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INDUSTRY STUDY

FINAL REPORT

AIRCRAFT INDUSTRY

The Dwight D. Eisenhower School for National Security and Resource Strategy

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AIRCRAFT INDUSTRY STUDY 2016

ABSTRACT: The 2016 Eisenhower School Aircraft Industry team analyzed the European military aircraft industrial sector and assessed emerging implications for the United States (U.S.) government and the Department of Defense (DOD). The team conducted research using a variety of methods consisting of a guest lecture series, visits to key domestic and international defense firms, and independent research. For this study, the European military aircraft industry was divided by market segment namely; fighter aircraft, transport, and rotorcraft. The team evaluated each market segment based on their development, production, and exportability leading to insights on current and emerging trends involving European and transatlantic collaboration. Based on this analysis, the group identified opportunities and challenges regarding the participation of U.S. firms in the industrial dynamics of each market segment and emerging implications for the U.S. government and DOD.

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INDUSTRY FIRM VISITS

Fixed-wing Aircraft Prime Integrators and Manufacturers	
Boeing BDS, St. Louis, MO	F/A-18E/F, EA-18G, F-15E
Lockheed Martin Aeronautics , Fort Worth, TX	F-35, F-16
Lockheed Martin Aeronautics, Marietta, GA	C-130J
Manching Eurofighter, Munich, Germany	Eurofighter
The Airbus Group, Toulouse, France	Commercial & A400M
Rotary-wing Aircraft Prime Integrators and Manufacturers	
Boeing Mobility, Ridley Park, PA	V-22, CH-47
Bell Helicopters, Amarillo, TX	V-22, UH-1Y, AH-1Z, Model 525
Aircraft Components and Missile Systems	
Moog Components, Blacksburg, VA	OEM Parts
MBDA, Schrobenhausen, Germany	Missiles (Air-to-Air, Surface-to-Air, Air-to-Ground)

GUEST LECTURES

Richard Aboulafia — Topic: *World Aircraft Industry*
Vice President, Analysis, Teal Group Corporation

W. Alexander Vacca — Topic: *Defense Budgets and Corporate Strategies & Aircraft Design*
Corporate Director, Business Analysis, Northrop Grumman Corporation

Brian Kough — Topic: *Commercial and Military Fleet Trend & Maintenance, Repair, and Overhaul Demand*
Director of Forecasts & Analysis, Aviation Week Intelligence Network

James Hasik — Topic: *Transatlantic Defense Industrial Dynamics*
Nonresident Senior Fellow for Defense,
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AREAS OF STUDY

Department of Defense and Defense Industrial Base Relationship

Unmanned Aerial Systems: Market and Industrial Dynamics

Rotorcraft: Market and Industrial Dynamics

International Arms Sales Dynamics

Defense Industrial Cooperation: Joint Ventures and Strategic Alliances in the Defense and Aerospace Sector

International Defense Offset Dynamics

Transatlantic Defense Market and Industry Analysis

European Military Aircraft Industrial Cooperative Programs

F-35 as an International Collaboration Program

Competing via Business Models, Boeing and Airbus

Cybersecurity: Challenges and Implications for the Defense & Aerospace Industry

Innovation in the Defense and Aerospace Industry

Maintenance, Repair, and Overhaul in the Commercial & Military Aircraft Industry

NATO Eastern Europe Aircraft Industry Dynamics: Challenges & Opportunities

France's Military Aircraft Industry Dynamics

United Kingdom's & Italy's Military Aircraft Industry Dynamics

German Defense Market & Military Aircraft Industry Dynamics

Dynamics in the Russian & Chinese Military Aircraft Industries

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1. INTRODUCTION

Thesis: The relative continuing downturn in U.S. and European defense budgets and military aircraft procurement over the foreseeable future is leading Western aerospace and defense firms to pursue exports as key components of their business strategies and competitive positioning. Changing U.S. and international defense priorities coupled with airframe price affordability, reliability, and sustainability costs remain drivers of market opportunities. For U.S. firms and the government, international market opportunities shape economic and security interdependencies. Due to globalization, U.S. firms must rely more and more on collaborative international business opportunities in order to sustain their defense industrial base. Specifically, European firms are driven by U.S. firm dominance in fifth generation aircraft to seek means to sustain their military industrial base by country and market. In order to maintain the health of the industrial base and their competitive advantage, international market opportunities are viewed as a means to sustain their production facilities, human capital, and supplier/partner relationships. In response to the market trends resulting from both globalization and economics, European defense aerospace firms have had to fine-tune their strategies to best position themselves to compete effectively in the global marketplace. The changes in the European defense military aircraft firms' development, production, and market have significant implications for U.S. firms.

However, in accessing security, economic, and regulatory dynamics across international markets, U.S. firms may find challenges in executing current business models. Requirements for fighters, rotorcraft, and mobility/tanker by region, and procurement and lifecycle costs are major considerations. In this regard, U.S. firms face an additional challenge of price for these systems. Additionally, if firms begin to focus on international markets and exports, business models would potentially change and therefore create additional tensions for firms to balance domestic, international, and possibly commercial portfolios. For the U.S. government, the potential shifting defense industrial base business models may impact U.S. national security needs with respect to capacity, human capital, and technological dominance. Moreover, the export of technologies may impact international competition and regional military balances, and narrow the historic U.S. military technology advantage. Over the long term, U.S. planning and postures could be altered due to technology diffusion.

Research Methodology and Limitations

Research was conducted from January to May 2016 and included review and analysis of open-source data, reports, and studies from government, academic, industry, and news media sources. Industry perspectives were gathered from guest lecturers and non-proprietary corporate reports, as well as from research team visits to aerospace industry firms in the U.S. and Europe conducted from February to May 2016. This report is unclassified and is based exclusively on unclassified sources, to include all lectures, interviews, and documentary information.

Disclaimer

The views expressed in this paper are those of the seminar members (students and faculty) and do not reflect the official policy or position of the National Defense University, the DOD, or the U.S. Government.

2. STRATEGIC ENVIRONMENT SURROUNDING THE EUROPEAN AIRCRAFT INDUSTRY

Security Situation in Europe

As we examine the European military aviation market in this year's report, security developments both in Europe and globally since 2014 provide a brusque reminder of the relevance of North Atlantic Treaty Organization (NATO) and transatlantic security cooperation. The U.S. and our European allies confront a challenging strategic situation, one that will take all of our collective skills and capabilities to manage for the long-term. A concrete, executable, and appropriately resourced strategy for the U.S. and its European allies is still in development.

Of most immediate concern to the transatlantic relationship and our European allies is Russia's renewed aggression towards its eastern neighbors, including the forcible annexation of Crimea in 2014:

> Russian President Vladimir Putin's seizure of the Crimean Peninsula from Ukraine in early 2014 was the most consequential decision of his 16 years in power. By annexing a neighboring country's territory by force, Putin overturned in a single stroke the assumptions on which the post-Cold War European order had rested.[1]

Dmitri Trenin warned that 2014 saw the reintroduction of the bipolar element into European security, with Russia now prepared to compete openly against the U.S. and its European NATO allies. "Moscow's use of force to change borders and annex territory did not so much mark the reappearance of realpolitik in Europe…as indicate Russia's willingness and capacity to compete militarily with NATO. The year 2014 was when European security again became bipolar."[2] Kamp counseled that NATO would need to reassess its tasks and missions in light of Putin's renewed emphasis on orienting Russian against the West:

> It seems difficult to overestimate Russia's aggression against Ukraine as a 'game changer' for the Atlantic Alliance. Vladimir Putin's push to extend Moscow's sphere of influence and to lastingly position Russian as an anti-Western power requires a profound reassessment by the NATO of its future tasks and missions.[3]

Kamp warned that Russia has now abandoned any pretense of acting in accordance with international law, and we should not expect this situation to alter in the near future. "Russia changes border in Europe by force, breaches existing treaties, and break with all European principles of legality and legitimacy. Hence the current Russia-Ukraine crisis is neither an 'accident' nor 'bad-weather' period, but rather, a fundamental climate change."[4] Kamp also warned that some NATO allies still had not come fully to terms with this disturbing strategic reality.[5]

Security analysts were not entirely shocked at Russia's move to annex Crimea and partition Ukraine. Russia had been engaged in a large-scale military build-up since 2008, one which is expected to cost $700 billion by 2020. Trenin states that the project "is intended to transform the Russian military form a massive standing force designed for global great-power war into a lighter, more mobile force suited for local and regional conflicts."[6] He also notes that

Russian warplanes in 2007 had resumed "Cold War-era patrols around the world—skirted the borders of the United Kingdom, the United States, and several Scandinavian countries".[7] Russia invaded Georgia in 2008, in a move many believe was aimed to prevent Georgian President Saakashvili from bringing this former Soviet state into NATO membership.[8] Russia's actions in 2014 were the culmination of a longer process of military modernization and rearmament.

In September 2014, NATO members met in Wales to respond to this renewed Russian aggression in Europe. In the "Wales Declaration on the Transatlantic Bond," NATO members declared their concern with "Russia's illegal self-declared annexation of Crimea and Russia's continued aggressive acts in other parts of Ukraine and the spread of violence and extremism in North Africa and the Middle East."[9] In Wales, NATO members agreed on a Readiness Action plan, revising NATO posture in Eastern Europe, and reaffirming Article 5 protections for mutual assistance in the event of an attack on any NATO member. "The Alliance poses no threat to any country. But should the security of any Ally be threatened we will act together and decisively, as set out in Article 5 of the Washington Treaty."[10]

NATO Security Commitments

In early 2016, NATO's Secretary General Jens Stoltenberg provided an update to NATO's revised military posture and outlined members' increased budgetary commitments:

> …2015 also saw a dramatic slowing of cuts to defence spending among most European Allies and Canada, and the greatest strengthening of NATO's collective defence since the Cold War…. We have increased our presence in the east of our Alliance. We have agreed to increase the presence of NATO's AWACS early warning aircraft over Turkey. We have roughly tripled the size of the NATO Response Force to more than 40,000 troops.[11]

Since the Wales Summit, NATO has reinforced its eastern border with a 4,000 member rapid-reaction force, and placed four warships on the potentially contested Black Sea. The U.S. increased its military spending in Europe by four times.[12] The Secretary General also highlighted NATO Exercise Trident Juncture, "incorporating more than 36,000 troops, over 140 aircraft, and more than 60 ships from over 30 countries" in a "tremendous display" [13] of unified NATO capability.

Looking more broadly, Kamp argues that NATO must also be able to manage security challenges globally, in the Middle East, with a rising China, and in its operations in Afghanistan and Libya. It does not have the luxury to remain focused on its own eastern flank. Hence, NATO faces the challenge of coping the legitimate security concerns of its Eastern members and, at the same time, not falling into the trap of creating a one-dimensional "East Alliance." Instead, the Alliance as a global actor has to "work to preserve its 360-degree perspective to be prepared for the complexities of the twenty-first century security environment."[14]

Robert Kaplan argues that both Russia and China are increasingly operating, not as is often assumed, from a position of strength, but rather from a position of economic decline, given economic slow-down in China, and Russia's dependence on a challenged oil market. He argues that their governments are likely to act in a reactive and impulsive manner to retain control.

> As China asserts itself in its nearby seas and Russia wages war in Syria and Ukraine, it is easy to assume that Eurasia's two great land powers are showing signs of newfound strength. But the opposite is true: increasingly, China and Russia flex their muscles not because they are powerful, but because they are weak. The prospect of quasi anarchy in two economically struggling giants is far more worrisome.[15]

Kaplan cautions that the internal stability to both Russia and China can no longer be assumed, and that they are likely to try to "export their troubles" to provide another focus for their citizens' discontent.[16] Regardless of whether one agrees with Kaplan's assessment, both the U.S. and our NATO allies are increasingly challenged by the rise of China and its increasing assertiveness in the East and South China seas. Our European allies are hampered because they generally they lack the ability to project power in Asia, despite their significant trade interests in the region. Kamp notes the paradox for NATO of a region which like the Strait of Malacca, which "carries more than 40 %of the world's trade…but where only the United States has the capabilities and to maintain order…."[17] He suggests some type of agreement in which European NATO members increasingly "take care of the stability of their neighborhoods in Africa or the Middle East, thereby freeing U.S. resources to be deployed further afield in the Asia-Pacific."[18]

Kenneth Pollack writes about the cataclysmic challenges facing the globe from the Middle East and North Africa:

> The modern Middle East has rarely been tranquil, but it has never been this bad. Full-blown civil wars rage in Iraq, Libya, Syria, and Yemen…. Tensions between Iran and Saudi Arabia have risen to new heights, raising the specter of region wide religious war…. Not since the Mongol invasions of the thirteenth century has the Middle East seen so much chaos.[19]

Pollack points to nascent conflicts, including within NATO member Turkey, and spillover threats to western partners such as Jordan, Saudi Arabia, and Tunisia, among others. Pollack warns that both engagement and failure to engage in the region to help facilitate its return to stability have high costs, exceeded only by failing to choose one coherent course of action:

> Stabilizing the region would almost certainly require more resources, energy, attention, and political capital than most advocates of a forward-leaning U.S. posture recognize. Similarly, giving up more control and abandoning more commitments in the region would require accepting much greater risks than most in this camp acknowledge.[20]

Instability within Turkey or on Turkey's border, also NATO's eastern border, is of particular concern and relevance for NATO and our European allies. Refugees from Syria and Afghanistan, and refugees and economic migrants from Africa, continue to seek new routes to Europe. The flow has dangerously destabilized EU relationships with Turkey, with possible impacts on NATO internal cohesion. Der Spiegel recently remarked about Turkish President Erdogan: "Erdogan's fit of rage is only the most recent escalation in the conflict over German Chancellor Angela Merkel's refugee deal with Turkey."[21] Meanwhile, Turkey and Russia have confronted each over the last year during alleged Russian incursions of jets into Turkish air space, resulting in Turkey shooting down two Russian fight planes.

Slow Global Economic Growth and European Defense Budgets

Balanced against this array of increasing security challenges, global economic growth continues to lag. "In every single region of the world, economic growth has failed to return to the rate it averaged before the Great Recession…experts have largely overlooked what may be the most important factor: the global slowdown in the growth of the labor force."[22] Sharma warns that the impact of declining growth in the labor force could herald a likely permanent transition to much lower rates of growth, lopping at least a full percent off of growth rates globally. Meanwhile, NATO member states continue to wrestle internally with the appropriate level of defense resourcing. "All this will have to be achieved within the confines of tight budgets and a climate of dissent on both sides of the Atlantic on the amount of resources that should be devoted to security and defense."[23] The financial crisis and resulting economic hardship have introduced legitimate competition for scarce resources, and NATO member states' publics may not be willing to carry the burden of greater defense resourcing.

