by installing special machinery – which it has already done – to place the fibers used to make parts in composite materials. This technology, already used to build major parts of the Boeing 787 fuselage, will also be used on the Jsf, but will require placing a large amount of much thinner fibers to create the composite material. Another process innovation consists in the use at Fort Worth of a pulsed, rather than fixed, assembly line, with a technique somewhat like that of a car assembly line, but much more sophisticated and accurate, with great advantages in terms of assembly time and above all a great reduction in wasted time.
More broadly, two other factor help process innovation: production targets and the precision required by the prime contractors. On one side, the production volumes envisaged by the F-35 program are the largest so far placed before the Italian defense industry, and can teach much about working with large quantities, for instance in terms of organizing human resources, supply

of materials, etc. On the other hand, American prime contractors, starting with Lockheed Martin, on order to obtain a perfect assembly of the components built in the several partner countries require that subcontractors meet standards of precision much higher than those previously employed. This is a strong stimulus to improve manufacturing and workmanship.
Another contribution to the transfer of knowledge and a stimulant for process innovation is the insertion of Italian industrial staff in various areas of the F-35 program in the United States, which in itself engenders the maturation of a widespread knowledge about the program. Unlike product innovation, restrictive legislation has a limited impact on process innovation: once the decision to work in team with staff from allied countries it becomes difficult – if not impossible – to quantify or stop the personal experience accumulated day by day by individual technicians and which can then be reused directly by the same person in other programs handled directly by his company.
With regard instead to product innovation, a foreword is necessary. The handling of F-35 components is subject to the same level of classification of other programs such as the F-22. In addition, because these technologies are also destined for the international market, they are designed to be impossible to copy – whether because, like the paint, they will not reveal their secrets even if analyzed, or because they are impossible to open without destroying them, like certain software codes or hardware components. Despite this it is still possible to identify positive fallouts even for product innovation. From the avionics point of view, for instance, the F-35 incorporates a wide range of technologically innovative sensors. The F-35 is only the second military aircraft, after the F-22, to make widespread use of so-called modular avionics that should significantly reduce the equipment costs. Italian industry is laying the foundations for its involvement in the production and repair of the associated components.
In general it should also be considered that the number of product and process innovations that can be received is limited, because in some areas, such as avionics, the gap between the United States and Europe is not huge. For instance, the F-35 structure uses materials that are not completely new, for the Alenia technicians and the European colleagues are already familiar with composites through their experience with the Efa. American products and processes can be different from those used in Europe, but this does not make them automatically more advanced; in some cases knowledge can be thus exchanged on an almost equal basis. This is demonstrated by the good integration of the Italian engineers in the working

groups in the United States, which is in turn reflected in the fact that the nature of the problems with the transfer of technology is not technical but rather political. Further evidence of this comes from the fact that the F-35 weight-saving program, a very significant problem because of its impact on aircraft cost, saw the significant contribution of Italian industry, which was congratulated by the American prime contractor. Alenia Aeronautica was subsequently tasked with the structural design of the wing box for the Ctol and CV variants. It is therefore essential to reinforce this qualified Italian presence.

Reasoning about possible spin offs, some of the innovations and steps forward brought about by the F-35 program are certainly capable of being reused in the aeronautical and space domain, particularly in avionics and remotely piloted vehicles. In some cases there is no immediately visible fallout, but it cannot be ruled out that in the future the new technologies could be used for further applications. With regard to the spill over of innovation in the civil field and in non-aeronautical fields, the experience of the past decades shows that the development of new technologies in aeronautics ultimately has a positive impact in multiple industrial fields in terms of quality, performance, reliability and maintainability.

But the main actual generator of spin off and spill over opportunities in the F-35 program will probably be the Cameri Faco, in which Alenia Aeronautica and other Italian companies will work on Operational Maintenance (OM). The Faco would allow Alenia Aeronautica to assemble and test complete aircraft in full autonomy, except for measuring the level of aircraft stealthiness, which is currently considered a critical element by the United States. Indeed the plan foresees the building within the Cameri Faco of a separate section to measure the stealthiness, fully fitted out by the American prime contractor and exclusively reserved for US staff. Every other Faco structure will be built by Italian industry and managed by non-American staff, with an intensive planned interchange with Italian staff tasked with carrying out repairs on other aircraft components. These activities will entail the acquisition of a considerable transfer of technology in order to perform aircraft assembly and test/certification activities.

For instance, Italy anticipates the acquisition of information and technologies associated with a cockpit based on advanced software that supports a reconfigurable screen divided into several windows that can visualize the information required by the pilot, who can select the most relevant data by touching the screen.

Another significant technology acquisition will stem from the radar based on the Active Electronically Scanned Array (Aesa) already used and developed for the F-22. This type of radar has no moving parts and is considered so reliable that its compartment on the airframe is sealed, there being no foreseeable need to open it for maintenance. Other interesting new technologies transferred are the Electro-Optical Targeting System (Eots), which is based on Lockheed Martin technical developments in this technology which has marked infrared vision abilities, and the clearly innovative Electro-Optical Distributed Aperture System (Das) which has six cameras distributed around the airframe in order to give the pilot a 360° field of view.
The last significant innovation is the helmet, which brings together the classic Helmet Mounted Display System ability to display information and the ability to also see infrared imagery or images from on-board cameras; the visor also offers protection from lasers. With these functionalities the helmet because a true aircraft control system, through which the pilot can perform everything from routine operations to target acquisition and designation.
In addition to the technological innovations associated with aircraft assembly and test phases, it should be considered that Lockheed Martin has introduced for the first time a new concept of aircraft logistics, which will no longer be maintained to a set schedule nor following the discovery of a problem with some component. On the F-35 it will be the integrated aircraft itself to "constantly communicate, through Prognostic and Health Management, the state of its health, underlining with ample warning those systems that are beginning to show problems." [19] This will allow maintenance to be carried out promptly but only where necessary, reducing maintenance downtime and therefore cost. This support philosophy will be applied to the entire F-35 fleet "and spare parts manufactured by each industry involved will be handled by a network of shared depots that will distribute them to the appropriate airfield."[20]
In theory therefore all parts will centrally managed through a network of depots and sites, with a flow of data on the condition of individual aircraft to a single database of the mother company, which in turn will transmit its feedback to individual network centers affected by the specific repair.
Maintenance work will be guided by subsidiariety: repairs or replacements will be carried out nationally where possible, proceeding to a regional-continental level (which for the European region would likely mean using the

[19] D. Lissoni, "Lockheed Martin sceglie l'Italia come base", *LiberoMercato*, 6 March 2008.
[20] Idem.

Cameri Faco/Mrou center) and, should this also prove unable to operate, to the American center that performs at the global level. This architecture offers significant room for a European logistics center and Alenia, understanding the new approach to logistics, has made proposals to Lockheed Martin in areas in which it believes that Italian industry could represent a center of excellence. Lockheed Martin, on the other hand, plans to contract to local industry those activities linked to Faco/Mrou activity that can be outsourced with a better cost/effectiveness ratio.

Logistics concepts are already being structured and evolving, in parallel with the development of the aircraft, systems, simulator and all the other technologies and structures required to employ the F-35. For instance, on its sixth sortie the aircraft was already monitored by the electronic system that will monitor the entire American fleet.

If the wide scale use of the new logistic concept, and particularly of the Prognostic and Health Management already used on the F-35 prototypes already flying, will deliver the anticipated results, in the near future it could also be applied to commercial aviation with comparable time and cost savings. Since Cameri will be the only Faco/Mrou facility in Europe, supporting the fleets of both the European partners and the United States in the Old Continent, it clearly follows that Alenia will operate the center that will radiate the new logistics concept that will operate on hundreds of aircraft for several decades.

In evaluating the implications for Europe of the Italian participation in the F-35 program it is useful to examine its position comparatively with Holland, a Level II partner like Italy and having important ties with the Italian defense industry. DutchAero, for instance, is a subsidiary of Italy's Avio.

Dutch companies have received contracts valued at about 700 million dollars, while their government has contributed some 800 million to the Cdp and Sdd program phases. According to a study published by the IISS, participation in the F-35 program clearly benefited the aerospace industry in terms of both turnover and employment,[21] but the quality of the participation won by the Netherlands is more interesting than the quantitative aspect. In fact consideration must be given to the opportunity for additional activities directly derived from the innovations created through partici-

[21] M. Van De Vijer, B. Vos, "Improving competitive positioning in the aerospace industry: a case study of Dutch participation in the F-35 Lightning II (JSF) programme", *Defense and peace economy*, B. Vos, December 2007.

pation in the F-35 program, both in the aerospace industry (spin-off) and in other fields (spill-over). DutchAero has for instance developed the Electro Chemical Machining process, which is based upon a process modified specifically for the aerospace sector and already used in other engine programs such as the CFM 56 managed by Avio and Snecma and the RB199 in collaboration with Rolls-Royce.[22]

When other technological innovations are taken into account, such as Embedded Training (a new pilot training methodology) or the special wind tunnel built for the Stovl variant, it can be seen that "especially in the development phases, valuable knowledge is created, characterised by the development of new technological standards that often are transferable to other aerospace programmes, either military or civil." [23] It is also worth mentioning that, in addition to technical and system knowledge, there has been a useful transfer of strategic knowledge, because the study shows that "participating in the development of the F-35 Lightning II enabled Dutch companies to perform and compete on a 'best value' basis. This requires another mentality within the firm and a different type of management." [24] Also of great importance is the "qualified supplier" label earned by companies working as subcontractors to the American prime contractors, which enables European industries to participate in United State competitions with better chances of success.