NATO leadership has focused closely on the resourcing issues. In Wales in 2014, NATO members agreed to reverse the trend of declining defense budgets, pledging, to move towards the existing NATO guideline of spending 2% of GDP on defense within a decade, with a view to fulfilling NATO capability priorities.[24] In the NATO Secretary General's most recent annual report, Secretary General Stoltenberg highlighted the recent reversal of long-term declines in NATO defense budgets. "2015 also saw a dramatic slowing of cuts among most European Allies and Canada, and the greatest strengthening of NATOs collective defence since the Cold War."[25] He noted that in 2015, member states made significant progress towards goals agreed in Wales:

> The guideline agreed by Allies is that at least 2% of GDP should be allocated to defence spending and at least 20% of that spending should be invested in major equipment, including research and development. In 2015, there was real progress toward fulfilling the commitment made in Wales…Overall, the annual real change in NATO total defence expenditures showed a move in the right direction.[26]

That said, buried in the fine print of the report was an admission that total NATO defense spending had in fact fallen in 2015. Balancing the continuing economic malaise (and in some countries, continuing economic crisis) continues to be a challenge in terms of increasing defense spending:

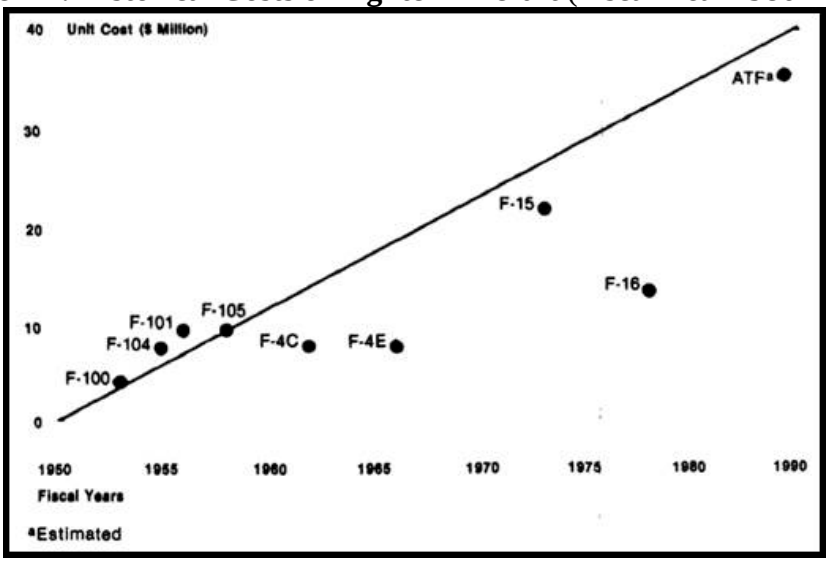
> Despite the fact that many NATO countries increased their defence spending in 2015, cuts by some with larger economies meant that overall NATO defence spending is estimated to have decreased in 2015…Given the challenges to Euro-Atlantic security, it is essential that NATO members remain committed to investing in defence.[27]

As the Secretary-General himself acknowledged, NATO needs to do more to meet its evolving security challenges. For the U.S., considering how we collaborate and cooperate with our European NATO allies in these fraught and financially trying times has never been more important.

Cost/Complexity of Modern Aircraft Programs

As the complexity, and thus cost, of fourth generation fighter aircraft began to exponentially increase, individual European governments began to seek collaboration. Figure 2-1 provides a representative example of the costs increases experienced in the U.S. as fighter aircraft transitioned through the third-, fourth-, and fifth-generations of technological advances; European aircraft experienced a similar trend. These cost increases resulted from new structural materials (e.g., titanium) and engines that allowed supersonic and high-g flight and electronic enhancements in radar, avionics, and other mission systems. Development of a new fighter aircraft that is fourth or fifth generation capable is estimated to cost $30-$50 billion.[28]

Figure 2-1. Historical Costs of Fighter Aircraft (Fiscal Year 1986 Dollars)



European Defense Industrial Base

European military forces and armament producers have followed a localized approach for centuries. During the Cold War, NATO interoperability and U.S. defense technology leadership drove Western European countries to outfit their military forces with a mix of equipment and supplies primarily from domestic and U.S. sources. After the Cold War ended, the creation of the European Union (EU) set the stage for improved collaboration among member states on industrial development, including in the defense arena. Joint European projects have showed the potential to concentrate funding, talent and output capacity in ways that could shift the transatlantic defense market balance away from the United States and toward Europe, but they have proven lengthy and costly. Yet, aside from a few strong firms and a handful of collaborative programs, the defense industry in Europe continues to exhibit a largely nationalistic character, with each nation aligning political, military and industrial priorities with a bias toward self-interest over collective benefit.

Even as some EU-wide organizations and projects gain momentum, Europe's financial doldrums, political and economic conflicts with Russia, terrorism threats and tremendous migrant inflows have deepened internal pressures among EU members to keep defense

production and supply chains close to home. Meanwhile, the European military aircraft industry to remains fragmented, with low internal demand driving increased export competition, diminishing profits, domestic employment, and research and development funding. Europe's dysfunctional defense industry structure has kept the transatlantic military aircraft market tilted in favor of the U.S., with several European nations choosing to purchase major programs such as the Joint Strike Fighter as well as U.S. military cargo aircraft and unmanned aerial systems in addition to or instead of those produced by European collaborations or so-called "national champion" producers. These conditions raise the question, does Europe possess what can be called a defense technology and industrial base? Regardless of how the European defense industry is described, what are the implications of its structural trends on the military aircraft sector of the transatlantic defense market?

Although Europe hosts advanced defense industrial firms, structural problems keep it from attaining a defense technology and industrial base comparable to that of the United States. Unless the strongest economic, industrial and military countries in Europe shed more nationalism in favor of collective security and industrial development, the transatlantic military aircraft market will continue to favor the United States indefinitely.

The political composition of modern Europe is multifaceted. The continent includes approximately 50 nations, including Russia on the eastern frontier. The EU is made up of 28 member states,[29] 19 of which are in the European Monetary Union (EMU).[30] All EU members except Denmark are members of the European Defence Agency (EDA).[31] Another overlapping but different group of states are NATO members, of which European states comprise 26 of 28 members.[32] Six EU member states are not NATO members, most notably Sweden and Finland. Norway is a member of NATO, but not an EU member state. For the purposes of this paper, "Europe" will be defined as the EU and its member states.

Joint Publication 1-02 defines the U.S. *defense industrial base (DIB)* as, "The Department of Defense, government, and private sector worldwide industrial complex with capabilities to perform research and development, design, produce, and maintain military weapon systems, subsystems, components, or parts to meet military requirements."[33] This definition encompasses the entire global network of internal and external actors creating defense articles for DOD agencies and the military departments. Applying the definition globally, each state procuring defense articles for domestic use can be seen to rely on a DIB. Components of these many DIBs overlap significantly, often in correlation with defense and trade alliances, partnerships and interests. A key difference between a *defense industry* and a *defense industrial base* is that a base implies more than just an available market for producers and consumers of defense goods. This paper defines a DIB as including fundamental and developmental research as well as effective political alignment, capital, industrial structure, and a supply chain trusted by a nation or group of nations to outfit military forces to respond to crises or engage in war.

Legislative bodies in the United States and the EU recognize that modern international security threats are both facilitated and addressed by technology diffusion, requiring individual and collective state action to seek and adopt a technological advantage to maintain security interests in the face of rising competitor capabilities. In a 2010 U.S. statute, Congress sought to

define and support what it called the national *defense technology and industrial base (DTIB)*, expanding the DIB notion to include the importance of technology development, adoption and sharing in both the national defense arena and the commercial economy.[34] For its part, the European Parliament expressed in a 2013 policy document its resolve to establish a definitive *European Defence Technological and Industrial Base* (EDTIB), promoting industrial cooperation and technology sharing among EU members.[35] How effective have the DTIB development efforts been on both sides of the Atlantic Ocean?

The EDTIB can be seen as a veritable sounding board for political, economic and industrial issues. When deconstructing the EDTIB acronym into its component words, the E for "European" implies something that extends beyond the national framework of member states, beyond the logic of borders and territory. Unfortunately, this has not come to fruition to date; it is more of an objective to be achieved than a reality. In addition, this raises the question of the definition of the "European" nature of a company or an entity, including collaborations and joint ventures. The D for "Defense" could irrevocably tie the EDTIB acronym to the political arena, linking it to powerful concepts like sovereignty, autonomy and security. Traditionally, these concepts will continue to operate in great tension with the collective connotation of "European." Combining European with Defense here is meant to relate to the collective defense of the entire EU rather than just its most powerful member states. The T for "Technological" and the I for "Industrial" could refer more to the economic arena, more specifically to production structures, technological and industrial competences and know-how, innovative corporate behavior, and links between the scientific and the industrial worlds.

The B for "Base" in EDTIB is a rather vague notion covering all players, companies (large groups, small and medium-sized companies), laboratories and public or private research centers. It raises the issue of the contours of the industrial sector and its segmentation, the existence or not of specificities of defense industrial activities, of synergies and complementarity between defense activities and civil activities. Until now, however, beyond the prime contractors, major integrators and equipment suppliers, knowledge of the subcontractor chain is a real grey area, with very little consolidated data and indicators. Currently, Europe's defense industry is concentrated in six major industrial nations: the United Kingdom, France, Germany, Italy, Spain and Sweden. Each includes one or more clusters of defense research laboratories of governments, academic institutions and/or firms, as well as defense production and supply chain activity. World class defense firms operating in one or more of these countries include BAE Systems, Dassault Aviation, The Airbus Group, Finmeccanica-Leonardo, MBDA, Rolls-Royce, Safran, Saab, and Thales. These firms form the basis for defining and identifying the EDTIB.

As Europe's feudal kingdoms began consolidating and transforming into nation states in the seventeenth century, each retained control over raising and supplying their armies and navies. Up through most of the nineteenth century, domestic armament production primarily included ships, small arms, cannons, ammunition. By the Second World War, success in large scale mechanized warfare added demands for adopting rapidly emerging defense technologies, vast supplies of raw materials, extensive fuel and munition stocks, and networks of factories producing parts and assembling high quantities of complex vehicles and aircraft. Production required planning and funding on a scale beyond that of the large-scale conflicts of the

nineteenth century and even the First World War. While countries on both sides of the war attempted to produce arms indigenously whenever possible, the greatest success took place in the United States, Great Britain, Russia, Germany and Japan.[36] With national survival at stake against determined enemies, high output as well as the quest for technical innovation took precedence over efficiency and cost control for nations on both sides of the conflict.

Immediately following the Second World War, devastated European nations lacked the human and financial capital to rebuild their economies, infrastructure, industries and people without U.S. assistance. As the Cold War deepened, Western Europe relied upon U.S. arms production as well as armaments from indigenous producers, many of which were owned partially or entirely by the state. Over time, defense firms in major European nations gradually developed a more privatized structure, although with extensive subsidies and captured domestic markets. As part of the NATO alliance, these major powers still relied on U.S. support in the form of forward military presence, technologically sophisticated equipment and interoperability.

The end of the Cold War brought slashed defense budgets and defense industry consolidation to Europe just as it had to the United States. In 1991, there were over 20 major defense firms in Western Europe, but by the end of 2000 only four remained (EADS, BAE Systems, Thales and Leonardo-Finmeccanica). The European consolidation took on a necessarily different character, with cross-border mergers and acquisitions being hallmarks of the reconstituted industry (See Figure 2-2). As shown in Figure 2-3, anemic defense spending by governments in Europe since the Cold War has hampered the European defense industry's ability to innovate in step with the United States. As a result, the U.S. has maintained its primacy in production of stealth aircraft technology, precision guided weapon systems and munitions, space-based and atmospheric ISR platforms and systems, as well as submarine and anti-submarine warfare. This would affect the ability of European firms to compete with U.S. firms both within Europe and in the global defense market, including in the military aircraft sector.

Unlike the unitary defense consumer and large defense budget in the United States DTIB, the European defense market relies internally on numerous consumer countries with relatively small defense budgets. These conditions have led to widespread consolidation of producers and nationalistic tendencies as each European government seeks to support and preserve indigenous defense firms whether or not they can compete viably in the marketplace. Although European defense industry consolidation has included cross-border investments and joint ventures, the strongest European governments and defense firms have exhibited strong nationalistic tendencies, routinely putting national interests above collective European security interests.

Figure 2-2. European Defense Industry Consolidation, 1990-2000.[37]

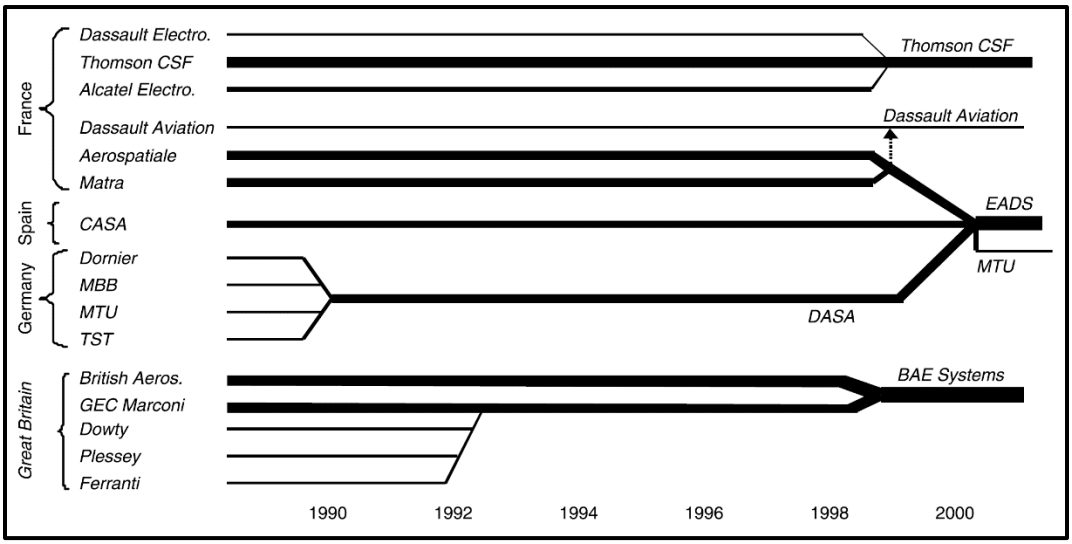
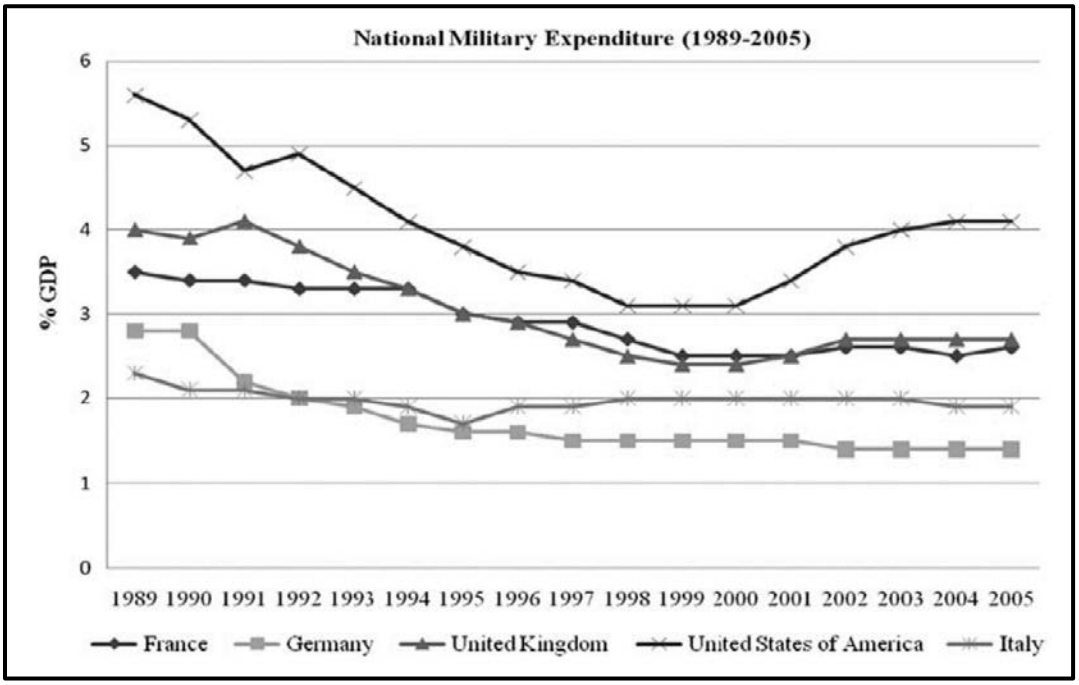


Figure 2-3. National Military Expenditures.[38]



Efforts to centralize Europe's internal defense cooperation began shortly after the Second World War ended, with a purpose of preventing conflict and defending against the threat of further Soviet incursion toward the West. Treaties signed in 1947 and 1948 linked the United Kingdom, France, Belgium, Luxembourg and the Netherlands into a broad-based economic and collective self-defense relationship.[39] These accords led to a proposed European Defence Community (EDC) in 1950. Initiated by French Prime Minister René Pleven, the plan called for a European force equipped by European industry, funded by European governments, and commanded under a European supranational authority.[40] Although supported by most countries

in Western Europe and the United States, the plan crumbled when the French National Assembly rejected the treaty in 1954. This relegated future Cold War defense cooperation to occur through the U.S.-dominated NATO construct, with Europe-centric efforts such as the Western European Union (WEU) and the Independent European Program Group proving largely impotent.[41]

Effective on November 1, 1993, the Treaty of Maastricht formalized creation of the European Union as a political entity, but it also sought to foster European defense cooperation outside NATO.[42] The Treaty established the Common Foreign and Security Policy (CFSP) as a means of avoiding a repetition of Europe's inability to organize quickly a military force to intervene early in the Balkan conflicts.[43] The CFSP created a mechanism for intergovernmental coordination of collective security matters, but did not include formal processes, rules or commitments by EU member states. Such structure was added through creation of the Common Security Defence Policy (CSDP) in 1999 after the Kosovo conflict revealed the EU's inability to move from broad defense policy agreement to provision of forces to take action.[44]

The CSDP has become the driver of EU collective defense policy, to the extent one exists. The CSDP led to creation of a European Rapid Reaction Force in 2003, comprised of military forces provided by member states which can be deployed to crises under the "EUFOR" banner. More detailed structure and rules were added to the CSDP through the 2003 Treaty of Nice and 2009 Treaty of Lisbon, respectively.[45] In addition, the 2003 European Security Strategy (ESS) set forth important concepts, including "the link between internal dynamics and external ambitions."[46] Since the beginning of 2003, the EU has deployed "several thousand civilian and military personnel to four continents" on over 30 missions through the CFSP, CSDP and EUFOR frameworks.[47] However, forces provided by member states for EUFOR operations remain only about one sixth the size originally contemplated, and outward EU defense policy remains situational rather than prescriptive.[48] Each EU member reserves and exercises the right to balance the benefits gained from EU defense involvement with national sovereignty imperatives.[49] With its small size and unpredictable, ad hoc employment primarily in peacekeeping or humanitarian operations, the EUFOR framework has not alone required the kind of consistent military equipment volume or sophistication warranting a robust DTIB.

The European Defense Agency (EDA) was founded in 2004 as a defense industrial policy arm to improve the EU's collective defense capabilities.[50] The EDA was created by a Joint Action of the EU Council of Ministers "to support the Member States and the Council in their effort to improve European defense capabilities in the field of crisis management and to sustain the European Security and Defence Policy as it stands now and develops in the future."[51] The EDA has four primary functions: (1) develop capabilities; (2) promote research and technology; (3) promote armaments cooperation; and (4) create "a competitive European Defence Equipment Market and strengthening the European Defence Technological and Industrial Base."[52] To its credit, in 2013 EU leaders charged the EDA to coordinate requirements and development of European capabilities in four key areas: intergovernmental satellite communications, air-to-air refueling, cyber defense and unmanned aerial vehicle (UAV).[53] These efforts are progressing, albeit slowly. Nonetheless, if success of the EDA is measured by whether it has fostered broad-based EU member involvement in defense capability development utilized by most EU member states and thereby establishing a true European DTIB, then such success has yet to be achieved.

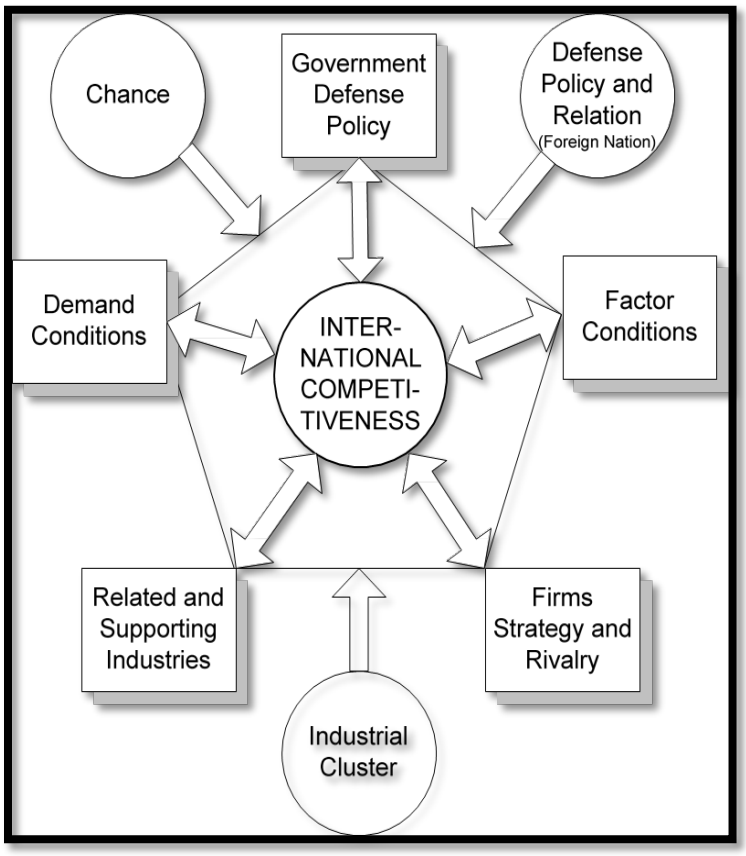
Analysis of Europe's Defense Industry. European nations have drawn closer together since the early 1990s with the formation of the EU, the European Monetary Union, CFSP, CSDP, and the EDA, yet Europe still does not possess a cohesive DTIB. Europe's vibrant and innovative defense industry is not a DTIB upon which its members can and do mutually rely to further their collective security interests. Roadblocks to a cohesive European DTIB include a lack of overall market competitiveness, the inflexible exercise of national sovereignty by EU member states, the NATO alliance, and dominant U.S. influence over international political, economic and security matters.

Europe's struggle defense industry competitiveness can be analyzed using a modified version of Michael Porter's "diamond of national advantage."[54] Porter's diamond model depicts the definition and interplay of four attributes comprising the "playing field that each nation establishes and operates for its industries."[55] A modified pentagon-shaped version of Porter's model is shown in Figure 2-4. The four core determinants found in Porter's model are *factor conditions* (e.g., availability of capital, skilled labor, infrastructure, raw materials), *demand conditions* (i.e., internal market demand), *related and supporting industries* (internationally competitive internal supply chain), and *firm strategy, structure and rivalry* (corporate structure and governance of firms as well as the nature of domestic competition).[56] Added to the model in Figure 2-4 (changing its shape to a pentagon) is the role of *government defense policy* in shaping the domestic corporate environment, which Porter discussed at length.[57] Governments are key defense market actors because they serve as the regulator and the principal domestic customer of defense firms. Importantly, interdependencies among the five determinants can mean that change in one determinant can weaken or strengthen the impact of another determinant.

In addition to the five determinants discussed above, three influencers also are useful when analyzing defense markets using Porter's diamond model. These influencers are the presence (or not) of *industrial clusters* (a high concentration of related specialized firms, technology and labor in an industry or industries); *defense policy and international relations* (external or outward governmental policy and actions); and *chance* (developments beyond control of firms, like breakthrough innovations, financial market shifts, international conflicts or regional wars). Influencers can impact the competitiveness established by determinants, sliding it up or down the scale. While a detailed analysis of the U.S. DTIB using Porter's diamond is beyond the scope of this paper, such an analysis would reveal a highly competitive U.S. DTIB.[58]

Applying Porter's diamond to Europe requires analyzing EU-wide and member state inputs through each attribute, revealing inherent competitive weaknesses in the European DTIB.[59] Applying the model to the EU, *government defense policy* translates to EU defense policy, which would mean the combined effect of policies set by the EDA and the separate defense policies of EU member states. The mere existence of an overarching government actor and 28 member governments makes the market unduly complex and exaggerates the impact of changes in the *factor conditions*, *demand conditions* and *government defense policy* determinants, as well as the *defense policy and international relations* influencer.

Figure 2-4. Modified Porter's Diamond for Analyzing a Defense Technology and Industrial Base.[60]



There are several drivers of weakness in the European DTIB. Individual firms in Europe prioritize nationalistic interests over collective EU interests, distorting firm *strategy, structure and rivalry* when viewed from the EU level. The same nationalistic bent affects the efficiency of *related and supporting industries* as "buy local" rules can sometimes preclude firms from choosing the best supplier when that supplier competes with a local firm. The distributed power structure of the EU also interferes with the natural formation and growth of *clusters* and dilutes the technological innovation that could be harnessed under the *chance* influencer. Austere EU member state funding conditions severely impacts *demand conditions* in Europe, with a resulting disruption of *firm strategy, structure and rivalry* as national champions from the EU's strongest members fight for a greater share of international export markets, particularly in the Middle East and North Africa (MENA) and Indo-Asia-Pacific regions. The *defense policy and internal relations* influencer is affected by commitment of most members to the NATO alliance, not the EDA, as the source for capability requirements, equipment standards and interoperability guidelines. Finally, the U.S. DTIB maintains a strong competitive position in Europe, affecting all five determinants and both the *defense policy and international relations* and *chance* influencers.

The United States is comprised of 50 states plus the District of Columbia and a number of territories. Each state or territory possesses a limited degree of sovereignty within their borders, but all are subordinate to the U.S. federal government on matters of central government taxation and spending, as well as national security policy and military structure, procurement, deployment and employment. The United States invests military power in one organization, the DOD, led by one head of state, the President. Because a functioning DTIB is heavily dependent on government requirements, procurement and regulation, the unitary nature of U.S. government involvement presents the U.S. defense industry with a cohesive source of research goals and funding, system requirements, purchasing activity and regulatory structure. The overlapping U.S. defense research, development and acquisition (RDA) processes as well as export controls and foreign ownership barriers are byzantine and inefficient. However, this is a far more coherent and predictable structure than that found in Europe.

Twenty-eight national sovereigns exercise authority over EU defense matters. Member states have ceded some authority to central EU bodies and each must abide by agreed upon rules and share in funding collective policies and interests. However, member states can block most EU attempts to dictate domestic taxing, spending or military structure, procurement, deployment or employment. Because the security interests, geopolitical influence and both military and economic strength of EU members varies broadly, they have not established a unitary defense policy to guide a cohesive European DTIB. Importantly, individual EU member state sovereignty has precluded development of enforceable EU-wide laws, policies and regulations on industrial base security and health, export controls and foreign ownership of defense firms.

The strongest EU members in terms of technological innovation as well as political, economic, industrial and military power are France, the United Kingdom, Germany, Italy, Spain and Sweden. Instead of establishing and following a coherent, Europe-wide defense policy, these nations decide major defense policies and initiatives for themselves, finding partners among each other, the United States and other countries on a per-program basis. As a result, the defense technological and industrial strength in Europe is concentrated among these same countries, with each being the home of a “national champion” defense firm and an array of suppliers at lower tiers of the defense market. This uneven structure obstructs formation of a cohesive European DTIB because, despite the aspirations expressed in the CSDP and the mission of the EDA, Europe has not agreed on an overarching and binding defense policy to drive member state funding, creation, provision, regulation and maintenance of collective defense capabilities.

Europe’s defense industry has long experienced declining demand among EU member states due to national political decisions and budgetary constraints. The European defense industry’s internal consumers are national governments. External consumers include the United States, NATO and the governments of other nations around the world. The producers include state-owned as well as privately- and/or publicly-held firms, and firms with a combination of state, private and public ownership. While Europe is home to healthy, innovative defense technological and industrial producers, funding from national governments of member states has stagnated since the Cold War ended. With the U.S. DTIB maintaining a strong market share among EU member states, European firms have been forced to compete with one another for

exports, particularly in the Middle East and Asia. The offsets required by export customers place downward pressure on profitability and domestic employment in the EU nations where defense firms reside. A prime example of this phenomenon is the fierce export competition among Eurofighter (Airbus Space & Defence), SAAB, and Dassault in the fourth-generation fighter aircraft market segment. Had EU nations, particularly those where these firms reside, fulfilled orders anticipated at the beginning of the development programs, then the firms would not have to undercut each other as much in the global export market. Europe's "race to the bottom" on price and offsets shrinks funding available for research and development of next-generation products.

For over forty years, NATO was an important source Western European states looked to for policy, standards and doctrine to help guide defense spending. Efforts by the EU since the end of the Cold War to establish guidance through the CSDP and EDA have not overcome NATO influence because each NATO member state must uphold its NATO obligations even if they choose to conduct military initiatives or operations on their own or as part of the EU. As a result, the European defense industry produces articles to meet domestic and NATO standards first. This acts as a sort of entry barrier for the EDA to shift the defense industry toward satisfying its requirements for serving the EU's collective security interests. Starting in December 2001, NATO member states experienced a mixture of battlefield and security cooperation successes and failures during the 13-year life cycle of the International Security Assistance Force (ISAF) in Afghanistan. However, the operation bridged a relevancy gap that otherwise would have weakened NATO between the turn of the century and Russia's 2014 seizure of Crimea and follow-on operations in eastern Ukraine. The battlefield interoperability challenges NATO member states overcame collectively in Afghanistan were real, impacting life-or-death combat situations. As a result, as NATO adjusts to its renewed continental relevance, it can address Russian threats having proven its resilience and cohesiveness. Russia's economic and military aggression also has driven EU members to prioritize nationalistic interests over EU interests on defense matters. Thus, NATO and nationalism leave little room for grand, EU defense policy, undermining the EDA mission to build a strong European DTIB.

The U.S. strongly influenced the European defense market throughout the Cold War and beyond. As Europe recovered fully from the Second World War and then emerged from the Cold War, the 1993 EU formation had the potential to displace the United States from its prominent influence over EU defense procurement.[61] However, holdover commitments by member states to U.S. Cold War platforms (e.g., F-16, Patriot), both U.S. interoperability and U.S.-dominated NATO standards, as well as a lack of significant European technological innovation in the 1990s have combined to help the U.S. maintain its competitive advantage through subsequent conflicts in the Balkans, Afghanistan and Iraq. During those operations the U.S. DTIB further refined and innovated battlefield technology, most notably UAVs and GPS-guided munitions. U.S. stealth technology was necessary only briefly during Operation ALLIED FORCE in Kosovo (1999) and Operation IRAQI FREEDOM (2003), but was effective and still faces neither friendly nor hostile peer competition.

The United States remains the primary source for superior military technology across many categories. U.S. firms dominate several market segments, including medium and high

altitude/long endurance (MALE and HALE) UAVs (MQ-9, RQ-4, MQ-4C), PGMs [Joint-Direct Attack Munition (JDAM)], maritime air defense systems (Aegis Combat System), and a variety of missile systems. By design, strong U.S. export and foreign ownership controls restrict or prevent many countries from the most advanced capabilities in the U.S. arsenal (e.g., F-22).

Although U.S. defense firms lament the drag export controls put on foreign sales, they continue to outperform all other countries and regions in worldwide arms sales. In 2014, and for the eighth year in a row, U.S. defense firms delivered more goods than firms of any other nation, providing $12.2 billion in defense articles, or 26% of the global total.[62] Russia ranked second and France ranked third in 2014.[63] The three nations combined delivered over $26 billion, which was 56.6% of all worldwide arms deliveries.[64] The picture is not all bright for U.S. firms, however, because in recent years a large proportion of U.S. sales have been to Saudi Arabia and Iraq (see Table 2-1). [65] It is not likely such high spending by these two countries is sustainable.

Table 2-1. Worldwide Arms Deliveries, 2007-2014 and Suppliers' Share with Developing World.[66]

(in millions of **current 2014** U.S. dollars)

Supplier	Worldwide Deliveries Value 2007-2010	Percentage of Total to Developing World
United States	45981	67.4%
Russia	24500	96.3%
France	8400	50.0%
United Kingdom	10400	50.0%
China	8900	100.0%
Germany	15900	33.3%
Italy	5000	46.0%
All Other European	21900	43.4%
All Others	27500	21.1%
TOTAL	**168481**	**56.8%**

Supplier	Worldwide Deliveries Value 2011-2014	Percentage of Total to Developing World
United States	65934	67.8%
Russia	38300	91.4%
France	15600	53.8%
United Kingdom	11800	49.1%
China	8200	98.8%
Germany	7100	46.5%
Italy	7500	54.7%
All Other European	27400	49.6%
All Others	27900	25.1%
TOTAL	**209734**	**62.0%**

Supplier	Worldwide Deliveries Value 2014	Percentage of Total to Developing World
United States	12180	62.8%
Russia	9200	91.3%
France	5100	49.0%
United Kingdom	3000	53.3%
China	1800	100%
Germany	1800	61.1%
Italy	1200	41.7%
All Other European	5900	45.8%
All Others	6600	28.8%
TOTAL	**46780**	**44.0%**

Source: U.S. government.