Finally, with regard to the position on the international market, it must be underscored that participation in the F-35 program allows Dutch companies to launch further cooperations and contracts, also through a closer cooperation with other American companies involved in the program. For instance, it was precisely through the participation of DutchAero in the Jsf program, Rolls-Royce has stated that its relationship with Dutch industry has evolved into a "strategic partnership". The vast majority of the observations on the Dutch case are also true of the Italian case: to a certain extent technical and system knowledge as a basis for later spin offs and spill overs, strategic knowledge of the "best value" system, improved "ratings" of national companies on the US market are goals achieved and achievable by the Italian companies involved in the F-35 program.

[22] M. Van De Vijer, B. Vos, "Improving competitive positioning in the aerospace industry: a case study of Dutch participation in the F-35 Lightning II (JSF) programme", *op. cit.*, p. 514.
[23] M. Van De Vijer, B. Vos, "Improving competitive positioning in the aerospace industry: a case study of Dutch participation in the F-35 Lightning II (JSF) programme", *op. cit*. p. 513
[24] M. Van De Vijer, B. Vos, "Improving competitive positioning in the aerospace industry: a case study of Dutch participation in the F-35 Lightning II (JSF) programme", *op. cit*. p. 516.

In general, in Italy as well as in other European countries, the evaluation of the transfer of technology and the quality of the work share won should take into consideration the overall program and its long-term fallout, first and foremost in terms of quality.
Considering the introduction of a new level of competition in which technological innovation and international competition are decisive variables, the first broad evaluation of the quantity and quality of the work share obtained by Italian companies in the F-35 can be considered positive. The result, however, is not fully satisfactory, because the Italian industrial base has reacted unevenly to the available opportunities, putting together good successes and missed opportunities for a mixture of industrial, technological and political reasons.
Faced with the uncertain scenario and the new rules of the game, another trait in the behavior of the Italian industrial base has been the initial will to maximize opportunities by making – each with its own technologies - a number of bids in order to be included in the development phase. Although important goals have been reached, the results of Italian companies were also determined by the degree of sensitivity of the technologies involved. In fact "because of the limited information on the mechanics and guidelines of American policy on transfers of technology, it has been, and still is, difficult for Italian companies to choose work share goals combining high quality with the release of sensitive information at a level altogether acceptable to American authorities."[25]

3.4 The Transfer of Sensitive Technologies

The United States regulated the export of weapon systems and advanced technologies long ago, making the export of defense materials subject to official government authorization. According to the current regulations, the Dod has the authority necessary to launch international defense cooperation programs, but the National Disclosure Policy Committee (Ndpc)[26]

[25] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit*.
[26] "The Ndpc comprises representatives of the Dod, State Department (which obviously has an important say in the supervision of such exports given their fallout on the security and stability of the various regional theatres), of the Department of Commerce which underscores the needs of the American economy, of the Central Intelligence Agency (Cia), of the Energy Department and of other departments variously involved. The Ndpc includes no representatives of private industry." Cfr. A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *Quaderno IAI*, n. 30, June 2008.

controls the trade of defense products and services and "establishes procedures and criteria for releasing classified or sensitive military information to other countries."[27] The Ndpc assesses the security and reliability of foreign governments and of their defense industries, and transfer of sensitive information and technologies "must be consistent with U.S. foreign policy, consistent with U.S. military and security objectives, provided the same degree of security protection by the recipient, beneficial to the U.S., and limited to information necessary for the purpose."[28]

The International Traffic in Arms Regulations (Itar) are the main tool used by the American authorities in assessing the applications for transfers of technology: "a sum of procedural norms aimed at standardizing the information and requirements demanded of destination countries, at fixing a number of steps in the bilateral relationship between the exporter and importer of sensitive technologies at both the industrial and government levels."[29] Itar is thus the path through which to reach the assessment of the application for the transfer of technology, but the decision to grant or refuse the authorization is political and discretionary. Itar procedures have remained substantially those developed under Cold War conditions and priorities, and today in the United States both government officials and industry believe that reform is necessary. The European point of view also considers the export license granting system to be "overly complex, cumbersome, pervasive (...), invasive (in that it places too many restrictions on how foreign customers can use US technologies and systems, particularly in terms of subsequent exports to third countries), or simply slow."[30] It is no accident that when in 2007 the eight main associations of the US defense industry formed a "Coalition for Security and Competitiveness", their demand for greater freedom in the transfer of technology was immediately supported by European companies such as Bae Systems, Eads, Dassault, Raytheon, Saab.[31]

In international programs such as the F-35, the United States compound this

[27] General Accounting Office, "JSF Management of the Technology Transfer Process", March 2006, p. 6.
[28] General Accounting Office, "JSF Management of the Technology Transfer Process", March 2006, p. 14.
[29] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit*.
[30] M. Nones, "Il controllo degli investimenti stranieri nel settore della difesa", CeMiSS, April 2005, p. 46.
[31] Defense Industry Daily, *US Industry Associations pushing to reform export control*, 31 July 2007.

very restrictive regulation with a policy regarding the transfer of sensitive technologies that is sharply criticized by its partners. American policy is also influenced by issues of internal politics, such as protectionist pressure, relationship with allies and the international economic, strategic and political context: events such as 9/11 lead to less openness. American authorities officially view the international participation in the F-35 positively, with DoD guidelines themselves stating that "the department will give favorable consideration to transfers of defense articles, services, and technology consistent with national security interests to support these international programs."[32]
In fact, however, the DoD and to a greater extent the State Department and Congress are very worried for the risks and disadvantages associated with such openness, thus contributing to a very rigid position on the transfer of sensitive technologies and knowledge. To understand the American point of view on development, two other elements are required. In the first place, a single transfer of a given technology to a foreign company is enough to lose the national exclusive on it, with the associated risk of a subsequent uncontrolled transfer to third parties.[33] Secondly, in the F-35 program the transfer of technologies is not considered in absolute terms but rather in relative terms compared to previous transfers undertaken in other international cooperations: "because of the breadth of the international participation, a great number of export clearances are required to share information with partner governments, to solicit bids from suppliers and to execute contracts. It is anticipated that previous transfers of advanced military technologies will be greatly exceeded."[34]
In part because of this approach, the history of the F-35 has been marked by public and unofficial positions of both the governments and companies of the allied countries that criticized the American unwillingness to transfer sensitive technologies. There is truth to the statement according to which "even in those cases in which the Pentagon openly solicited international participation – such as Jsf and Meads – foreign industrial partners once again found themselves operating with severe security restrictions on technology, "black boxes"

[32] General Accounting Office, *JSF Management of the Technology Transfer Process*, March 2006, p. 5.
[33] For instance the fact that English firms involved in the F-35 program, such as Bae Systems, have developed in recent years cooperations with other European players "contributes to US anxiety about sharing its most sensitive technologies with the UK". Cfr. P. Chao R. Niblett, "Trusted partners: sharing technology within the Us-Uk security relations", Csis, 26 May 2006, p. 6.
[34] General Accounting Office, *JSF Management of the Technology Transfer Process*, March 2006, p. 1.

(...) that have placed their involvement in these programs under severe stress."[35] However, it must also be considered that such positions are also part of the bargaining process aimed at getting something more from the American side, and after all the fact that none of the protesting parties left the F-35 program proves that the potential benefits balance the costs and difficulties they have encountered.[36]

The stealth technology that makes the F-35 less visible to enemy radar is an eloquent example of the American attitude. In 2003 the Dod signed with Lockheed Martin a 603 million dollar contract to make the aircraft delivered to partners different from those for the United States military, in order to protect stealth technology while still maintaining as many common parts as possible. For this purpose some stealth technology components are built in dedicated facilities with high levels of security and are only incorporated after the aircraft has been completely assembled on the common assembly line at Fort Worth. At the end of 2007 a further 134 million contract was signed to develop the partners' F-35 version "that meets U.S. National Disclosure Policy, but remains common to the U.S. Air System, where possible."[37] There is a very fine and intrinsically contradictory balance between the partners' need not to be saddled with a product that is second-class compared to the American variant and the US protection of its technological leadership. While F-35 program vice president Tom Burbage has stated that "we are not designing multiple versions of the aircraft", the United States ambassador to Australia has officially stated that their aircraft "the airplane will not be exactly the same airplane as the United States will have." [38] The 737 million dollars spent by the Dod with Lockheed Martin would seem to support the latter statement. Another significant example of clashes over the transfer of technology – less publicized but of no smaller import – is that of the software code that underlie the electronic management of the weapon system: the United States currently envision using the code on partner country aircraft with protective measures that would pre-

[35] M. Nones, "Il controllo degli investimenti stranieri nel settore della difesa", CeMiSS, April 2005, p. 47.

[36] According to Dod estimates "the potential exists for partner nations to earn between $5 and $40 of revenue for every $1 invested through program contracts". Cfr Congressional Research Service, "F-35 Joint Strike Fighter Program", February 2009, pp. 22-23.

[37] B. Sweetman, "My JSF is Stealthier Than Yours, Or is It?" *Aviation Week web site*, 16 November 2007.

[38] Idem.

vent them from accessing the software, understanding its workings and modifying or performing repairs.[39] In general, at present it is not possible to say how different, and under which aspects, the aircraft used by the United States will differ from those delivered to European partners; it seems clear however that all F-35s built will share the same airframe, engine, systems and logistics and that this will ensure the full interoperability of the armed forces that use the platform.

From the Italian point of view the analysis of the issue of transfers of technology should perhaps begin with the international documents signed by Italy. Section VII of the 2002 MoU, which covers the distribution and use of project information, states clearly that the IT MoD "will have prompt and complete access to all classified first level releasable project information." [40] It is also stated that the MoD IT will receive "all project information required for the autonomous use, maintenance and support of the air system at its highest capabilities, save for US national policies on distribution." [41] The "save for" expression represents a first limitation stemming from a compromise between the two countries on the quality and extent of the sensitive information that can actually be transferred. Italy on the other hand undertakes to use any information received exclusively for the purposes of this program and in agreement with the stipulations of the MoU.

It is also necessary to consider the letters exchanged by the Italian minister of Defense and the American secretary for Defense simultaneously with the signing of the MoU. These letters, which are not on the same level as the MoU, establish that the "US DoD and IT MoD will strive to ensure that the IT MoD and Italian industry on behalf of the IT MoD will have access to and use the technical information to meet the IT MoD national requirements throughout the program life of the Jsf. The IT MoD and US DoD declare that an opportune sharing of technical information to meet Italian requirements is a fundamental principle underlying the Italian participation in the Jsf program." [42] Unfortunately it must be underscored that neither the Letter nor the MoU include provisions pertaining to the pre-bidding exchange of information

[39] Defense Industry Daily, "US Industry Associations pushing to reform export control", 31 July 2007.
[40] Chamber of Deputies, Study Service, "Programma pluriennale di R/S n. Sma 002/2002", 22 May 2002, p. 61.
[41] Idem.
[42] Chamber of Deputies, Study Service, "Programma pluriennale di R/S n. Sma 002/2002", 22 May 2002, p. 23.

necessary to enable Italian companies to participate competitively: the text only says that the IT MoD will have "visibility" over the F-35 program in order to verify that the competitions are conducted "fairly" and guaranteeing the "best value". On the other hand, "it would have been difficult to obtain further formal prescriptions for the carrying out of a process that is mainly influenced by the discretionary decisions of the American institutions involved and by the daily work of both the companies and governments allied in gaining the trust of the United States." [43]

In any case from 2002 onward the Air Force Staff has spoken positively on this aspect, stating that the "potential for technological and industrial returns derived from this specific cooperation with the United States are replete with interesting implications and guarantee the Country a precious increase in technological capabilities."[44] Later the then-Undersecretary Forcieri stated in Parliament that «in exchange for the participation of other countries the United States provide an unprecedented technological opening. This was an important technological and political opportunity, which the country elected to take immediately with the decision that came about in 1998."[45] This member of the government concedes that many industry insiders have "expressed doubts as to the real transfer of technology, but these rumors could stem from the dissatisfaction and difficult negotiating moments that followed the entrance of our industries in the project."[46]

The greatest technology transfer problems occurred at the beginning of the cooperation, when tackling the issues of upgrading regulations and exchanging sensitive information. Later the licenses under Itar regulations, the international agreements covering specific technologies (the Technical Assistance Agreements, Taa in short), did not prove decisive in reaching an adequate transfer of knowledge and sensitive technologies. In the case of Alenia Aeronautica, for instance, all the Taas signed so far only cover unclassified technologies or information. There follows that the entire Italian country-system – industry, government, armed forces – need to strengthen their work to overcome the barriers to the release of such sensitive information.

[43] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit*.
[44] Chamber of Deputies, Study Service, "Programma pluriennale di R/S n. Sma 002/2002", 22 May 2002, p. 22.
[45] Chamber of Deputies, Defense Committee IV, transcript of meeting of 16 January 2007, p. 5.
[46] Idem.

This frames the issue of whether Italian industries applying for the transfer of sensitive information or technologies have the knowledge required to make effective use of them. US authorities some times turn down an application by saying that the applicant has no "need to know" and that therefore sharing poses an unnecessary risk to US security. This line of thought is potentially damaging as it can lead to an endless loop in which the lack of the required knowledge prevents the transfer of other knowledge, thereby increasing the gap which in turn prevents access to other technologies, and so on and so forth. Specifically, this could happen for the main sensitive technologies of the program and there are two main ways of avoiding it. On one side, through the strong participation of Italian industries in the Psfd phase, in production and in aircraft logistics, which imply Italian staff working continuously side by side with their American colleagues, thereby creating *de facto* the required know how. On the other hand, through a strong request by the Italian government and armed forces for the transfer of all the information required to integrate armament on a national basis and about their impact on low observability, the mission system and generally about all aspects of the "operational sovereignty" on the weapon system.

On the other hand the Lockheed Martin attitude towards classification must also be taken into consideration. In some cases the prime contractor has not shared its industrial patents hiding behind the pretext of national security and government authorizations, while in other cases – in which the American company had an industrial interest in a subcontractor to begin working earlier – it pressured government authorities to accelerate the issuing of the required clearances. It must be borne in mind that it is the American company that interacts with the United States government to stipulate a Taa (or any other type of license provided for under Itar procedures, such as Manufacturing License Agreement, Mla), whereas an Italian company is only an object, rather than a subject, of the agreements. It is therefore certainly useful for the Italian side to insist with Lockheed Martin that it is also in its own industrial interest to enable its partners and suppliers to operate at their best by having the necessary information and technologies. Alenia, for instance, is working to build up a database of American companies active in Operation and Maintenance (O&M) to whom it would offer a team of Italian suppliers in this field in order to obtain a more coordinated and effective approach.

Another issue linked to relations with the prime contractor is the Lockheed Martin insistence to insert provisions in the contracts or even the Taas barring the reuse in other programs of technologies transferred to Alenia for periods up to 10-15 years.
Furthermore, it should not be forgotten that in addition to the public part of the agreement, known to all the parties involved, there is often a secret part signed by the US government with its prime contractor, in this case Lockheed Martin. This consists of the so-called "provisos". The "provisos" include a detailed list of releasable technologies and in some ways provide guidance for the technician or official that from time to time works on the transfer of a specific information or technology. The "provisos" can be different and more restrictive than the public part of the Taa, over which they take precedence. In general, once the Taa is signed, American authorities will give it a more restrictive interpretation than their Italian or European counterparts – e.g. regarding access to specific technologies or the participation of non-American staff to the main design teams – and everything must be continuously negotiated.
From the point of view of Italian companies, the procedures to issue Itar authorizations and stipulate the associated licenses (Taa, Mla, etc.) appear to be excessively bureaucratic and sometimes handled by staff with inadequate technical and scientific preparation. It is a fact that over the past 4-5 years the bureaucratic process has further extended, creating a bottleneck jammed by an ever-growing number of applications required to implement the international cooperation. With regard to Alenia, so far there have been no insurmountable problems with its American counterparts with regard to wing production in its Turin-Caselle plant, also because joint Italian-American teams at Alenia's Pomigliano d'Arco site had already designed the wing box. Although all the procedures required to carry out their work have been completed, it should be noted that Italian personnel working on flight tests in the United States required on average three years before obtaining all the required Taas. Such delays are somewhat worrying, in part because activating the Cameri Faco is estimated to require the stipulation of tens of Taas for the various technologies to be employed in the Faco, including low observability. The licenses for the Faco are expected to require long delays – at least nine months – before the government authorizes the American industrial counterpart to transmit sensitive information.
In attempting to evaluate the general situation of Italy on the issue of the

release of sensitive technologies, the judgment on the Sdd phase is moderately positive but with full awareness of the fact that the approach to the Psfd and then production will be decisive. It can be noted that, thanks to the constant commitment of the Italian side, the United States have shifted from rigid close-mindedness to a degree of flexibility, as shown by the willingness over the Cameri Faco, and there is very high potential to exploit as long as the United States and even Italian partners themselves can be kept under pressure to guarantee the levels of quality, security and information exchange which has been reached.

But it should not be forgotten that the F-35 program demands of the Italian authorities involved with their American counterparts a much greater level of attention compared to European programs, which proceed with a greater degree of autonomy once the national work share percentage has been defined at the outset. In the F-35 program, once the important chapter of the Pfsd negotiations is complete, the commitment to implement the agreements reached is just as important.

One of the most critical aspects in this regard is the ability of the Italian authorities involved in the program to keep up with the pace of their American governmental counterparts, both in the ordinary daily activities and in the moments when the most important decisions must be made. It is necessary to be in step with the deadlines and procedures of the Anglo-Saxon allies, which are much faster and effective than those experienced in other European cooperations, for instance in terms of the exchange of information within an office, the organization of meetings and the decision-making process in general.

Extending the analysis of the issue of technology transfers, it is interesting to see how the United Kingdom has taken up the issue with its American counterpart. Obviously London is a unique position because of its historical "special relationship" with Washington, which contributed to make the United Kingdom the only Level I partner and the only country to see its national industry – in this case Bae Systems – included among the prime contractor team.