3. EUROPEAN MARKET STRUCTURES

Introduction

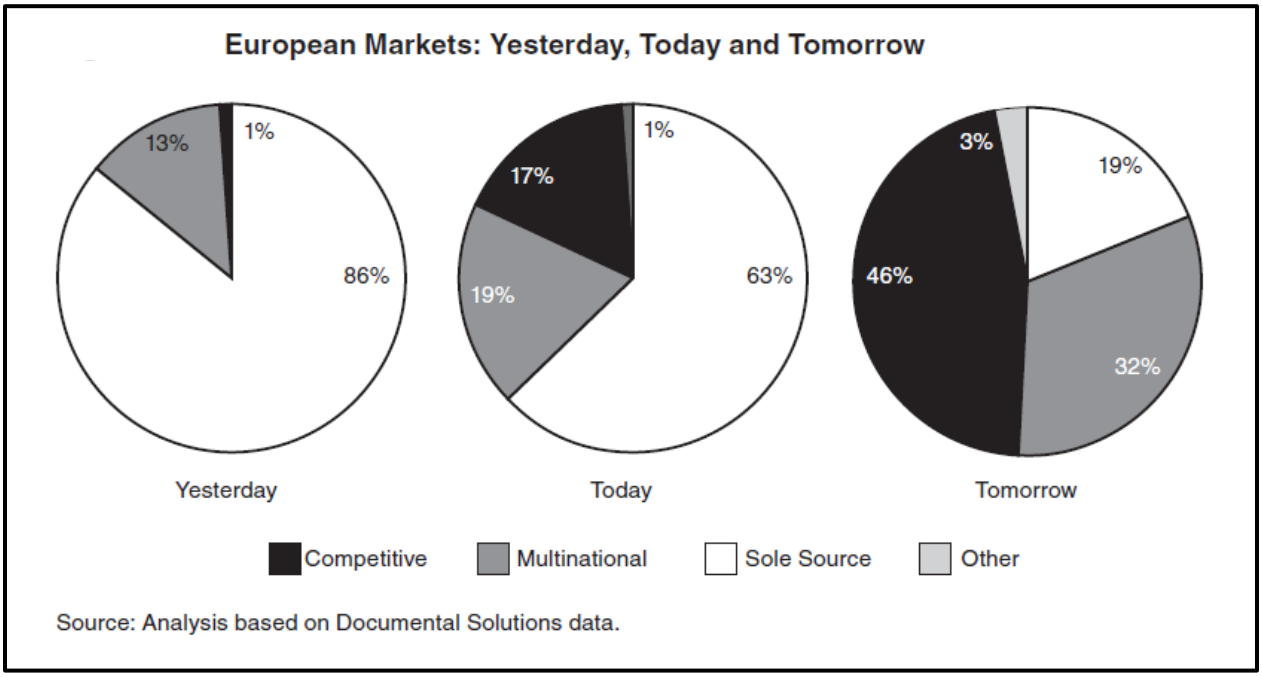
In response to the market trends resulting from both globalization and economics, European defense aerospace firms have had to fine-tune their strategies to best position themselves to compete effectively in the military aircraft marketplace. After a considerable economic downturn in defense spending in the post-cold war world, international arms sales are on the rise in several countries. While the U.S. and the European Union are cutting their defense spending, market opportunity in East and South Asia, the Middle East and South America is increasing.[67] Although historically defense markets were highly protected and closed due to the direct tie to national sovereignty and security, demand for innovation and affordability has driven the defense aerospace market to evolve. As a result, both industry and government have had to reassess and adjust their internal and external alignment to maximize their market access in vastly different political, economic and technological environment.

Consequently, the European defense industry has advanced from a traditional model of a closed market consisting of national firms positioned to meet the requirements of their particular nation.[68] In the past two decades, the European defense industry has transformed to meet the demands of a market that goes beyond national and regional borders. In response, the European firms have had to overcome structural challenges in order to operate in a vastly different competitive environment in the years prior to collapse of the Soviet Union.[69] Price affordability, reliability and sustainability are key tenets to capture military aircraft sales. However, in today's market there is not just one best strategy or one business model that will ensure firm growth or survivability. Defense exporters must not only provide technologically desirable products, but they must also be well-priced to compete against new entrants in the market.[70] Not only is today's global market dynamic and highly competitive, the trends vary by market segment and in some cases, by country.

As a result, the European business models and government roles have evolved to respond to the trends in what has become a more open and competitive market (see Figure 3-1). The aftermath of the economic crisis has prompted European companies to seek a more cooperative approach within the EU structure to improve its industrial bases in the framework nations by fostering industrial participation. Data reflect that protected national markets remain within Europe, but they are being replaced with more open, and thereby, more competitive markets. This trend is a reflection of the financial reality that many national defense procurement programs are no longer affordable to maintain without cooperation from European partners.[71] For the European military aircraft industry, the strategic framework encompasses cooperation with other countries a crucial component of collaboration and industrial participation. The industry has expanded its business models to include transatlantic relationships and increased bilateral and multinational collaboration among European partners. However, not all segments of the European market have embraced a cooperative approach in the defense industry. Some European segments, such as France and Sweden, maintain entrance barriers in their domestics markets.[72] At the same time, the government, at both the individual level and within the EU construct, has had to shift its role as buyer and regulator to better align itself with both the emerging market trends and European defense cooperation priorities. For the foreseeable future there will be a demand for weapons platforms such as military aircraft. National security and political interests will continue to drive nation-states to require and want defense products. In a

globally competitive industry like the military aircraft market, firms strategy will have to take into consideration both national priorities and the European market implications.

Figure 3-1. View of European Markets



European Only Collaboration

In their search to provide security, governments of industrialized nations have a range of options in acquiring the necessary military technology. They can build it themselves; they can buy it from someone else; or they can collaborate with other industrial nations in some form of partnership or technology sharing arrangement. Governments prefer to build strictly within their own nation if they have the ability to do so. This option allows government expenditures to be captured within their own industrial base, providing jobs and income to national firms. Additionally, this option allows any advanced technologies to be retained in house and leveraged for either economic gain via exports or military advantage in war.

However, the economic theory of comparative advantage influences those governments with a more liberal economic persuasion. These governments realize that buying some items from others might allow them to specialize in other areas for which they have an advantage in raw material, skill, knowledge, labor, or some other economic input. They may even choose to export these items if their export control laws governing national security allow them to do so.

Lastly, a government lacking the required resources for self-sufficiency might choose to collaborate in order to gain access to the required military technology. Partnerships bring a whole host of undesired inefficiencies, such as technology transfer limitations, unfavorable work share agreements, duplication of facilities, and complicated management structures; however, it

may be the only way to pursue acquiring the desired technology. International collaboration is a means for nations to overcome the limited scale of their national outputs. Additionally, collaboration offers an avenue to mitigate the defense economics problem caused by rising costs and decreasing defense budgets.

In an effort to maintain a functioning and credible aircraft industry, European countries have historically started collaborative efforts in order to address a growing capability gap vis-à-vis the U.S. aircraft industry. The smaller nations have often found themselves at a disadvantage compared to the U.S. starting in the latter half of the twentieth century. In an effort to bring themselves back competitively, partnerships and cooperative efforts have been utilized to maximize limited resources and budgets. The fundamental reason for such efforts links to desires to maintain a separate, non-U.S.-influenced, Defense Industrial Base within Europe in order to protect sovereignty and maintain sanctity in supply chains. Whether or not it was intended, this concept of collaborative efforts to design and produce an aircraft has had other consequences other than those intended (economies of scale and finance) in that it provided European sellers a degree of flexibility with respect to their customers. Case in point: India's decision to purchase the Rafale vice the Typhoon cited reasons of possible issues with supply with the Typhoon and its roots with the American supply chain. The Rafale, however, is seen as a separate product without some of the less desirable ties to multiple nations.

Since the 1970s, collaborative fighter programs are the norm in Europe with the exception of France (Dassault's Rafale) and Sweden (Saab's Gripen). Europe prefers collaboration for many reasons. Given the limited defense budgets in Europe and the rising costs of fighter aircraft, the governments, as buyers, seek out collaboration to reduce costs that would otherwise not be affordable on an individual basis. Collaboration spreads the research and development costs between those involved and lowers production costs through economies of scale and learning curve savings resulting from the longer production runs. In fact, a survey of British and Italian fighter aircraft in service today show a strong preference for collaboration (see Table 3-1).

Table 3-1. Fighter Aircraft In-Service Today, UK and Italy

Country	Fighter Inventory (#s)	% of Fighters from Collaboration
United Kingdom	Tornado Gr. Mk 4/4a (73) Typhoon FGR. Mk 4 (110)	100%
Italy	Tornado IDS (55) Tornado ECR (15) AMX (40) Typhoon (76) Harrier II (14)	93%

Additionally, multinational programs open up greater export opportunities. For example, Italy secured a deal for 28 Eurofighter Typhoon aircraft with Kuwait, and the United Kingdom secured a 72 Eurofighter Typhoon aircraft deal with Saudi Arabia. Leveraging the existing political and economic ties between countries allows for additional export opportunities that

would otherwise not exist. These additions extend the overall production run benefiting all involved.

European governments depend upon alliances and partnerships to provide their security. Over time, governments formalized their security interdependencies via organizations like the United Nations (UN), the North American Treaty Organization (NATO), and the European Union (EU). These security dependencies naturally align governments towards a preference for industrial collaboration in producing the military equipment necessary to implement these multinational security structures. While approximately 20% of European procurement budgets are spent on collaborative weapons systems today, the European Defense Agency, part of the EU, plans to increase this to over 50% as its long-term goal.

With such great importance placed on security alliances, European militaries pursue high levels of interoperability to maximize combat effectiveness in joint or combined operations. According to Peter Antill and Pete Ito, interoperability with the U.S. is a "cornerstone of UK defence and security planning, and it is probably a consideration for a number of countries, particularly NATO allies". As demonstrated in NATO's Operation UNIFIED PROTECTOR in 2011, European governments prefer to jointly employ their combat forces. "During the NATO-led operation…, Italian aircraft flew 12% of the combat air sorties…; the U.S. performed 27% of the total air sorties; France, 21%; and the UK, 11%."

As can be imagined, cobbling together so many diverse national interests into a coherent product that meets the needs of each participant, as well as the whole, can be challenging. A common framework is difficult to find, but realistically threats (to the program, not a nation) and risks are the only areas that can be claimed as "shared." Commonly cited threats and risks are increased costs, increased delivery/production times as a result of overly complex management constructs, and a slower decision-making timeframe all result in a product that takes longer to get to the customer at a higher than anticipated cost.

A collaborative aircraft development program can work, but requires a prime contractor to ensure efficiencies are maintained. The four nation Eurofighter program is a major collaborative weapons project residing strictly in Europe. Each of the four nations were unable to accept the risk or the financial costs involved with developing a new multi-role fighter aircraft. By coming together in a consortium to collaborate in the production of the Eurofighter, the four nations were able to achieve economies of scale and learning compared with a national venture. The collaboration ensured the project would be largely immune from cancellation. It provided greater funding in the research and development stage compared with a national project. The nations could together create a much larger market than what they could not provide on their own while gaining the advantages of aircraft standardization and interoperability. However, the work sharing arrangements across the countries is inefficient with the use of multiple production lines with duplicative efforts. The work is allocated on political and equity reasons rather than efficiency. In the case of the four Eurofighter nations, each country's production plant has two production lines; one to produce the aircraft components they are responsible for and one to put together all of the components to construct the aircraft that country has specifically purchased. The economies of scale on collaborative programs have been estimated to half of those on national projects.

Common threats, however, are far more difficult to manage for participant nations since each has a different construct of what it desires to defend and the conditions from which it finds it necessary to do so. A brief example would be the needs of an island nation contrasted with a land-locked one. The latter nation would find a naval capability mostly worthless, instead needing robust ground and air defense forces. Subsequently, that nation would likely object to any effort that furthered the capabilities of seaborne airframe compared to a traditional ground based platform. This varied and diverse group of variables means that a consensus for required platforms would be challenging, if not impossible in its entirety.

Transatlantic Collaboration

Transatlantic industrial cooperation relationships are gathering pace and these relationships are primarily industry-led and will take shape from existing links established through previous cooperative programs. Nevertheless, such developments will likely face significant political, regulatory and business challenges. Given these challenges, transatlantic relationship building will follow an evolutionary path. In the short term, the broadening and deepening of transatlantic industrial linkages will be through program-specific teaming, strategic alliances and joint ventures as well as some small and medium-sized acquisitions. Full-blown mergers uniting large European and U.S. prime contractors would remain a distant prospect under the existing conditions. Future defense industrial relationships regardless of their potential to lead to mergers will be driven by one overriding consideration: if they don't make business sense, they won't happen. Success in partnerships will be measured by the ability of the U.S. and European firms to open new market opportunities.

To date, the lack of success in transatlantic policy between countries sums up the current state of affairs. As a U.S. General Accounting Office report states, "transatlantic industrial partnerships appear to be evolving more readily than transatlantic cooperative programs that are led by governments."[73] This alludes to the fact that defense industry has been successful in spite of government policy, not because of it. The industry has evolved quite well on its own. A further question resulting from this would be what government entity mandates the policy, and how would NATO nations enforce it from an institutional perspective? Efforts to enforce simple spending minimums of 2% Gross Domestic Product (GDP) have historically proved fruitless within most European partners, leaving no reason to believe another multinational mandate would be treated any different.

Continuing current policies by all participants in NATO with respect to the military aircraft sector will result in increasingly costly platforms over time with competition between the U.S. and Europe resulting in a zero sum game. While this competition would seem to be healthy between nations or firms, it is counterproductive within the transatlantic (NATO) construct. Former CEO of Lockheed Martin Vance Coffman suggests "the system [is] not truly cooperative, and it [is] short from competitive," and warns against the fortress mentality with respect to defense industry that emanates from within each nation.[74] Instead, competition should be perceived as that which occurs from *outside* those nations participating in NATO. By maximizing what can be produced within the alliance, as well as carefully allocating resources

and funding with shrinking defense budgets, NATO can address its air mission in a far more efficient manner. While some nations within NATO will find this more difficult than others due to geographic and cultural ties, precedence has already been set with Norway's decision to participate in the Joint Strike Fighter program instead of purchasing the Swedish Gripen fighter.[75]

Convincing NATO nations to partner in a program like the JSF may not be possible via a regulatory policy, but not participating may mean a continued effort to develop an advanced fighter or tanker alone with diminished resources. Therefore, a policy that incentivizes relationships necessary between firms in NATO nations would produce better results in a forced collaborative environment. As noted in Keith Hayward's iceberg analogy of U.S. and European cooperation, the subsurface interactions that are taking place between component manufacturers and suppliers makes some degree of cooperation essential in order to sustain weapons systems of great complexity.[76]

As resources become scarce, a collaborative policy in NATO will ensure that competition for resources is not within the alliance, but instead with firms and companies outside. This provides further economies for partners while still ensuring their mission needs in NATO are met. However, efficiencies are lost when multiple nations team up on a project, and this is particularly true during the decision-making process, especially in NATO with respect to defense procurement.[77] As the saying alludes, "a camel is a horse designed by a committee"; what a collaborative effort is designed to produce and what it eventually delivers are not always the same. Balancing the needs of the group while providing for specific missions for each country is a challenge. A failure to address either can be interpreted as a threat to national sovereignty for one or all nations. As Moelling states: "The defining issue in security of supply is the tension between national desires and the global reality of [the defense industrial base]."[78] 'Supply' in this quoted context refers to defense assets vice the more traditional meaning of 'materiel.' However, the author's statement can certainly be applied to a much broader scope to include capabilities and what is possible for a smaller nation in a globalized economy.