The English partner has often criticized the American unwillingness to share stealth technology and other sensitive information that the United Kingdom considers indispensable to maintain its "operational sovereignty" over the aircraft. The expression indicates the ability by domestic industry to perform upon request of the armed forces maintenance, repair, modification and upgrade operations on the main components of the weapon sys-

tem. This ability is considered "vital" by the British government and parliament, [47] leading to a long and stiff test of wills during which the United Kingdom raised the possibility of exiting the F-35 program.[48]
At the end of the negotiations, in early 2006 it was officially announced that "both governments agree that the U.K. will have the ability to successfully operate, upgrade, employ, and maintain the Joint Strike Fighter (…) and agree to protect sensitive technologies found within the Joint Strike Fighter program."[49] Following this statement in principle, on 18 July 2006 the heads of Pentagon and UK MoD procurement signed an agreement guaranteeing that London would have actual and complete operational sovereignty over each F-35 it purchases.[50] Again with an eye to its operational sovereignty requirements, the United Kingdom also inserted into its agreement with the United States a provision covering a maintenance and logistics center on British soil to support its national fleet, and it is unclear if and how such a center might compete with the Italian Faco/Mrou center. After this agreement, Bae Systems Ceo Mike Turner said that the United Kingdom said that "was now able to acquire whatever JSF technology it wanted from the US."[51] A positive example of this came in October 2006 when Northrop Grumman delivered to Bae Systems and four subcontractors in the United Kingdom and United States the structures and software required to test aircraft systems – including stealth technologies - through computer simulations. [52] This network of test stations is crucial to test flight programs, components and subsystems before system integration by Lockheed Martin at Fort Worth.
This agreement however did not suffice to bridge the gap between the quantity and quality of the technology transfer requested by London and that which Washington has actually shared, leading to a number of bilater-

[47] "We fully support MoD's position that the ability to maintain and upgrade the JSF independently is vital. We would consider unacceptable for the UK to get substantially into the JSF programme and then find out that it was not going to get al the technology and information transfer it require to ensure «sovereign capability»". The United Kingdom Parliament, Defense Committee, *Defense – Second report*, 20 December 2005.
[48] "If the UK does not receive assurances that it will get all it require to ensure sovereign capability, we would question whether the UK should continue to participate in the JSF program". The United Kingdom Parliament, Defense Committee, "Defense – Second report", *op. cit.*
[49] Congressional Research Service, *F-35 Joint Strike Fighter Program*, June 2006, p. 22.
[50] Defense Industry Daily, "F35 JSF program: Us & Uk reach technology transfer agreement", 4 August 2006.
[51] J. Boxell, "UK opposed to joint fighter assembly line", *Financial Times*, 19 July 2006, p. 19.
[52] Global Security, *Northrop Grumman Delivers Technology to Ensure F-35 Mission Capability*, 5 October 2006.

al meetings to discuss "around the ability to repair and maintain stealth technology and computer software sources codes for the highly sophisticated flight-control and weapons systems."[53] To overcome the stall, in June 2007 United States and United Kingdom signed a broader agreement on defense cooperation, exempting the United Kingdom from applying for export licenses for a number of technologies, products and sensitive systems for those products destined to British armed forces. The exemption "aids closer co-operation between both industry and the armed and also helps faster sharing of classified information" [54]. Such an agreement had already been sought in previous years, but was blocked by the opposition of the US Congress,[55] and reaching it represented a positive turn for existing industrial cooperations in the F-35 program, by simplifying the complete sharing of technical knowledge, but for the future as well because it "also potentially enables British companies to bid more easily on US defense programmes by removing barriers to technology transfer." [56]

Although certain issues remain open, including low observability technologies, the framework agreement has thus partially satisfied the British demands regarding the transfer of sensitive technologies and can be considered an example of how a cooperative but firm negotiating stance can achieve a certain change in American attitude. The United Kingdom, as stated before, certainly enjoys a unique position in the transatlantic cooperation framework; still, it is an example to be followed and it is conceivable that the unique British position and the hoped for common European position within the F-35 program could lead to a more balanced technological and industrial relationship between the two sides of the Atlantic.

[53] B. Cox, *U.S., Britain work to resolve dispute over JSF*, Csis, 17 June 2006.
[54] UK Ministry of Defense, "US & UK sign treaty on Defense co-operation", 22 June 2007.
[55] P. Chao, R. Niblett, *Trusted partners: sharing technology within the Us-Uk security relations*, 26 May 2006, p. 22.
[56] UK Ministry of Defense, "US & UK sign treaty on Defense co-operation", 22 June 2007.

4. THE STATE AND PROSPECTS FOR INTERNATIONAL COOPERATION

4.1 The Consequences for Europe of the non-Europeanization of the F-35 Program

The development of the F-35 cannot be considered an equal cooperation between Europeans and Americans. Rather, it is an international program led by the Usa with a strong European presence, in which the European partners have been involved for the first time from the outset of the development phase.
Before evaluating the extent of the "Europeanness" of a given international cooperation in the field of defense procurement it is necessary to "decide whether a program is European with reference to system architecture or to its content. The Jsf is an international program in which leadership and architecture are American, with the participation of five European countries and a partial European content."[1] To base the degree of European character of such a program on the quality and "quantum" of the workshare performed by participating European countries, avoids the risk of classifying as European those programs that are proposed by a single country with a virtually non-existent industrial return for the other countries of the Old Continent.

[1] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit*.

In the F-35 program the US Department of Defense is at once the government customer that deals directly and exclusively with the industrial prime contractors, and on the other side the counterpart of every single international agreement with the various countries participating in the program. Each partner negotiates bilaterally with the United States on issues such as its economic contribution, the prospects for industrial returns for its own national industry and the aspects related to the transfer of knowledge and technologies. Although five European countries, including such significant players as the United Kingdom and Italy, have been involved in the program for seven years, there has not been a significant "Europeanization" of their participation, meaning by this a real intra-European coordination of interests and proposals aimed at negotiating with the American counterpart from a shared position.

There are a number of reasons for the non-Europeanization of the program, in part influenced by the approach taken to transatlantic relationships. Some underscore that, at the outset of the program, the United States launched a "veritable 'political marketing' campaign aimed at reassuring prospective partners about their level of influence on the program itself."[2] According to this view, by outlining the advantages of significant technology transfers and of a certain access to the desirable US defense market, the United States enticed European countries to join the F-35 program and accept the unfavorable terms offered them. Conditions based upon a rigidly bilateral cooperative structure placing the American government at the center of a network of MoUs, on a steel grip on the transfer of technologies outside the United States, on the exclusion of partner countries from program leadership. Some maintain that these aspects of the cooperation have blocked not only the process of "Europeanization" of the program, but also the prospective technological and industrial benefits.[3]

The judgment on the relationship between the F-35 program and Europe changes significantly if a different approach is taken which clears the field from preconceived notions and ideologies. Firstly, by analyzing national defense budgets, it appears that in 2005 the United States invested in this field 4% of their GNP, against an average of 1.8% in European countries; furthermore, in the America investment amounts to some 32% of the total,

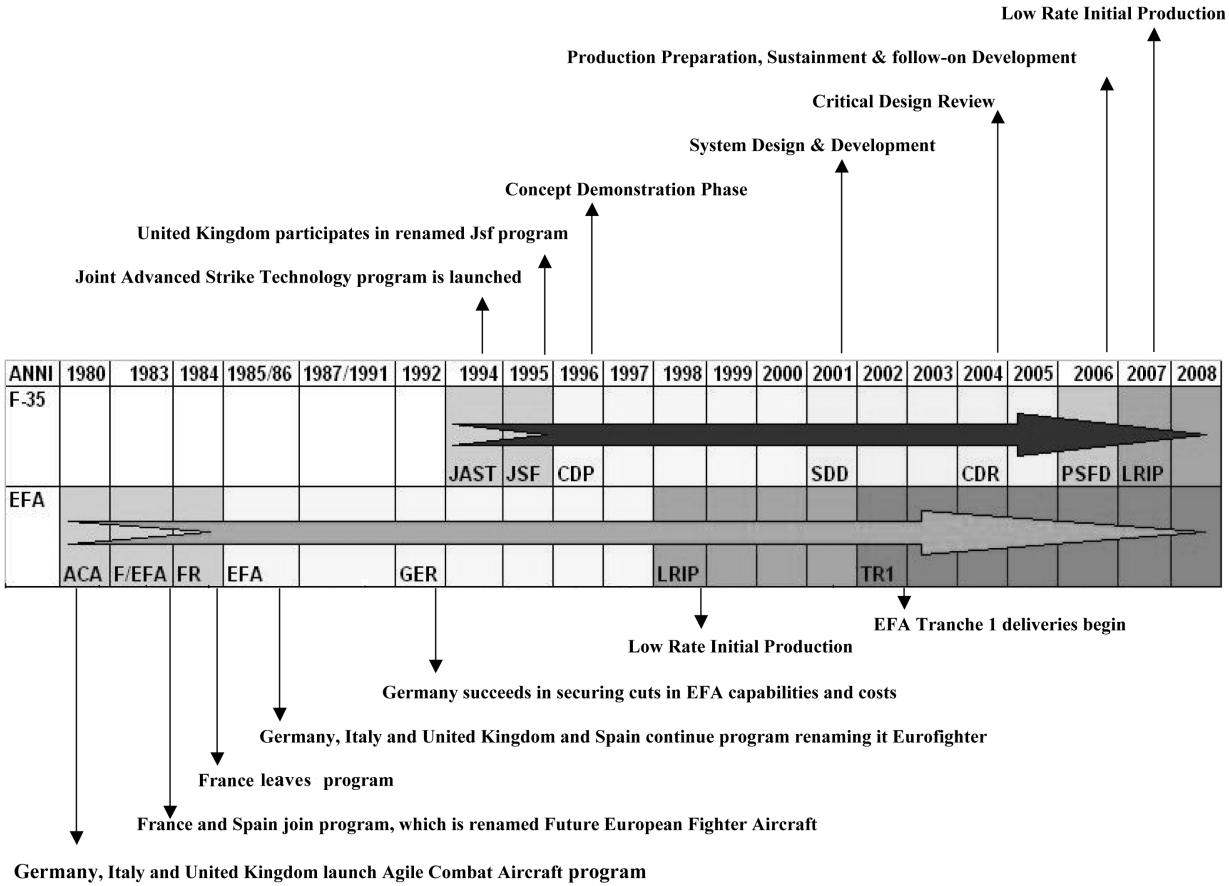
[2] P. Giuri, C. Tomasi, G. Dosi, "L'Industria aerospaziale", Ed. *Il Sole 24 Ore*, February 2007, p. 230.
[3] P. Giuri, C. Tomasi, G. Dosi, "L'Industria aerospaziale", *op. cit*.

against 18.4% in Europe. [4] In the specific case of F-35 cooperation, "since, according to the final 2006 estimate, the United States bear 89.1% of the costs, their position of absolute predominance in relation to the other eight partners which together contribute 10.9% (4.5 billion dollars) of the total program cost becomes more clear." [5] In other words, the European governments spend too little in defense compared to their international ambitions, and more specifically by contributing only one-tenth of the overall financial burden of the F-35 program they are not in the best position to demand a fair share of the decision making, because in the military, as elsewhere, the axiom is that decisions are made by those who pay.

Secondly, from both the industrial and government point of view, in the years leading to the launch of the F-35 program the main countries in the Old Continent had already experienced their share of difficulties to find a European agreement to share the burdens and technologies for a comparable military program, i.e. Eurofighter.

[4] M. Nones, L. Marta, "Il processo di integrazione del mercato della difesa europeo e le sue implicazioni per l'Italia", IAI, Contributions of specialist research institutes, Study Service, Italian Senate, November 2007.

[5] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit.*


Low Rate Initial Production
Production Preparation, Sustainment & follow-on Development
Critical Design Review
System Design & Development
Concept Demonstration Phase
United Kingdom participates in renamed Jsf program
Joint Advanced Strike Technology program is launched
ANNI 1980 1983 1984 1985/86 1987/1991 1992 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
F-35
JAST JSF CDP SDD CDR PSFD LRIP
EFA
ACA F/EFA FR EFA GER LRIP TR1
EFA Tranche 1 deliveries begin
Low Rate Initial Production
Germany succeeds in securing cuts in EFA capabilities and costs
Germany, Italy and United Kingdom and Spain continue program renaming it Eurofighter
France leaves program
France and Spain join program, which is renamed Future European Fighter Aircraft
Germany, Italy and United Kingdom launch Agile Combat Aircraft program

During its long and difficult history, in the 1980s the Efa program saw France first commit to and then pull out of the consortium. In the 1990s this was followed by a significant delay caused by Germany when it threatened to withdraw from the project had the partners not reduced certain characteristics of the project in order to bring down costs which were considered no longer affordable in the post-Cold War strategic context. It was also because of such reasons that it took 18 years to launch the production of a fourth generation aircraft like Efa, while the F-35 program required 13 years to begin the production of an aircraft belonging to the fifth generation and thus technologically superior.

In the light of the difficulties encountered by the collegial intra-European management model represented by Eurofighter, the position of those who considered it inevitable to join a large program such as the F-35, under American supervision and a single prime contractor with a proven track record like Lockheed Martin appears far from unfounded. The supporters of this position underscore, in addition, that cooperating on the F-35 can transfer, as it is doing in part, the strategic and system knowledge required to develop future European programs maintaining high standards of effectiveness and efficiency.

Given the experience of a warped and inefficient idea of "Europeanization" seen in other cases, the lack of an immediate "Europeanization" effort for the F-35 program should not be surprising. It should not be forgotten, in fact, that political-industrial limitations led to absolutely identical cost-share and work-share and the Efa consortium to have four assembly lines and four test centers, one for each partner country, with evident additional costs for the overall program. This without forgetting the delays bred by a cumbersome decision-making process.

Even within a European program such as Efa there exists some industrial compartmenting, because in Europe – unlike in the United States – governments pay the development cost of technologies the full availability of which remains however in the hands of industry. In fact, neither Italy nor Germany alone are fully able to independently manage the entire Efa weapon system because Bae Systems has not released certain information to its partners, as Eads (then Dasa) had previously done with the Tornado. The fragmentation of European defense industries is certainly a strong obstacle to the Europeanization of any cooperative program, because companies view each other as competitors as well as partners, and are naturally inclined to restrict as far as possible the release of their own advanced technologies and information.

In third place, the non-Europeanization of the F-35 program has been affected by the overall European delay in adopting an industrial policy in the defense field, a delay in turn closely linked to the lack of a European Security and Defense Policy (Pesd) until 1999. It was only in 1996 with the Organization Conjointe de Cooperation en matiére d'Armement (Occar, which today comprises France, United Kingdom, Germany, Italy, Belgium and Spain), and in 1998 with the Letter of intent (Loi, signed by United Kingdom, France, Germany, Italy, Spain and Sweden), that the countries which are the largest European makers and buyers of weapon systems have tried to achieve a minimum level of coordination in defense procurement. But it was still necessary to wait until 2004 for the weak intergovernmental push to succeed in establishing an institutional representation within the European Union through the creation of the European defense agency (Eda). In this political and institutional representation, marked by continuing national control over strategic defense and security choices (including military procurement), it is logical that European countries would decide and structure their participation in the F-35 program on a national basis.
In the early phases of the program each European country has sought to maximize the industrial return for its own national economic system, exploiting every point in its favor to obtain more contracts and a greater transfer of technology. Specifically, the United Kingdom leveraged the Bae Systems presence in the prime contractor team and national financial contribution which positions it as Tier I partner – as well as the preferred political relationship with the United States – has obtained an industrial return ten times greater than the funds committed by its government. Finding itself in such a favorable position, London had very little interest in seeking to coordinate with the position of other European countries. In any event, and beyond the English case, in each of European partners of the F-35 program prevailed a competitive, rather than collaborative, approach to cooperation. However, this generalized attitude has had negative long-term consequences for all of the Old Continent countries which took part in the cooperation. It is evident that in a bilateral negotiation with the United States, each European country taken individually (including the United Kingdom) is handicapped by a disproportion in means and faces therefore greater difficulties in achieving its goals, first and foremost that of the greatest operational sovereignty over the weapon system. It is no accident that such a piecemeal approach is preferred by the American counterpart which can effectively apply a "divide et impera" logic.

In addition, while competition between European is positive in economic terms because it stimulates the competitiveness among all players and helps hold down the overall program costs, in the case of the transfer of technologies and knowledge it is also negative for two different reasons. In the first place because it allows the United States to threaten to assign a contract under negotiation to a European competitor which asks for a lower level of technology transfer, thus limiting the requests of other European counterparts and holding the actual transfers of technology and knowledge to the lowest possible level. Secondly, if European countries consider each other a technological rival, they slow the transfer of knowledge even at the intra-European level, thus strongly limiting the benefits for the continental industrial base of what might be learned by cooperating with the United States.
The structure of the bilateral relationship with the Americans favors this state of things, also because of the rigidity of the licenses to transfer know-how. The approval of an overall European Taa would ease the situation when compared to the over 2,000 Taas issued thus far.
The overall effect of the lack of coordination of the positions of the European partners in the F-35 program is therefore that of diminishing both the national operational sovereignty on the weapon system and the flow of knowledge and technologies actually acquired by Europe. Some authors have rightfully asked if "there is an actual consolidation of transatlantic cooperation or whether there is a mere creation of a condition of European dependency and subordination to the United States."[6] Still, ensuring that the F-35 program follow the first direction rather than the second is a responsibility that falls upon the European partners, still unwilling to coalesce, and not just on the United States which are behaving exactly as Paris, London or Berlin would do – and have done in the past – had they been in their place.

4.2 The Opportunities to Reinforce European Cooperation

Considering the above starting conditions, and the disadvantages brought about by the non-Europeanization of the F-35 program, in recent years something has moved in Europe to build some coordination among European partners to improve their overall position within the international cooperation.

[6] P. Giuri, C. Tomasi, G. Dosi, "L'Industria aerospaziale", *op. cit.*, p. 230.

In particular, Italy has promoted an intergovernmental initiative that could represent the starting point of a path that would reinforce collaboration within the European F-35 component.
On 30 March 2006 the national armaments directors of Italy and the Netherlands signed an agreement that marks the first significant example of strong European synergy within transatlantic cooperation. The agreement sets out to identify two important areas of cooperation. On one hand "an aircraft Final Assembly & Check Out (Faco) capability, to be established in Italy, in which to build and verify on the ground and in the air the Jsf aircraft that will be acquired by Italy and the Netherlands, as a starting point for a future higher-level maintenance and repair capability for the fighters."[7] On the other, "a Maintenance, Repair, Overhaul & Upgrade (Mro&U) capability for the engine and some aircraft equipment, to be established in the Netherlands, which will maintain, repair, overhaul and modify such parts, for those aircraft which will be purchased by the two countries."[8]
The innovative characteristic of this kind of European cooperation is the division of work on the basis of competence, replacing the duplication of work on a national basis tried out previously with unsatisfactory results. The Faco center will look after the final assembly of aircraft, offering Italy a greater production role that can contribute to Faco effectiveness and the Netherlands to use the maintenance capabilities that will then become available; symmetrically, the Dutch Mro&U site will work on the engines of both fleets saving Italy the same expense. The close interdependence that this work sharing generates – one need but note that Italian pilots will have to rely on work performed by Dutch engineers, and vice versa – requires a close partnership between both the two ministries of Defense and the national industries of the Netherlands and Italy. Starting from this experience other areas of cooperation could be identified and studied jointly, and the agreement establishes the objectives and principles upon which to develop any further steps forward in this direction.
The bilateral agreement between the countries has preceded, and to some extent positively influenced, the Dutch and Italian signing of the respective MoUs with the United States for the Psfd phase. It can indeed be considered that the work-sharing agreement between the two countries drove them to