The Joint Strike Fighter program diverges significantly from previous transatlantic collaborations in the fighter market. Given European governments' strong preference for collaboration inside of Europe, prior to the JSF U.S. firms were left with only two options for entry into the European market: provide components to the large European consortiums or win export contracts to provide fighter aircraft sales (i.e. F-16 and F/A-18). Transatlantic collaboration for the development and production of a complete fighter aircraft simply did not exist. The JSF program changed the game as eight partners joined the U.S.-led program in the development phase.[79]

So, what changed? Fundamentally, the JSF program allowed partners the ability to join the U.S. in becoming 'first movers' in the actual production and fielding of a large number of fifth-generation fighter aircraft.[80] Due to austere defense budgets in Europe and the increasing costs of fighter aircraft, many prospective European partners realized they were unlikely to even become 'fast followers' in fifth-generation aircraft if left to a European-only solution. The JSF

program offered them the ability to leap ahead with the U.S. bearing the largest portion of the development costs and the associated risk.

The F-35 provides combat forces with a whole new level of interoperability. From the seamless, real-time transfer of information between platforms during combat to the shared maintenance, repair, overhaul and upgrade facilities, this platform allows users to fully integrate operations. Not only does this level of interoperability improve warfighting capabilities, but it shortens repair times and lowers sustainment costs as support facilities and parts pools are distributed throughout a network of users.

Beyond the game-changing warfighting capabilities that a fifth-generation aircraft brings to the fight, transatlantic collaboration offers European governments several other benefits. The technology transfer and work shares to ensure their own aerospace industry remained relevant into the future. Even as these interests became points of contention as Lockheed Martin balanced them against the U.S. government's stringent technology transfer regulations, the European partners have benefited from some level of technology transfer and work shares. Given the spin-offs the military aviation sector provides, most European governments are not ready to concede the aircraft industry by simply importing aircraft. Additionally, these governments have a keen interest in maintaining as many high technology jobs as possible in this market sector.

From the U.S. perspective, transatlantic collaboration allows Lockheed Martin to achieve greater economies of scale. This is a key consideration given the U.S. government's pressure on Lockheed Martin to achieve affordability on the program. Of the 3,190 aircraft currently planned for production, 727 (or 23percent) are for international partners or foreign military sales customers.[81] Additionally, the U.S. sought to capture the entire European fighter market by creating "domestic industrial support in target markets through the technology transfer and work share agreements encompassed in the JSF's partnership for co-development and co-production".[82]

Moreover, the JSF's enhanced capabilities and interoperability make NATO a more credible deterrent. The U.S. government sees value in increasing the security of our partners and allies around the world as a means to alleviate our own security requirements. This has resulted in a transatlantic Joint Strike Fighter program consisting of eight partner countries, three export customers and international industrial participation.[83] Success or failure of the JSF program will determine the future of transatlantic collaboration in the aerospace industry.

National Only Markets

The market for fighter aircraft in Europe has transformed significantly over the past one hundred plus years of flight. From military aviation's earliest days, multiple national companies or firms produced fighters primarily for their own militaries. While a limited number of aircraft were produced in one country and flown in another, sowing the seeds for future European collaboration, predominantly the design, production, and utilization of military aircraft remained within one's own country. This market structure adequately supported the European

governments and their militaries through two world wars—including numerous technological advances in fighter aircraft up until the dawn of fourth generation jet fighters in the 1970s.

Two countries embody different approaches to maintaining a national-only defense industrial markets. The French model of industrial capitalism pre-dates the Gaullist policy of national autonomy, and was founded on close personal, financial and political ties between elites in government civil service, industry, the financial sector and the military. The relationships that constitute the "Grand Corps d'Etat" were created and have been sustained by France's elite, state-funded higher educational system, "les grandes ecoles", some of which pre-date the French revolution. These elites agree on the basic values that underpin France's autarchic defense innovation and production system: 1) maintaining a viable and competitive defense industrial base that provides France autonomy in defense and foreign policy, 2) creating French jobs, and 3) contributing to French economic growth. The essentialist view of non-French military procurement is that it is a transfer of sovereign wealth, employment and potential military capability outside of France, and implies sacrificing resources from a limited tax base that could be used to develop capable systems for both domestic use and eventual export sale.

With its heavy statist orientation, the Gaullist policy of national autonomy managed to create a defense industry that far exceeded what France's capabilities would have been had it remained within the NATO architecture under the strategic umbrella and reliant on the U.S. for protection and technological innovation. In a relatively short time after its first nuclear test in 1960, with some help from its American ally, France developed and deployed its own nuclear triad. This required that France develop and maintain independent capabilities in nuclear weapons production, combat aircraft, submarines and missiles. French procurement policy has evolved from exclusive national autonomy to "strategic autonomy", which seeks to maintain European defense capacity while retaining France's ability to act autonomously.

France's autarchic policy allowed business to profit from a consistent patron, and has given government the authority to influence, if not dictate, the shape of its defense industry. In the postwar era this was done by state ownership of shares through purchase or nationalization, which, while reduced from 1960s levels, remains significant to this day, especially in the areas of shipbuilding (DCNS), land combat systems (NEXTER), and nuclear capabilities (CEA, SNPE).[84] France enjoyed sufficient economic growth to build and maintain a diversified defense industry in the postwar era, but it did so in part by directing companies into divergent business models and avoiding direct internal competition. This can clearly be seen in the aviation sector, where the French government has historically directed or influenced mergers and acquisitions, and dictated lines of business.

France began to implement a policy of competitive autonomy, or Europeanization in the late 1990s after realizing that it could not independently fund all of its own R&D. First, "ownership matters". Put another way, maintaining national control of major defense contractors, intellectual property, production and sustainment of vital platforms is essential to France maintaining operational effectiveness and independence. Barring urgent need, France will make procurement decisions that strengthen its DIB, even when it might be more efficient or cost less to procure from a third party. Second, France is resistant to ITAR-controlled content, both for its own independence of action and for foreign sales. That resistance extends to

partnerships with U.S. companies and those, like BAE Systems, that do a substantial business with the U.S., for fear that its own producers might begin to rely on ITAR-controlled items that would limit France's control of its own technology and its foreign sales. Because of these policies, France was able to produce the Rafale, a vertically-integrated generation 4+ fighter aircraft using its three national champions, Dassault, Thales, and Safran with exclusive French content. That approach has allowed France to sell the Rafale anywhere in the world without requiring ITAR (U.S.) approval of the original sales or later parts for MRO. This makes the Rafale a comparatively more attractive product, when compared with the Gripen, which is produced with BAE systems and is largely composed of ITAR-controlled, U.S. content.

European Countries with National Only Market

France. Relations between the French government and its defense industry are rooted in a tradition that dates to the "ancient regime" and the fortifications built by Vauban under royal decree. The particular relationship between France's defense industry, military and government must be understood in the context of the "grandes écoles", which date to revolutionary France. In their current form, these schools create a meritocratic elite, some of whom move into the highest ranks of government service, the military and industry.[85] The "French Model" of industrial capitalism, allowed business to profit from a consistent patron, and gave government the authority to influence, if not dictate, the shape of its defense industry. In the postwar era this was done by state ownership of shares through purchase or nationalization, which, while reduced from 1960s levels, remains significant to this day, especially in the areas of shipbuilding (DCNS), land combat systems (NEXTER), and nuclear capabilities (CEA, SNPE).[86] France enjoyed sufficient economic growth to build and maintain a diversified defense industry in the postwar era, but it did so in part by directing companies in divergent business areas and avoiding direct internal competition. This can clearly be seen in the aviation sector, where the French government has historically directed or influenced mergers and acquisitions, and dictated lines of business. In the aviation sector in the 1960s it directed Dassault to specialize in combat and private aircraft, Nord Aviation and Sud Aviation (later Aérospatiale) in missiles and civilian transport, defense mobility and rotary-winged aircraft, respectively.[87]

Such interference would be difficult to imagine in the postwar U.S. defense industry, where the government seeks to get the greatest value for the taxpayer by maintaining a competitive environment wherever possible. By contrast, the French model since De Gaulle has sought the greatest degree national autonomy, and obtains value for the taxpayer by creating a diversified defense industrial "ecosystem", like Darwin's Galapagos finches, that would meet its own requirements for national defense and power projection, while accruing benefits for domestic employment and GDP through domestic and foreign sales. Accordingly, France's internal market is characterized by collaboration among national champions, each with their specific area of expertise, who then compete together for a share of the world's arms market.

The French defense industrial model is further reinforced by substantial cross-shareholdings between its largest defense and aerospace champions, Dassault, Thales, Safran, Airbus and the French state. After mergers encouraged by the French government and transfers of its own shares since the 1990s, Airbus Group currently owns 23.4% of Dassault; Dassault and

the French Government own 24.9% and 26% of Thales Group, respectively; and the state share of Safran was estimated to be 22% in 2014. After Aerospatiale-Matra became a part of Airbus Group, it formed a joint venture with Alenia Marconi Systems of Italy and British Matra BAe Dynamics to form MBDA, with ownership divided between them as 37.5% Airbus, 37.5% BAE Systems and 25% Finmeccanica. Finally, while their shares have been reduced, Germany and France each have retained 11% stakes in Airbus Group's shares, giving them substantial influence over corporate policy.[88]

While France has moved in the last twenty years to increase private ownership of its major defense companies, it continues to exercise influence over corporate strategy in the defense industry through the use of special voting rights (golden shares) and board positions.[89] Because of generations of close personal relationships between leaders in government, the defense industry and the French military, that influence is reciprocal: while the French government can and does influence corporate strategy by its national champions (Dassault, Thales, Safran), the leaders of these companies also wield considerable influence at the highest levels of the French government, in parliament, important ministries and the media, regardless of the party in control of the presidency. That Lockheed Martin or Boeing would own the New York Times or HarperCollins publishing would seem odd in the American context. For the French, Dassault's ownership of Le Figaro, France's leading center-right daily newspaper, and Lagardère's status as France's third largest book and magazine publisher while being a major shareholder of Aérospatiale then EADS are considered normal. One example of that reciprocal influence, and the French desire to maintain local control ("ownership matters"), could be seen in the attempt by EADS to purchase Thales in 2008, which was blocked by the French government when it sold a 21% stake in Thales to Dassault at a lower price than that offered by EADS.[90] This at a time when EADS was largely a Franco-German joint venture with some Spanish participation.

With its heavy statist orientation, the Gaullist policy of national autonomy managed to create a defense industry that far exceeded what France's capabilities would have been had it remained within the NATO architecture under the strategic umbrella and reliant on the U.S. In a relatively short time after its first nuclear test in 1960, with help from its American ally, France developed and deployed its own nuclear triad.[91] This required that France develop and maintain independent capabilities in nuclear weapons production, combat aircraft, submarines and missiles. French procurement policy has evolved from exclusive national autonomy to "strategic autonomy", which seeks to maintain European defense capacity while retaining France's ability to act autonomously.[92] While there has been a gradual opening of defense procurement to non-French and some non-European producers, it is still driven by De Gaulle's basic autarchic values: 1) maintaining a viable and competitive defense industrial base that provides France autonomy in defense and foreign policy, 2) creating French jobs, and 3) contributing to French economic growth. The essentialist view of non-French military procurement is that it is a transfer of sovereign wealth, employment and potential military capability outside of France, and implies sacrificing resources from a limited tax base that could be used to develop capable systems for both domestic use and eventual export sale. Moving beyond that mindset required pressure, which was provided in part by French participation in Operation DESERT STORM.

While the Gaullist model created the basis for France's defense industrial achievements, in the context of air capability, France had relied on its nuclear deterrent and neglected its conventional forces. DESERT STORM underscored the limits of that approach: French pilots and aircraft lacked adequate IFF, night vision, electronic warfare, self-protection, and navigation capabilities in order to contribute productively in an interoperable environment.[93] It also became clear by the mid-1990s that France could not compete with the U.S. revolution in military affairs (RMA), and viewed it as an attempt by the U.S. to use its overwhelming budgetary might to eliminate any near-peer competitors from arising from within the NATO alliance.[94] These two developments made it clear that the Gaullist model would not provide France with a conventional military capable of achieving its objectives for political influence and independent action. In short, France needed European partners to assist with R&D costs, so it adopted the "Europeanization" policy of competitive autonomy. Outside of certain areas of absolute sovereignty (largely nuclear, land combat systems and shipbuilding), European procurements and partnerships were given priority. "French competitiveness in the defence industrial area could be preserved only by accelerating and intensifying European co-operation."[95]

While that process began in the 1990s and has accelerated since, there are two informal limits to the policy of competitive autonomy or Europeanization. First, "ownership matters" to the French—or put another way, maintaining national control of intellectual property, production and sustainment of vital platforms is essential to maintaining operational effectiveness and independence.[96] Barring urgent need, France will make procurement decisions that strengthen its DIB, even when it might be more efficient or cost less to procure from a third party. Second, France is resistant to ITAR-controlled content, both for its own independence of action and for foreign sales. That resistance extends to partnerships with U.S. companies and those, like BAE Systems, that do a substantial business with the U.S., for fear that its own producers might begin to rely on ITAR-controlled items that would limit France's control of its own technology and its foreign sales.[97]

Another limitation is the fact that EU nations benefit from Article 346, which protects national defense industries from competition within the EU to promote "essential security interests," allowing each country to protect their national champions from outside competition.[98] This creates certain tensions when national partners create structures that encourage cooperation and pooling of R&D resources, while permitting partners to demand a "juste retour" based on the size of their procurements. One example is a consortium such as MBDA, which is jointly owned by Airbus Group, BAE Systems, and Finmeccanica and maintains national headquarters and production facilities in France, Germany, Italy and the U.K., each of which provide for their respective national defense procurements.

Competitive autonomy does provide that under certain limited circumstances, France may procure from extra-European producers: "Simply put, French aspirations for a European DTIB and European procurement may very well be subordinated to best value considerations of cost and capability in cases when France faces a choice between an existing, highly capable and affordable U.S. system and an undeveloped or more costly, less capable European alternative."[99] Recent examples illustrate the way competitive autonomy has been implemented by the French Directorat Général de l'Armement (DGA). In the past three years France has purchased a total of 12 General Atomics' MQ-9 "Reaper" UAVs over the immature European MALE UAV

program in order to meet its ISR requirements in the Sahel.[100] France also recently concluded negotiations to purchase four C-130Js to supplement its seven A400M allegedly because of the "operational tempo" in Operation Serval.[101] The French press has reported separately that the C130J simply outperforms the A400M as a tactical transport, and compensates for the A400M's inability to refuel rotary winged aircraft—one of its initial requirements.[102] One can extrapolate from these examples that France will purchase from non-European producers when it is confronted with an imminent operational requirement that cannot be adequately fulfilled by existing French or European alternatives, even when they may partially exist.

Finally, given the relatively small size of French procurement budgets, foreign military sales play a qualitatively different role in France than they do in the U.S.—they are understood to be vital to France maintaining its defense industrial base, its independence of action and its political influence. Consistently ranked behind the U.S., Russia and China as the fourth largest global arms exporter, France recently surpassed China with 16 billion euros in sales in 2015, up from 4.8 billion in 2012. That amount is projected to more than double in 2017 after the announcement of the sale of 12 French submarines to Australia, making the defense industry one of France's only industrial sectors to show substantial growth in an otherwise stubborn environment of anemic economic growth and stagnating French productivity.[103] As a result, France's defense exports are essential, not only for its DIB, but for its global economic position and political status as well. The French aggressively coordinate their diplomatic, political, commercial and informal levers of influence to successfully conclude military sales.