[7] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit.*
[8] Idem.

face the American counterpart with a common position, reinforcing both requests concerning the Mro&U and Faco centers to be established in Europe and easing, for instance, the American assent to create the latter at Cameri.
In addition the agreement was the first step on the way to the creation of a European F-35 logistics plan, because the Italian-Dutch MoU is not structured to remain bilateral in nature; rather, it is predisposed to welcome the other European countries participating in the program. The representatives of Denmark, Norway and Turkey were already present at the policy meeting held in the Netherlands some three weeks before the agreement was signed. These countries have shown a strong interest in the Italian-Dutch agreement "which represents the first nucleus of a broader European role in the Autonomic Logistic Global Sustainment (Algs)."[9]
Precisely with a view to this, on 13 June 2007 a meeting of the Undersecretaries of Defense and national armament directors of Denmark, Italy, Norway, Netherlands and Turkey was held in Rome, again upon an Italian initiative. On that occasion Norway signed the Italian-Dutch MoU, which has thus increased its chances to become the actual basis for a common European position. The representatives of the five countries also adopted a final declaration that restates and articulates in seven points the commitment to reinforce the "European Footprint" in the next phases of the program.
According to the document, the parties in the first place "agree on the importance of continuing the dialogue for a European Footprint for the purpose of increasing regional cooperation for the Jsf and supporting the mutual synergies among national defense industries."[10] Next to this declaration of principles there also is a practical commitment on the legal side: "each nation shall identify the laws, regulations and national import/export procedures that could have a potential impact on Jsf program activities and will activate any appropriate internal actions to solve the problems."[11]
In this case a weak point of the Italian country-system emerges, i.e. the regulations on the international trade of weapons systems that revolves around Law 185 of 1990. This law, conceived twenty years ago in a very different international and industrial framework, is now inadequate. Specifically, the law subjects intergovernmental collaborative programs to procedures and controls

[9] G. Alegi, "JSF: accordo bilaterale per montaggio in Italia, manutenzione motori in Olanda", Dedalonews, 24 May 2006.
[10] Air Press, "Si rafforza la componente europea all'interno del programma JSF", 18 June 2007, p. 24.
[11] Idem.

similar to those for true exports. As a result, from 1997 the administrations involved have been forced to define a specific procedure which, weaving through the regulatory waypoints, offered a limited and, initially, temporary solution. As is often the case in Italy, this procedure has de facto become permanent, despite appearing increasingly inadequate with the growing number and complexity of the programs. For this reason many are calling to reform the oversight system to separate intergovernmental activities from exports.

The countries of the European Footprint are studying the operating aspects, such as the circulation of materials, capable of promoting the internationalization of the program with resultant advantages in the handling of the customs and tax aspects. The need to overcome the legal and regulatory barriers to the exchange of knowledge, technologies and products among companies partnered in the defense sector is the base for the commitment made by the five European countries to form "an international working group for import/export tasked with investigating problems and identifying the associated solutions." [12] This working group will have to work in close contact with the F-35 program team, and it is foreseen that its results "will be used as a common regional position towards the 'Export License Forum' headed by the international office of the Jsf program." [13]

This work on European regulations is even more important because of the logistics system conceived by Lockheed Martin. The traditional logistics approach would see each country own its dedicated set of spare parts, but with the F-35 the cost of such an approach would be absolutely unbearable. The solution offered is to entrust the management of spare parts to Lockheed Martin itself. For Italy this solution could be implemented, in legal terms, through two alternatives

The first alternative would make spare parts property of the industry: a workable solution in terms of the service to be provided but which would clash with the present Italian laws on oversight on the interchange of military equipment centered around law 185 of 1990. In the second alternative spare parts would be owned by the government. In practice this would mean creating a pool of countries, as with the C-17 airlifter, in which each government would buy a share and would then be entitled to an equivalent amount of spare parts. Individual spares would become property of a specific national government

[12] Air Press, "Si rafforza la componente europea all'interno del programma JSF", 18 June 2007, p. 24.
[13] Idem.

only when installed on an aircraft and only as long as it remains on board. If a part fails and is removed from the aircraft it ceases to belong to the government and reverts to pooled ownership. Its place on the aircraft is then taken by a working spare owned by the pool but that becomes property of a national government as soon as it is installed on the aircraft. This is obviously an endless loop, difficult to implement in Italy without a radical change in the arms trade regulations.

The document also contains a reference to Norway joining the MoU between Italy and the Netherlands, stating that the countries are committed to its application also through some "Implementing Agreements". Furthermore there is a commitment to study at a technical level the possible Turkish participation in the European Footprint and to discuss it within a year in a new five-side meeting to be held in Istanbul. Although some intergovernmental meetings were held with Turkey, the collaboration would later remain in its initial stage. Technical work with Norway on the Implementing Agreements has also lagged behind and the planned meeting with the five countries has yet to take place. Some contacts are under way to assess areas of collaboration, or at least areas that do not overlap with the European signatories of the document, considering that the Turkish counterpart aspires to work in all areas of the program open to European industries.

On the industrial level, intra-European collaboration made another step forward in November 2007 with an agreement through the Dutch Ministry of Defense and DutchAero, a subsidiary of Italy's Avio, that "created a true public-private partnership with the Dutch defense establishment, initially having as its object the maintenance of the engines of the Dutch F-16 fighters." [14] The agreement, also because of the previous international Mro&u agreement between Italy and the Netherlands, "will later extend to the new air force aircraft, the F-35 Jsf and increasingly complete services to support military engines will also be offered to the Italian Ministry of Defense." [15] This outlines a practical sharing of work that does not duplicate structures – with the attendant, and no longer sustainable, duplication of costs – but distributes competencies leveraging the technological and industrial assets of the parties.

A mirror-image case is the Cameri Faco center. Italian assembly of the Dutch aircraft is advantageous for industry because "it would raise the aircraft that Alenia Aeronautica could assemble beyond the 210 mark, mak-

[14] A. Nativi, "Via al polo olandese per gli aerei militari", *Il Giornale*, 28 November 2007.
[15] Idem.

ing the required investment more attractive." [16] It should be borne in mind that the Italian intention is for the Faco to work on both Ctol and Stovl variants, a capability made possible by the high degree of commonality between the two aircraft which – powerplant apart – are very similar and required to meet the needs of the Italian Air Force and Navy, oriented towards a mixed F-35 fleet with a significant presence of both variants.
Building such a capability would increase the possibility for Cameri to become the reference point for the European fleet, independently of the specific variants acquired by individual European governments for their national fleets. Since the Faco center has in itself all the structures required for assembly, with a limited capability increase it could also accommodate the maintenance and logistics for both F-35 variants.
At present the working hypothesis foresees, in the first place, that the Netherlands and Italy make full use of the Cameri facility. Secondly, should another partner country so request, it would be allowed to use the Faco center subject to the approval of both the United States (which always carefully verify the security requirements of transfers of technology connected to assembly and logistics work) and Lockheed Martin, which is mainly interested in verifying the impact on program costs.
Commenting upon the overall Italian-Dutch agreement General Leonardo Tricarico, then the ITAF Chief of Staff, had said that "we are now trying to understand ways to 'Europeanize' the Jsf bringing together the activities related to transfers of technology, (...) the first significant step was the agreement we signed with the Netherlands."[17] Excessive illusions should not be entertained on the feasibility of this approach, which would require all the European countries to show a certain willingness to compromise over their interests, also because "the Netherlands had already attempted to catalyze support at the time when participation in the Sdd phase was discussed, about five years ago. There were discussions and meetings which also involved Italy, but nothing came of it and everyone went their own way."[18]
It is also necessary to consider that the lack of other collaborative programs that see the participation of all the European partners of the program translates into the absence of another table for possible industrial compensations

[16] G. Alegi, "JSF: accordo bilaterale per montaggio in Italia, manutenzione motori in Olanda", *op. cit*.
[17] Air Press, "A Cameri la linea di montaggio europeo per il JSF", 10 July 2006.
[18] A. Nativi, "F35, il tempo delle decisioni si avvicina", *RID*, May 2006, p. 47.

to balance the political-industrial agreements under way for the F-35. Any compromise over the interests of the various parties must therefore take place entirely within the F-35 program. The vast size of the anticipated work - amounting to some 400 aircraft without including those for Britain, in relation to Faco, Mro&U, logistics and maintenance – seems sufficient to find an adequate role for all partners as long as each one drops the desire to have a share in each work area. In theory it would be possible, albeit very difficult, to find on a bilateral basis those areas of specialization outside the program in which partners could be granted more space in exchange for their use of the Italian Faco center.