Sweden. Sweden is approximately the size of California and is the fifth largest country in Europe. The government is a constitutional monarchy with a parliamentary democracy since 1523. Early inhabitants were Vikings of Germanic descendants which held regional seventeenth century sea power. With the last war in 1814, Sweden has been a neutral country ever since. The country has two lead offices: since 1973, the chief of state is King Carl XVI GUSTAF and since 2014, the head of government is Prime Minister Stefan Loven. The population is equivalent to Chicago at about 9.7 million of which 85% are in urban areas. Sweden is the world's 8th largest per capita income distributed in agriculture: 2%; industry: 28%; and services: 70%. Though a member of the European Union since 1995, Sweden elected not to join the Euro and is maintaining its own currency—Swedish krona (SEK).[104] It has a well-established rail system connecting the populated cities in the south to the remote, isolated areas of the north countryside. (See Figure 3-2 below.) According to Economic Survey of Sweden 2007 by Organization of Economic Cooperation and Development (OECD), the average inflation in Sweden has been one of the lowest among European countries since the mid-1990s, largely because of deregulation and quick utilization of globalization. Overall, Sweden is a politically and economically stable country.[105]

Figure 3-2. Map of Sweden: Dense Cities in the South and Open Countryside in the North

Overview of Sweden's Military

With the collapse of the Iron Curtain, Sweden is one of those European countries that reconsidered its strategic defense policies. Less concerned about territorial defense, it had taken a hit on its defense budget which adversely affected its military. However, these last few years with the re-emergence of the Russia's threat, there have been some renewed discussions for defense taking place. Sweden has strategic policy of neutrality and official non-alignment declared during World War II and the Cold War period. During the war, similar to Switzerland, Sweden was well armed and avoided Nazi invasion. To maintain neutrality, it needs a strong national defense including armed forces, though the number of its armed forces may never get back up to the peak of the Cold War.[106]

The Swedish Air Force equipment declined since the end of the Cold War. At the height of the Cold War, there were 600 fighter aircraft. Currently, there are 109 left with 89 operational today. It currently has 15,000 active duty and 34,000 guard/reserve troops. Sweden has a well-developed industry. About 90% of all military equipment acquisitions are performed by Swedish contractors. Sweden has the Defense Material Administration, also called FMV, which procures, maintains, and stores equipment for the Swedish Armed Forces. The FMV has 3,000 employees and uses more than 2,000 different suppliers within domestic and foreign industry. There about 30,000 employees in the Swedish defense industry.[107]

Sweden's Strategic Outlook and Drivers of Defense

Just like many other European nations, with the collapse of the Soviet Union and assumption of the threat going away, Sweden's defense budget took a nose dive. Swedish industries had to be innovative and turned to export markets to survive. Often cited as an example of a smaller nation making considerable advances in emerging technologies, Swedish industry is in the forefront in adopting new technologies. It has produced a wide collection of forward-looking defense systems and is considered to be an innovative leader.

With the need to be self-sufficient in producing defense systems, this contributed to an immense level of technical and manufacturing know-how from Swedish corporations. Despite its small size and limited monetary resources, Sweden developed and produced world-class tactical aircraft, ordnance, ships and combat vehicles. Sweden established an extensive and technologically advanced national defense industry. A considerable amount of Sweden's industry is owned by international companies. This was a direct result of budget cuts and a conscious government policy to pursue cooperation and participate in international operations. Even Saab, the last remaining Swedish-owned large scale global contractor, is 20% owned by BAE Systems.[108] (See Figure 3-3 – Foreign Ownership of Major Swedish Defense Firms.)

Figure 3-3. Foreign Ownership of Major Swedish Defense Firms

Table 57. Foreign Ownership of Major Swedish Defense Firms

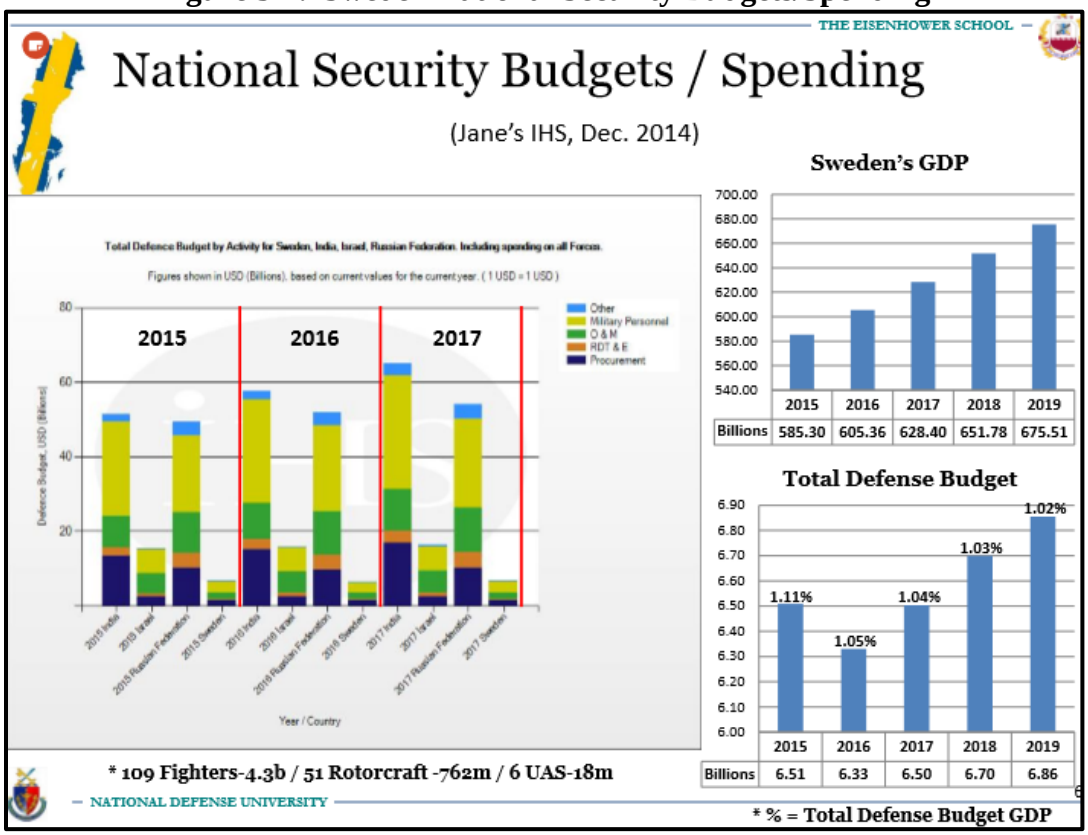
Company	Ownership Percent (%)	Country	Notes
Saab AB	BAE Systems, Inc.–20	UK	Sweden's largest defense company
BAE Systems Bofors	BAE Systems, Inc.–100	U.S./UK	Supplies artillery and heavy ordnance
BAE Systems Hagglunds AB	BAE Systems, Inc.–100	U.S./UK	Manufacturer of combat and tracked vehicles
Kockums AB	HDW (ThyssenKrupp Group)–100	GE	Naval surface ships and submarines
EURENCO Bofors AB	EURENCO–100	SE/FR/FL	Propellants, explosives and ammunition
Nammo Sweden AB	Nammo–50; Patria Oyj–50	NO/FL	Ammunition

Source: "The Swedish Security and Defence Industry 2006-2007," op. cit.

With the re-emerging of Russia's threat and constant flexing of its muscles in the Nordic and Baltic areas, Sweden has continued to be on the forefront for military research and development (R&D) embracing new technologies which helped it to be a step ahead of the threats. It continued to develop broad domestic capabilities on high-end aerospace, land warfare, networks, and electronic warfare to address its national security concerns and unique operational requirements. The military R&D is centralized and based on state-funded organizations as well as private industrial corporations. Though not a full NATO member, Sweden has been participating in multinational operations and at times more so than full NATO members. This has put a strain on the Swedish defense budgets. The defense allocation in terms of gross

domestic product (GDP) for military spending has been slashed over half. From 1975 through 1982 it was more than 3percent. For 2015, it was 1.11percent. It is projected to continue to go down to 1.02% in 2019.[109] (See Figure 3-4 on National Security Budgets/Spending) Consequently, budget cuts and reduction in armed forces (from a million fully mobilized troops in the 1980s to 320,000 that could be mobilized today) has caused concerns that northern Sweden is exposed and the best fighting units are abroad.[110]

Figure 3-4. Sweden National Security Budgets/Spending



Sweden's Business – Government Relations

The Swedish defense industry dates back to the time when Sweden had a functioning military power. Karlskronavarvet, specialized in naval surface vessels and submarines and Bofors, a producer of artillery systems, have been in business for more than 300 years. During the Second World War, Sweden was cut off from foreign imports. The defense industry became entirely self-sufficient and ended up with its current size and structure. It has become a minister for enterprise including national level focus for its innovation strategies. With Sweden's policy of military non-alignment, a strong national defense industry is needed. The industry has undergone substantial growth and development from the time of the Second World War to the present day. After WWII, access to materials for defense projects was severely limited. Sweden had to further boost its defense industry.[111]

The aerospace business model sees the need to export in the international market, including linking of high technology development in aerospace and defense to other industries. It sees a market driven industrial model where sellers competing against single, military buyers in countries. Thus, it is pursuing more research and development investments abroad as well as open technology policy and partnerships. Sweden is an indigenous manufacturer and produces 70% of its military equipment and 30% is imported where 45% is imported from the U.S. and 55% is from Western Europe.[112]

Demand for combat aircraft is relatively unyielding much as an effective air presence is fundamental to a defense strategy. For a product, there is some variation between models available in cost, technology, and lifespan. For manufacturers, they must anticipate to sustain enough orders to maintain production and revenues for the foreseeable future.[113]

Sweden's Role of High Technology in National Security

With the growing Russian threat and without guarantee of getting aid from the NATO countries, Sweden's both left-leaning opposition and center-right government had determined it needs to boost its high technology defense industry; specifically, its military equipment and readiness. With the neutrality policy, it has helped strengthened Sweden's high tech market drivers. Sweden's defense industry has continued to be an important aspect of Swedish national security; for example, its combat aircraft Gripen NG for the Swedish Air Force.

Sweden has made headway in pushing its strategic balance where innovation, high technology and import/export have worked hand in hand. Established on 21 Oct 2011, the Saab India Technology Center allowed collaboration with the Indian company Tech Mahindra. This provided Saab with skilled engineers which are much needed skills-set for its business. Sweden has benefitted in spillover where aerospace and defense firms have business sectors in multiple commercial markets. An example is the Saab/BAE Gripen South African business model. The spillovers are good for business since they provide management knowledge, competent customers, specialized subcontractors and skilled workers. For the South African business model, it holed turned an isolated South African industry into a modern commercial engineering industry.[114]

Changes in threats have also shifted emphasis away from large, fast bomber and interceptors to versatile and cost effective models such as the Gripen NG. Further, air superiority alone is not usually sufficient to win wars and building the fastest jet may not merit an adequately higher improvement given the cost. Information sharing is a key aspect for the Gripen, giving pilots awareness to improve communications and combat effectiveness.[115]

In conjunction with Sweden's established infrastructure and innovative technology, its aerospace and defense sector is extensive and well-developed. Sweden is politically and economically stable. It is one of Europe's best managed and open economies. It has well established legal system and well-executed business laws. Swedish fully indigenous capabilities

are focused on high-end aerospace, land warfare, C4I, naval vessel production and design and electronic warfare.

4. EUROPEAN FIGHTER AIRCRAFT IN DEVELOPMENT OR PRODUCTION

Introduction. The post-cold war reduction in defense budgets by 65% in real terms[116] combined with the global economic downturn has resulted in firms either leaving the military fixed-wing fighter aircraft market or consolidating. In both the United States (U.S.) and Europe, an oligopoly exists with a few firms building near identical products, barriers to market entry due to excessive economies of scale in the range of $30-$50 billion[117] to develop a new fighter aircraft that is fourth or fifth generation capable, a monopoly of profits in the long-run, and an environment of non-price competition which consists of advertising, research and development, and technical progress.[118] This oligopoly results in competition amongst the few[119] which can result in negative effects on government policy, competition, innovation, and cost reduction with regard to the market.[120] This overall economic situation has impacted both the number of U.S. and European fighter aircraft manufacturers that can be sustained (i.e., survivable firms). In the U.S., this has resulted in three relatively large primary U.S. fighter aircraft firms, namely Boeing, Lockheed Martin, and Northrop Grumman. In Europe, the result is either Dassault Aviation (maker of the French Rafale), Saab Group (maker of the Swedish Gripen), or Eurofighter Jagdflugzeug Gmbh (maker of the Eurofighter Typhoon) consortium of countries and companies.

Figure 4-1: Modern Western Combat Fighter Aircraft Size Comparison[121]

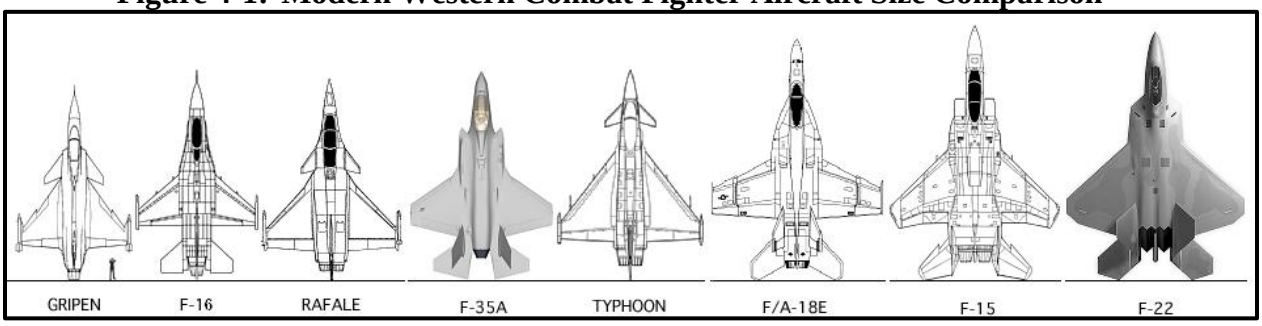


Figure 4-2: Modern Western Combat Fighter Aircraft Cost & Performance Comparison[122]

	JAS-39C/D Gripen	F-16 Fighting Falcon	Dassault Rafale M	F-35A Lightening II	Eurofighter Typhoon	F-18 Super Hornet	F-15E Strike Eagle	F-22 Raptor
Cost per Unit	$60,000,000	$27,465,000	$90,500,000	$100,000,000	$114,900,000	$66,900,000	$45,435,000	$150,000,000
Maximum Speed (mph)	1,367	1,500	1,324	1,199	1,320	1,190	1,875	1,498
Wing Loading (Lower Better) (Lbs/Ft^2)	69	88	63	91	64	94	133	77
Thrust-Weight (High Better)	0.95	1.06	0.99	1.07	1.07	0.93	0.93	1.14
Maximum Range (Miles)	1,723	1,740	2,299	1,200	1,802	1,458	2,400	1,839
Combat Radius (Miles)	800	340	1,151	590	863	449	790	472
Flight Ceiling (Feet)	52,500	50,000	55,118	60,000	55,003	49,213	60,000	65,000
Max Payload (Lbs)	11,700	17,200	20,944	17,857	16,535	17,747	24,500	22,597
Operating Cost (Per hour)	$4,600	$7,000	$16,500	$21,000	$8,200	$11,000	$4,500	$19,000

Eurofighter Typhoon

Eurofighter Consortium of Countries and Companies

The Eurofighter program emerged out of a long and conflicting set of multinational efforts that started in the 1950s to design a new European fighter. By 1983, the United Kingdom (UK), France, Germany, Italy, and Spain had come together with the Future European Fighter Aircraft (FEFA) program. However, the five nation partnership only lasted until 1985, as

differences with France over carrier compatibility, weight limits, and French insistence on the lead industrial role, ended their partnership. Consequently, France developed their own indigenous fighter aircraft, the Rafale fighter.[123]