The hope is that use is made of past errors that lead to the above-mentioned disadvantages, and the parochial or ideological resistance be overcome by an awareness that "the prize is certainly more important, while it is evident that an agreement among the five countries would allow them not merely to obtain more from the Usa but also to grant to their industries access to much more significant program."[19] The program in itself offers opportunities but it is up to the European countries to reap them: according to the former Undersecretary of Defense Forcieri "the Jsf represents a growth opportunity for Italian, and therefore for European, industry, based on terms of substantial technological partnership and not of subordination." [20]

Today it can be said that "in fact the European Jsf community is gearing up to organize and allow a size adequate to enable dialogue and technical-bureaucratic-legal operations with the giant ally across the Atlantic; the information and communication channels have been opened and, albeit timidly, the first results of a "two-way street" are appearing."[21]

Mainly thanks to the Italian initiative that involved first the Netherlands and then Norway, some believe that "the European side is creating a 'footprint' in the program that will bring the various countries to levels of interchange never seen before (...) In this way there will come to Europe a technological capability that would not be reached otherwise on account of both timing and the resources which would be otherwise required to develop and build an unlikely future homegrown system." [22] It should indeed be consid-

[19] Idem.
[20] Chamber of Deputies, Defense Committee IV, *op. cit.*, p. 6.
[21] G. Bernardis, "Non una colonizzazione, ma un'opportunità", *AffarInternazionali*, 26 October 2006.
[22] Idem.

ered that the participation of Old Continent countries to the F-35 program, with adequate strength and especially a truly European coordination, can allow all of Europe not to be cut off from the development of a fifth generation aircraft that it has been unable to launch itself in recent years.
European countries bear the responsibility for the opportunity missed in the 1990sm and must now deal with the fact that "the Jsf is a next generation aircraft and that no other country outside those participating in this program will have access to such technologies. There will therefore be a competitive advantage also for the other European states in having some countries in the EU that can manage such technologies. In theory, in the future all this could be transferred to a new generation of systems under European guidance." [23]
The path undertaken by some European countries with regard to the aircraft's logistics, the sharing of industrial work and the transfer of technologies that should be launched also is more strictly military field. Indeed it is "easy to imagine the fallout that would be achieved by agreeing configurations, weapon integration and aircraft equipment, trying to plan a single pilot training and preparation system." [24] A starting point could be provided by logistics, in which there is a strong objective push towards European coordination driven by both the single Faco/Mro&u center and by the new logistics concept introduced by Lockheed Martin to integrate "as much as possible the logistic supports systems, warehouse management, spare parts and, in the future, the so-called 'spiral' approach to aircraft upgrading."
In this view the position of the United Kingdom should be carefully considered. While continental European partners have been working on a common platform, so far London has maintained a "stand alone" position leveraging its role in the program and the "special relationship" with the United States. It cannot be excluded, however, that in the future the United Kingdom might move from a "wait and see" attitude to a real participation: London often prefers to wait for a European process to prove it is working adequately before joining in. At the same time at the European level it appears possible, albeit difficult, to involve even the United Kingdom in a policy of integration on the operational aspect, on new logistics and on training. With regard to training, specifically, the fact that a basic common training for all partner countries will be carried out in the United States

[23] A. Marrone, "Cooperazione transatlantica nella difesa e trasferimento di tecnologie sensibili", *op. cit.*
[24] A. Nativi, "F35, il tempo delle decisioni si avvicina", *op. cit.*, p. 47.

should contribute to the coordination effort. There is the hope that this would prevent repeating the mistake made with Efa, when despite sharing the same aircraft the air forces of Germany, United Kingdom, Italy and Spain drew up and operated different training programs.
A very important open issue, which should be the subject of a common European approach, is the F-35 armament set. The agreements with the United States allow for European weapons to be integrated on the F-35, but the implementation requires significant effort on the part of Europe.
It must be stated that European partner countries do not share the same needs. The basic outlook adopted by the Netherlands is not to take part in military operations abroad alone but only in coalition with the major Nato allies. It follows that the Netherlands have no interest in fighting for autonomous command centers, nor for the ability to reprogram the "library" predisposed for the aircraft by the United States, nor armaments different from those on the standard aircraft. Italy instead wishes to maintain its autonomy in this area, including equipping the aircraft with specific weaponry.
In previous years Norway has sponsored an initial study on the integration of Iris-T missiles on the F-35. According to some this study was made possible by the firm negotiating position taken by the Norwegian government, which went as far as threatening the American counterpart to exit the F-35 program and turn to the Eurofighter consortium for its national needs if its demands were not met.
Norway has not yet officially decided to acquire the F-35. In any case, even after choosing the F-35, there is no guarantee that the Scandinavian country will want to integrate armaments on a national basis. Should Norway wish to integrate the Iris-T missile it could do it with Italy, or it might ask the Jpo to commission Lockheed Martin to integrate it and pay the cost of this operation, as it would need to with any other aircraft type.
The United Kingdom has demanded and obtained the integration of the Asraam missiles in the weapon system, and the basic F-35 version will be built in such a way to be able to use them. Both countries have encountered string American resistance to revealing this "black box": then, in order to integrate the weapon into the platform the European partners need access to source codes, but these means in substance "baring" the software. This eventuality worries both the Pentagon, which fears the risks associated with releasing such a sensitive technology, and Lockheed Martin, which would have to abdicate its profitable position as the only holder of a leading-edge software. The American government is specifically unwilling to transmit

such information until partner countries commit to purchase the F-35 for their national fleets, because it cannot allow that in the event of a decision not to purchase the F-35 these advanced technologies – developed with American funds – might find their way onto its commercial rivals.
Another question is the definition of the possibility for those partners who are so inclined to integrate on the aircraft the European Meteor missile. On this point the then-Undersecretary Forcieri officially informed Parliament that the feasibility had been under consideration since 2002 and that "it is possible because this aircraft is an open platform on which different systems can be interfaced." [25]
In practical terms the Italian integration of the Meteor missile would require far from easy bureaucratic and legal procedures. [26] In theory the same procedure would have to be followed for the F-35: having integrated the Iris-T missile Italy would have to turn to Lockheed Martin to return the aircraft to the standard configuration. The implications of keeping the Italian F-35 fleet outside the standard aircraft configuration guaranteed by Lockheed Martin are not fully clear, for instance in terms of maintenance and logistics.
On the whole the European countries have shown to have, even on the issue of integrating weaponry, a certain negotiating margin with their American counterpart, a margin that increases at the moment in which national purchase plans are placed on the scale. Even in this respect it falls to the Old Continent partners to agree a common position rather than continue to show up in broken ranks.

[25] Chamber of Deputies, Defense Committee IV, *op. cit.*, p. 6.
[26] It should be borne in mind that at present the integration on the Tornado or Efa of weaponry different from the basic configuration requires ITAF operational certification and Nato Eurofighter and Tornado Management Agency (Netma) authorization to fly out of configuration. Later it is necessary to follow all the procedures to bring aircraft activities back into the Netma configuration. For instance, if IT systems are managed by the German side, any systems modified on Italian aircraft will require its specific operational certification.

CONCLUSIONS

The Italian and European participation in the Jsf program in its study, development, industrialization, acquisition and maintenance phases entails an intricate succession of decisions on the part of a multiplicity of actors of different types. The fundamental decisions mainly involve the governments of participating countries and comprise bilateral *government-to-government* agreements, mainly with the American counterpart.

In the recent past some slowness in implementing such agreements, or a tendency on the American side to interpret them restrictively, has emerged. Because of the high level of expectations from partner countries, this has created contrasts and frustrations.

On the other hand, on the European side there is always a tendency to forget that this is neither an intergovernmental program between more or less equivalent partners (in which case a cost-share/work-share criteria would apply), nor a program based on common technology and intellectual property.

The Jsf is an American program, which leverages previous experiences owned by the US government and industry, whose costs fall for three-quarters on American shoulders and that has as its main customers the US armed forces and only in second place European governments and potential exports.

There is a clear asymmetry among the players, and this cannot but translate in an unequal relationship, also because the considerable and qualified overall European contribution is split among a number of separate national contributions which are uncoordinated when not in outright competition with each other.

Quite aside from the general agreements, the actual success of the European participation (and particularly of the Italian participation) in the project revolves around a series of contracts and agreements, often industrial and commercial in nature.
These agreements depend in part upon the political situation, in part on local industrial and technological capabilities, and finally on the possibility for non-American industries to have access to specifications and supply contracts which are often classified and subject to restrictions on account of commercial or security sensitivities.
Starting from the Italian case, the analysis carried out has shown, together with merits and positive factors, also a series of problems which are largely common and shared with other countries.
Several critical aspects remain to be discussed through a close dialogue among the parties.
From the point of view of European governments the ultimate political and military goal of the Jsf program remains that of ensuring the interoperability of their national aircraft fleets at a transatlantic level, also in terms of logistics. This requires a deep knowledge of the potential use of the aircraft and the broadest commonality among its different versions as well as between the aircraft of different countries. Still, the airframe, engine, systems and logistics will be the same for all partners and this ensures interoperability. The issue should not be underestimated. Suffice it to recall that during the first Gulf War the European countries which deployed the Tornados built together discovered just how different their aircraft were. Partners must therefore insist on this point, guaranteeing first of all maximum commonality between their aircraft and demanding the same of the Usa.
A second aspect is the integration on the F-35 platform of other systems and armaments, particularly those of European origin such as missiles. This is a crucial issue for operational sovereignty and a test which, should it fail, could provide serious operational and political repercussions. This is not an easy problem to solve, because it requires access, at various levels, to system software, the very "heart" of the platform and one of the most sensitive areas together with stealthiness and Rcs control. This is certainly a gradual, but inescapable process if the program is not to be hurt. For this reason it would appear desirable that the European partners bring together their requests and related funding for the anticipated additional cost of integration.
A further element of uncertainty concerns aircraft maintenance, particularly with regard to its stealthiness. The current drive to locate a production

and maintenance center in Europe is framed by the goal of developing local technical and industrial competencies, as well as guaranteeing the long-term operational sovereignty. The Italian-Dutch agreement lays the foundation for this operation, but it will be necessary to face the inevitable restrictions imposed both by governments and intellectual property, as well as the additional costs incurred. Once again there would be considerable advantages in case of broader European participation which would bring both a greater bargaining power and a sharing of costs.