The Eurofighter Typhoon consortium is a partnership of the remaining four European nations, UK, Germany, Italy, and Spain, and their leading aerospace and defense companies. The consortium was founded in 1986 under a multinational company, the Eurofighter Jagdflugzeug Gmbh based in Munich, Germany. Eurofighter Jagdflugzeug coordinates the design, manufacturing production, and upgrade of the fourth generation fighter. The partnership is a genuine pan-European project providing each nation equal access to shared manufacturing development and connects the four nations in long-term political and industrial relations.[124] Additionally, NATO Eurofighter and Tornado Management Agency (NETMA) serves as the single point of contact for customers, governments, and the partner companies of British Aerospace (BAE) Systems, Leonardo-Finmeccanica (Aircraft Division), and Airbus Defense and Space. In other words, NETMA is the customer and Eurofighter Jagdflugzeug Gmbh is the contractor. Across the entire consortium, the Eurofighter program employs over 100,000 employees from 400 companies across Europe.[125]

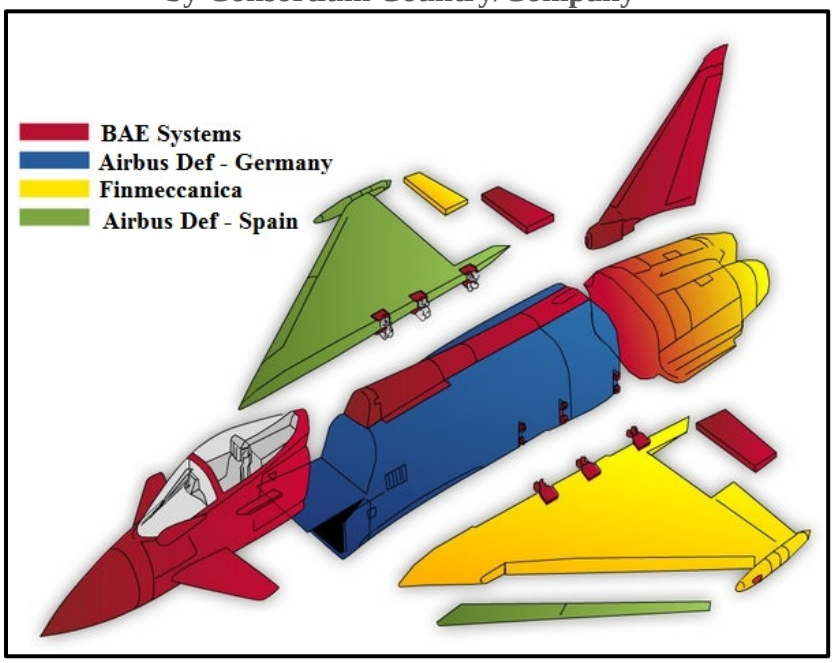
Each of the four nations host a production line of a specific component or set of components of the aircraft based on the nation's quantity of Eurofighters purchased. Additionally, each nation hosts a final aircraft assembly line for the aircraft the nation actually purchased. The production facilities are located at Warton, UK, for BAE Systems; Manching, Germany, for Airbus Defense Germany; Turin, Italy, for Leonardo-Finmeccanica; and Getafe, Spain, for Airbus Defense Spain.[126]

The Eurofighter consortium contract was designed to protect the fairness of each nation's agreed upon aircraft production workload by making it very expensive to withdraw from committed aircraft procurement orders. With continued declines in European defense spending, this has resulted in fractious contract negotiations around the third version (Tranche 3) of the Eurofighter. In June 2009, the partners took a diplomatic way out, splitting Tranche 3 into an 'a' part and a 'b' part.[127] This allowed the countries to adhere to the contract under the Tranche 3a portion, but be released from the contract withdrawal penalty for the Tranche 3b portion.

The original aircraft production workloads were designed to correspond to the number of Eurofighter aircraft ordered under the 1998 umbrella contract. The UK with an aircraft order of 232 Eurofighters would have a 37.5% share of the workload with BAE Systems producing the front fuselage including the foreplanes, canopy, dorsal spine, tail fin, inboard flaperons, and rear fuselage section. Germany with an aircraft order of 180 Eurofighters would have a 30% share of the workload with EADS Deutschland (today Airbus Defense Germany) producing the main center fuselage. Italy with an aircraft order of 121 Eurofighters would have a 19.5% share of the workload with Alenia Aeronautica (today Leonardo-Finmeccanica) producing the left wing, outboard flaperons, and rear fuselage sections. Finally, Spain with an aircraft order of 87 Eurofighters would have a 13% share of the workload with EADS CASA (today Airbus Defense Spain) producing the right wing and leading edge slats.[128] This specialization divided the work

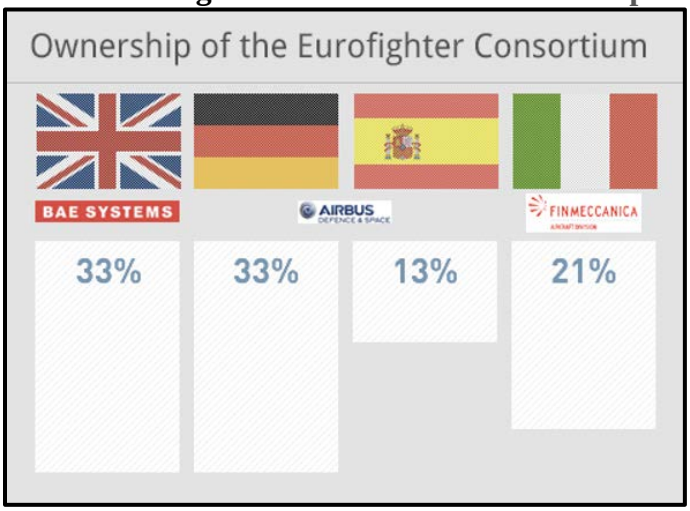
fairly across the four consortium nations and sought to create economies of scale in order to achieve lower unit costs.[129]

Figure 4-3: Eurofighter Production Workload by Consortium Country/Company[130]



Today the ownership of the Eurofighter consortium consists of the UK with a 33% share in the production program, Germany with a 33% share, Italy with a 21% share, and Spain with a 13% share. However, BAE Systems has a 43% share of the Eurofighter aircraft, without the engine, by value with Airbus and Leonardo-Finmeccanica having the remaining 57% of value.[131]

Figure 4-4: Eurofighter Partner Nations and Companies[132]



Nation-state collaboration is a distinctive feature of European defense industrial policy.[133] The international collaboration is a means for the nations to overcome the limited scale of their national outputs. Additionally, collaboration offers an avenue to mitigate the

defense economics problem caused by rising costs and decreasing defense budgets.[134] The "partner nations were to share its otherwise unbearable development and production costs, in return getting a common replacement for their aging fleets of Phantoms and Starfighters. In addition, they had the opportunity to secure long-term prospects for their indigenous defense industries and had the promise of lucrative export orders." [135] However, the Eurofighter Typhoon has been plagued by years of cost overruns, technical delays, and changes in political priorities.[136] The Eurofighter consortium is rapidly approaching the end of the Eurofighter's production run of 571 aircraft.[137] Although the Eurofighter consortium made important foreign sales to Austria, Kuwait, Oman and Saudi Arabia, barring new sales, Eurofighter is expected to exhaust its outstanding orders by 2018.[138] Airbus Defense and Space is already transforming its Eurofighter production lines in Manching, Germany, into fundamentally a sustainment program.[139] While Italy and the UK will largely mitigate the loss of their respective Eurofighter production lines with their investments in the F-35 program, the future of German combat aircraft production is very much in doubt as its remaining Eurofighter orders are filled.

Eurofighter Design and Capabilities

The Eurofighter is a single-seat, twin-engine, supersonic, multi-national fighter program.[140] The aircraft employs an aerodynamically unstable delta wing-canard design. The Typhoon has all-moving foreplanes, low detectability technologies, and extensive use of composites. Approximately 40% of the air frame is constructed of carbon fiber composites, 10% is glass reinforced plastic, and 50% is aluminum-lithium and titanium.[141] The Eurofighter individual unit fly away cost has climbed from a 2007 cost of EUR 71.97 million ($98.6 million) to a unit cost of EUR 88.9 million ($123.6 million) in 2009.[142] Eurofighter unit costs have continued to climb to the current level of EUR 100 million per aircraft.[143] Interestingly, due to the strengthening U.S. dollar exchange rate for Euros, the current 2016 program unit cost is at $114.9 million.

Figure 4-5: Eurofighter Typhoon - German Air Force[144]

Lockheed Martin Joint Strike Fighter, F-35

F-35 Lightning II Consortium

Lockheed Martin's F-35 Lightning II was the winning contender for the U.S. Joint Strike Fighter program, a joint U.S. Air Force/Navy/Marine program to create a new affordable multi-role fighter aircraft for the 21st Century. Lockheed Martin as the primary contractor lead formed a consortium of companies to produce the Joint Strike Fighter with Northrop Grumman having an 18% share and the UK's BAE Systems with a 12% share of the F-35.[145] This worldwide supply chain includes more than 1,400 suppliers from U.S. and international companies.[146]

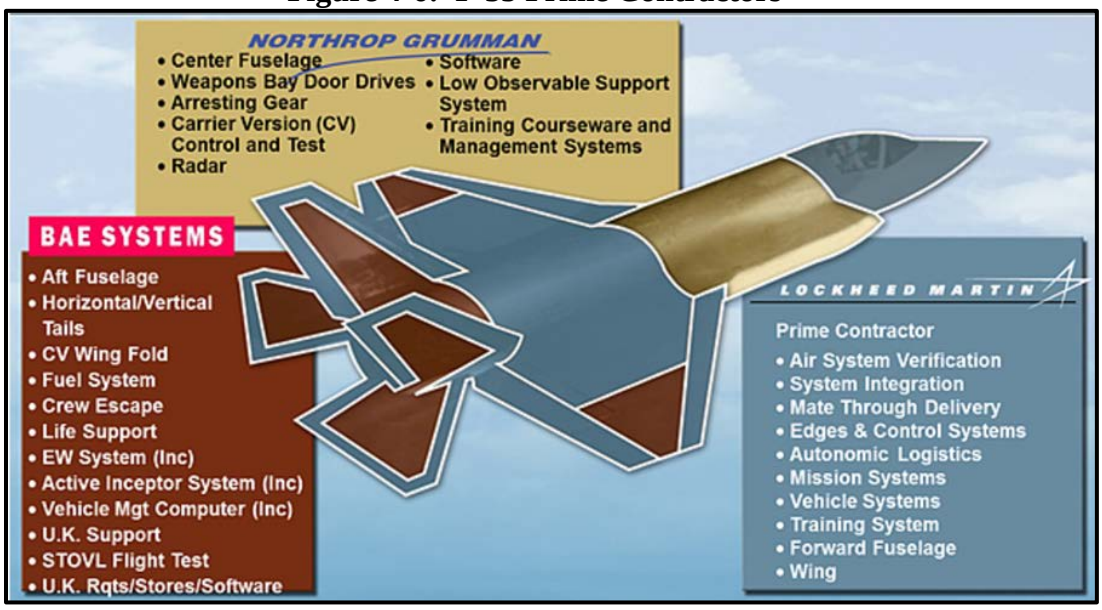
Prime Companies

Lockheed Martin Aeronautics is the number one ranked defense company in the world, overall number two ranked aerospace and defense company in the aerospace industry, and employs some 125,000 personnel worldwide. Lockheed Martin has five business segments with total 2015 revenue of $46.1 billion (aeronautics $15.5 billion, information systems and global services $5.6 billion, space systems $9.1 billion, missiles and fire control $6.8 billion, and mission systems and training $9.1 billion). Lockheed Martin is responsible for the F-22A, F35A/B/C, and the General Dynamics F-16 Fighting Falcon (General Dynamics sold its aircraft manufacturing segment to Lockheed Martin in 1993). Additionally, the company is responsible for the upgrade modifications to the A-10 to convert the aircraft and the aircraft's cockpit to an A-10C model.[147] Lockheed Martin's strengths include having the premier portfolio of fighter aircraft programs (i.e., the F-16, F-22, and F-35), company size and breadth to be an extremely strong defense market competitor, and a strong reputation for technological expertise, especially as a 'system of systems' integrator.[148]

Northrop Grumman is the number six ranked aerospace and defense company in the world and has four business segments with total 2014 revenue of $23.979 billion (aerospace systems $9.997 billion, electronic systems $6.951 billion, information systems $6.222 billion, and technical services $2.799 billion). Northrop Grumman is responsible for the E/EA-6B Mercury/Prowler, F-5E/F/N Tiger II, Fairchild Republic A-10 Thunderbolt II (last one produced in 1984, company became defunct in 2003).[149] Northrop Grumman brings strong operational performance and major defense program experience to the consortium.[150]

BAE Systems is headquartered in the UK and is a prime contractor and systems integrator for air, land, and defense markets. The company employs about 100,000 personnel worldwide. BAE Systems is the number five ranked aerospace and defense company in the world and has five business segments with total 2014 revenue of $24.029 billion (electronic systems $3.85 billion, cyber and intelligence $1.943 billion, platform and services U.S. $6.56 billion, platform and services UK $10.772 billion, and platform and services international $6.352 billion).[151] BAE Systems brings industry recognition in defense aerospace security, diversified geographic presence in business maintenance training and consulting, a focus on research and development, and decades of working within both the European Tornado and Eurofighter consortiums, the Saab Gripen, and the F-35 partnership.[152]

Figure 4-6: F-35 Prime Contractors[153]



Partner Countries

The U.S., as the lead nation and majority contributor, leads decision making on the F-35 Joint Strike Fighter and consequently shapes the parameters of fighter jet procurement of the partner nations. Internally, each partner nation's approach to the multinational consortium is different based on their individual geopolitical, strategic, and fiscal constraints. The initial attractiveness for each participating nation was the promise to be in the U.S.-led industrial and high-tech networks with relatively inexpensive access to the latest-generation stealth technology. Additionally, the opportunity existed for possible offset programs for national firms for a relatively limited initial investment.[154]

Each partner nation's level of participation determines their individual schedule of aircraft deliveries, the amount of technology transfers, and level of sub-contracting opportunities. The level of participation is directly tied to the national contributions of public monies directly invested during the system development and demonstration (SDD) phase of the F-35 program.[155] The UK is the only Level 1 (10% contribution) partner with $2.2 billion invested in the F-35 program's SDD phase and plans to order138 F-35Bs. The UK expects to receive a large return of approximately 24.2% on their 6.2% development costs investment with BAE Systems' as a primary industrial participant with Lockheed Martin. Although the British partnership provides the UK with expanded interoperability with U.S. forces, the UK has permission to broaden their weapons payload to include UK weapons such as the Meteor beyond visual range air-to-air missile. The two Level 2 partners (~ $1 billion in contributions) are Italy ($1 billion) and the Netherlands ($800 million). Italy plans to order 90 F-35s, reduced from their original 131 in 2009. Their agreement includes funding for final assembly and check-out (FACO) and maintenance, repair, overhaul, and upgrade (MRO&U) facilities of up to $796 million, about 4% of the shared cost. The Italians have shown 15 years of consistent support in the F-35 program.

The Netherlands has two F-35As on order, with another 35 planned, and expect a return of $3-4 billion to the Dutch industry. The Netherlands prepared their aerospace industry to be a part of the F-35 program through a coalition of military, governmental, and industrial interests.