The main advantage linked to participating in the early phases and to positioning certain Jsf program activities on European soil is linked to the prospect for technology transfers from the US to national industries. This should be expected to occur gradually in the course of the program rather than all at once and immediately. It should be kept in mind that from the American point of view it is a question of releasing leading-edge technologies that the beneficiary could later use competitively or transfer to third parties more or less willingly. Therefore all prospects will be facilitated by the European and Italian commitment to guarantee the reliable control – through adequate procedures and instruments – of those elements which come under technology transfer agreements.

In general, for the program to proceed speedily and without delays or needless costs, it is necessary to simplify the regulatory and bureaucratic processes affecting it, at the Italian national as well as bilateral and multilateral levels. This task is not as easy or obvious as might be imagined, because national regulations are still prevalent, particularly with regard to the export and circulation of airframe parts among the different countries. There are strong doubts, for instance, that Italian law will be equal to the challenges of the complexities of the international program. While it will be necessary to insist with the US administration to ensure simpler procedures that reflect partner status, it will also be necessary to clean up national regulations, where possible developing their European character in keeping with the indications that are emerging from European Union initiatives.

It would also be desirable to push the Usa to move from a bilateral approach, one country at a time, to a relationship with a cohesive group of government players. But to do so requires coordinating the efforts of countries which some times have goals which do not coincide in terms of timeframe – because of different national planning needs – and sometimes are actually industrial competitors. Therefore it will not be always possible or advantageous to reach an agreement, but it is necessary to at least try to

reach a degree of convergence on core interests, occasionally sacrificing some minor targets to achieve the final common result.
The purchase phase and the associated negotiations are a decisive moment for future outcomes. The time has come, therefore, to further develop the Italy-Holland agreement, involving as soon as possible Norway, Denmark and Turkey. The Dutch-Italian cooperation is very important, because together the weight of the two countries in European production and logistics is significant enough to offer a credible alternative with a direct and exclusive relation with the United States. The Faco agreement has therefore the potential to become the pivot for a European system to manage much more than the couple of hundred aircraft currently envisaged. The English position should be kept in mind in this respect: at present the United Kingdom has a "wait and see" position and does not participate in the European cooperation, but it could very well later join a European project should it be able to prove the added value of such a proposition.
The potential joining of other countries which are not yet part of the Jsf program – but which might later opt for this solution because of their fleet modernization requirements – should also be considered. This is particularly true for Germany, but also for all those countries that are presently operating F-16s or older aircraft. This would offer significant economies of scale and reinforce the European technological and industrial base, as well as greater interoperability. An "open door" policy should therefore be continued and reinforced with regard to the development of the currently bilateral agreements between Italy and the Netherlands.
In any case the building of the Faco facility in Italy represents a strategic opportunity for Italian industry to become a more authoritative and credible partner of American industry and become a catalyst in European collaboration in the context of a strengthening of transatlantic cooperation. The Faco can also be a moment of further innovation of product and process technologies or, in other words, of the ability to manage an industrial program even more advanced and complex than the experience already matured with Eurofighter.
The future Jsf fleets are potentially an opportunity of the greatest importance in order to develop a joint European management of their production, logistics and use aimed at reinforcing European defense within the framework of a closer transatlantic collaboration. It is up to European governments and industries, together with the Americans, not to waste it.

APPENDIX

Main Euro-Atlantic Industrial Capabilities in the Combat Aircraft Business

(*Source: Aviation Week and Space Technology – Aerospace Source Book 2008*)

Avio (IT)
2005 Turnover (USD millions): 1,652
Employees: 4,762
Areas of specialization:
- Propulsion: F-124, F-119, F-135 (for the F-35), EJ 200, TP 400 engine components
- Maintenance Repair & Overhaul (Mro): support services for commercial and military engines built

BAE Systems (UK)
2006 Turnover (USD millions): 29,394
Employees: 88,000
Areas of specialization:
- Platforms: EFA Typhoon, Harrier, Sea Harrier, Tornado
- Avionics: EFA and F-35 components, mission control systems
- Electronics: systems for communications, command and control, air defense, information management, navigation, identification and reconnaissance, electronic warfare, protection, surveillance, airborne and naval sensors

Boeing (USA)
2006 Turnover (USD millions): 61,530
Employees: 155,000
Areas of specialization:
- Platforms: AV-8B, F/A-18, F-15 Eagle
- Weaponry
- Electronics: systems for information management, communications, command and control (C3), intelligence, surveillance and reconnaissance (Isr)
- Maintenance Repair & Overhaul (Mro): support services for various Boeing products, upgrade, training and logistics services

Dassault (FR)
2006 Turnover (USD millions): 4,356
Employees: 11,928
Areas of specialization:
- Platforms: Mirage, Rafale
- Avionics: flight and systems simulators

Eads (FR-GER-SP)
2006 Turnover (USD millions): 52,025
Employees: 116,805
Areas of specialization:
- Platforms: EFA Typhoon, Tornado
- Avionics: mission and simulation systems
- Electronics: systems for communications, command and control, radar, sensors and air defense
- Maintenance Repair & Overhaul (Mro): support and logistics services for Harrier, F/A-18, Mirage, Tornado

Finmeccanica (IT)
2006 Turnover (USD millions): 16,454
Employees: 58,000
Areas of specialization:
- Platforms: Amx, EFA Typhoon, Tornado.
- Avionics (through Alenia Aeronautica and Aermacchi): Harrier, Efa, Tornado components
- Electronics (through Selex S&AS): systems for electronic warfare, radar, sensors, mission management and simulation
- Maintenance Repair & Overhaul: (through Alenia Aeronavali): support and logistics services for supplied components

General Electric (USA)
2006 Turnover (USD millions): 163,391[27]
Employees: 38,000
Areas of specialization:
- Propulsion: F/A-18, F-16, F-35 engines
- Avionics: landing gear, flight management systems
- Electronics: systems for navigation, ignition, thrust management
- Maintenance Repair & Overhaul (MRO): support and logistics services for supplied components

Lockheed Martin (USA)
2006 Turnover (USD millions): 39,620
Employees: 140,000
Areas of specialization:
- Platforms: F-117, F-16, F-35, F-22
- Electronics: systems for communications, commando and control, intelligence, surveillance and reconnaissance (ISR), radar, sensors and fire control, simulation, hardware and software development
- Maintenance Repair & Overhaul (MRO): support services for own aircraft, logistics

Northrop Grumman (USA)
2006 Turnover (USD millions): 30,148
Employees: 120,000
Areas of specialization:
- Avionics: F-35, F/A-18 fuselages and components
- Electronics: systems for communications, navigation, radar, sensors, surveillance, fire control, electronic warfare
- Weaponry
- Maintenance Repair & Overhaul (MRO): support services for own aircraft, logistics

Rolls-Royce (UK)
2006 Turnover (USD millions): 14,012
Employees: 38,000
Areas of specialization:
- Propulsion: F-35 engines
- Maintenance Repair & Overhaul (MRO): support and logistics services for supplied components

Saab (SW)
2006 Turnover (USD millions): 3,073
Employees: 13,600
Areas of specialization:
- Platforms: Gripen, Sas
- Electronics: communications systems, systems for data management, command and control, electronic warfare
- Weaponry
- Maintenance Repair & Overhaul (MRO): support and logistics services for supplied components

Thales (FR)
2006 Turnover (USD millions): 13,541
Employees: 68,000
Areas of specialization:
- Avionics
- Electronics: communications, command and control, surveillance and radar systems

LIST OF ACRONYMS

Adf	Air Defense Fighter
Aesa	Advanced Electronically Scanner Array
Af	Air Force
Cas	Close Air Support
Cdp	Concept Demonstration Phase
Cdr	Critical Design Review
Csar	Combat Search and Rescue
Das	Electro-Optical Distributed Aperture System
Dead	Destruction of Enemy Air Defense
Did	Defense Industry Daily
Dna	Direzione Nazionale Armamenti (National Directorate of Armaments)
Eaa	Export Administration Act
Eots	Electro-Optical Targeting System
EW	Electronic Warfare
Faco	Final Assembly and Check-Out
Fga	Fighter Ground Attack
Fy	Fiscal Year
Frp	Full Rate Production
Ftr	Fighter
GE	General Electric
Lrip	Low Rate Initial Production
Isd	In-Service Date
Isr	Intelligence, Surveillance, Reconnaissance
Mctl	Military Critical Technological List
Mla	Manufacturing Licence Agreement
Mob	Main Operating Base
Mrou	Maintenance Repair Overhaul and Upgrade
Netma	Nato Eurofighter and Tornado Management Agency
O&M	Operation and Maintenance
Jca	Joint Combat Aircraft
Psfd	Production Preparation, Sustainment & Follow-on Development
PW	Pratt&Withney
Rid	Rivista Italiana Difesa
Sead	Suppression of Enemy Air Defense
Sdd	System Design & Development
Sgd	Segretariato Generale Difesa (National Secretariat of Defense)
Taa	Technical Assistance Agreements
Uav	Unmanned Air Vehicle
Ucav	Unmanned Combat Air Vehicle
Wmd	Weapons of Mass Destruction

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This publication analyzes the participation of Italy and other European countries in the development and acquisition of the US F-35 Joint Strike Fighter (JSF) multirole aircraft. As this decision is bound to have strategic, operational, economic and industrial effects in the long-term, adequate knowledge of the consequences is required to inform the decision-making process at the political, military and industrial levels. The study identifies potential options for strengthening European cooperation in the JSF program, with a particular focus on the Italian case.