The five Level 3 nations ($100-200 million in initial contributions) are Australia ($150 million), Canada ($440 million), Denmark ($125 million in SDD, Norway ($125 million), and Turkey ($175 million). Australia's 2009 plan was to order 100 F-35As, but due to delays they expect to receive only two aircraft by 2020. The Australians are politically oriented toward continued alignment with the U.S. and support interoperability, but want to maintain their self-reliance. Additionally, they have continued concerns about offsets, technology transfer, and overall costs. The Canadians' original 2007 order was for 80 F-35s which was reduced to 65 in 2010, but with the election of a new government and continued concerns over offsets, technology transfers, and overall cost, the program has entered a reset period with a re-competition. Denmark postponed their decision to acquire F-35s several times and entered a reset period with a re-competition in which the Danish Ministry of Defense has chosen the F-35, but still must be ratified by the Danish government. To mitigate their concerns over the expensiveness of their participation in the F-35 program, the Danes have invested in upgrades to their existing F-16 fleet. Norway has planned for 52 F-35As with four aircraft ordered. The Norwegian government political parties were torn between the Saab Gripen and the F-35. They chose the F-35 as the best aircraft focusing on quality, price, and benefits to their industry. Finally, Turkey has delayed their order of 100+ F-35As due to a desire to gain as much benefit for their defense industry as possible. They would like to achieve a 50% work share with the aim to acquire enough technology transfer to build their own indigenous fighter.

Singapore and Israel as Security Cooperation Participants (SCP), and Japan and South Korea are foreign military sales (FMS) countries. Each of these are politically oriented to continue their alignment with the U.S. and continued interoperability with U.S. military systems. However, just like the partner nations, they have concerns with offsets, technology transfers, and overall cost.[156]

Consequently, all of the F-35 consortium nations are caught in the extended delivery schedule and increasing cost of the F-35. Structurally, this occurred due to concurrent acquisition with the aircraft being produced and tested simultaneously. This resulted in the program being restructured three times with each restructure resulting in a production delay and rising cost. Additionally, technical problems slowed production and inflated costs. Hence, the multinational consortium's collaboration in the F-35 defense acquisition is highly problematic. Each nation has to deal with shrinking defense budgets, aging military fleets, and unrelenting public and governmental criticism of the F-35 program. As a result, each nation has had to consider alternatives: some have ordered or upgraded other aircraft as a stopgap (Australia buying F/A-18 Super Hornets, Denmark upgrading F-16s, U.S. keeping A-10s and F-16s), reevaluated or reset (Canada and Denmark re-competing with F/A-18, Dassault Rafale, Saab Gripen, and Eurofighter Typhoon as possible replacements), delayed orders (Turkey), reduced original orders (Italy, Canada, and Denmark), awaiting affordable pricing (Norway and

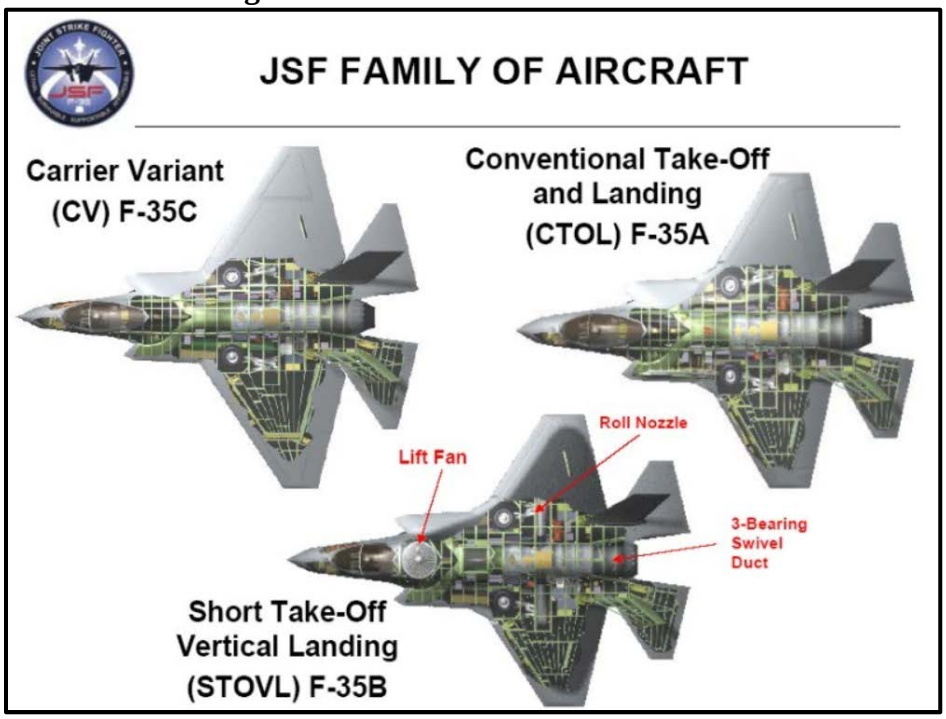
Australia). All has had a crucial impact on the domestic politics of the program in each of the multinational partner's countries and increased program uncertainty.[157]

Figure 4-7: F-35A Lightning II[158]

Joint Strike Fighter Design and Capabilities

The F-35 is designed to be the first fifth generation multi-role fighter aircraft with the world's only 360 degree situational awareness capability and is meant to leverage the U.S.'s advantages as an aircraft producer emphasizing low costs, volume, shared doctrine, and a global supply chain.[159] As a true Joint Strike Fighter, the F-35 is a family of single seat, single engine aircraft originally designed to have 70-90% commonality across the U.S. Air Force, Navy, and Marines.[160] However, the increased requirements across the Services for their variant of the F-35 has resulted in only about 20% commonality[161] and three nearly distinct aircraft variants in development and low rate production; the F-35A conventional take-off and landing variant for the U.S. Air Force and consortium air forces, the F-35B short take-off and landing variant for the U.S. Marines, UK, and Italy, and the F-35C aircraft carrier (flat deck) variant for the U.S. Navy. The total F-35 Joint Strike Fighter program is more than 3,000 units across the consortium of nations with some 2,443 of the fighters for the U.S.[162] The current unit price for the F-35A variant is $100 million[163] which makes the aircraft very competitive with the Eurofighter with regard to price, but is still a far cry from the F-35 Program Office and Lockheed Martin's goal price of $71.5 Million in 2012 dollars.[164]

Figure 4-8: Three Variants of F-35[165]



Dassault Rafale. France did not endear itself to its original partners in the Eurofighter project by demanding a 46% share of the work, a carrier-based version and then deciding to depart the program.[166] That said, after multiple delays it was able to deliver a high-performance, multi-purpose 4+ generation fighter platform that met national requirements while keeping development costs to a reasonable level.[167] The Eurofighter, while reaching full-scale production before the Rafale, suffered from the complexities of collaboration and meeting joint requirements of multiple national partners.

Regarding its combat characteristics, the Rafale is reported to have a lower radar cross-section than late model F-16s, and carries an impressive array of air-to-air and air-to-ground ordinance. The recent introduction and upgrades of older aircraft with Thales RBE2-AA AESA radar, puts its radar capabilities in the same league as comparable American products for fighter aircraft. It also can use Thales' OST Infrared optronics with MBDA's MICA infrared air-to-air missiles to passively target aircraft outside of visual range. The F3 model also integrates Thales' Damocles surveillance and laser targeting pod, which was successfully used in Operation UNIFIED PROTECTOR in Libya.[168] The French made a decision to forego full-stealth technology because of the expense, and therefore consciously chose not to pursue a SEAD-dedicated aircraft. The Rafale proved in the first days of the Libyan campaign that it could function within a non-permissive airspace without the support of stealthier SEAD aircraft in part because of its Thales/MBDA SPECTRA self-defense system, and because of the willingness of its pilots to enter contested airspace to carry out missions.[169] The Rafale also plays a vital role in France's nuclear triad by carrying the ASMP (Air-Sol Moyenne Portée) tactical nuclear missile.

In comparison with some of its rivals, the Rafale remains expensive with a "base price" without offsets exceeding EUR 100 million.[170] It is difficult to assess price in foreign sales

because of the different offset and armament packages that are included, but the Eurofighter sale to Kuwait in 2015 was reported to be for $140 million per aircraft, while the Rafale sale to Egypt (with over half of the financing coming from French banks) reportedly came in at $245 million per aircraft, and that with Qatar at $290 million.[171] The Rafale's operating costs are also reported to be high, at $16,500 per hour, less than the projected $21,000 for the F-35A, but more than double that of the Eurofighter ($8,200), F-16 ($7,000) and Gripen ($4,600).[172]

The cost of developing the Rafale was intended to be subsidized by export sales, but it only met with success in the recent deals with Qatar ($7.5 billion for 24 Rafales and MBDA missiles)[173] and an agreement with Egypt in 2015 for 24 aircraft for $5.2 billion that has been described as "saving" the Rafale line from closure.[174] France won India's MRCA fighter selection competition over its Eurofighter rival, but that deal was delayed due by disagreements over price, offsets and technology transfer.[175] It was eventually whittled down to simple $8.9 billion purchase agreement for 36 aircraft plus ten years of MRO, which remains under negotiation over price and offsets.[176] India was actively considering bids by Lockheed Martin for F-16s and Boeing for F/A-18s, and while it has been often-announced, the Rafale sale is now being held up by a corruption investigation, and may never successfully be concluded.[177]

The challenge of securing foreign sales underscores the advantages of the French model, as it guarantees long-term stability throughout the lifecycle of a platform, especially in the context of limited procurement budgets. The Rafale's state patronage stretched from initial R&D, prototype development and production, until the first third party sales and MRO. The first Rafale prototype flew in 1983; the first production aircraft was delivered to the French government in 1998; and the first contracts for foreign sales were concluded with Qatar and Egypt after 25 years of failing to find a foreign customer.[178] Experts currently predict that Rafale production will continue at least through 2024 and possibly beyond, based on current orders from the French government, foreign customers and projected foreign sales.[179] This kind of remarkably close government-corporate collaboration made it possible for France's largest primes—Dassualt, Thales, Safran/SNECMA and their subcontractors—to rely on a consistent demand from the French government of 11 planes per year, beginning in 2001, regardless of French budgetary conditions or the success of foreign sales. Through 2014, this resulted in 138 aircraft delivered to the French government, with that number being reduced in 2015 to cede production slots to meet foreign orders.[180]

In contrast, the Eurofighter consortium—the U.K., Germany, Spain and Italy—is rapidly approaching the end of the Eurofighter's production run of 571 aircraft.[181] The Eurofighter consortium made important foreign sales to Austria, Kuwait, Oman and Saudi Arabia, but barring new sales, Eurofighter is expected to exhaust its outstanding orders by 2018. Although it saw more initial success, the consortium approach to fighter aircraft production appears less efficient than the French autarchic model, at least regarding the objective of maintaining the respective defense industrial bases of the national partners. Airbus Defense and Space is already transforming its Eurofighter production lines in Manching Germany into fundamentally a sustainment program.[182] On the other hand Dassault is ramping up Rafale production to 24 aircraft per year, and will likely manage to keep its production line open for ten to fifteen more years while it continues to seek foreign customers, potentially outselling its rival on the foreign market.[183] At least as far as the Rafale is concerned, France appears to have put a greater

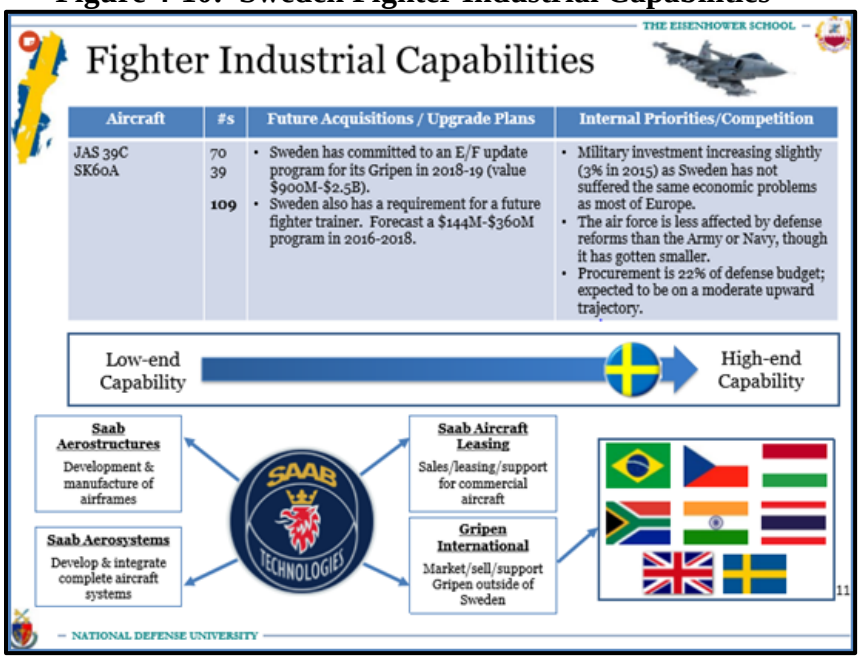
premium on maintaining an operational domestic supply chain and production line than on the need to deliver domestic fighters as soon as possible. That bet seems to have paid off.

While Italy and the UK will largely mitigate the loss of their respective Eurofighter lines with their investments in the F-35 program, the future of German combat aircraft production is very much in doubt as its remaining Eurofighter orders are filled. By 2025, France may well be the only remaining European producer of 4+ generation fighter aircraft in a world dominated by the F-35. Whether this was the original French strategy in creating the Eurofighter consortium and then backing out, it is an outcome that will certainly be seen as desirable by the French governmental-military-industrial elite. Their original German partners may have different feelings, however.

Figure 4-9: French Rafale[184]

Saab Gripen. Sweden has two aircraft in its arsenal – JAS-39C Gripen fighter and SK-60A trainer. There are planned upgrades and future acquisitions. Military investment increasing slightly since Sweden has not suffered in the same economic issues as most of Europe. It has service contracts with South Africa, Czech Republic, Hungary, Thailand, and the Engine Test School in UK (See Figure 8, Sweden Fighter Industrial Capabilities).[185]

Figure 4-10: Sweden Fighter Industrial Capabilities[186]



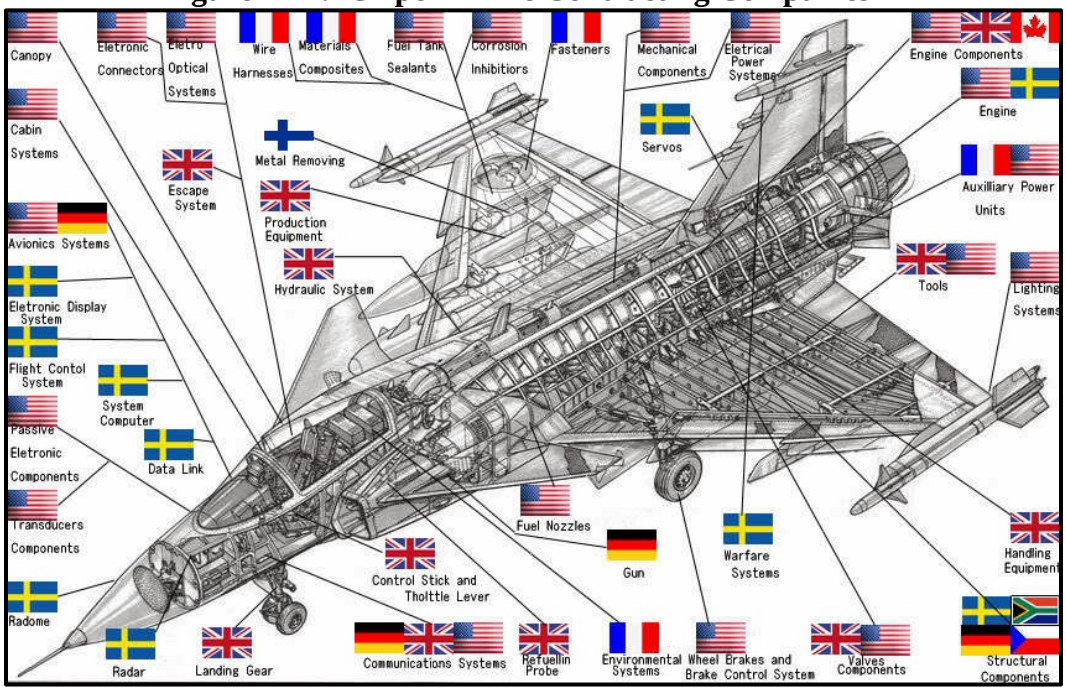
Swedish products provide the variation between models available in cost, technology, and lifespan attracting those countries that cannot afford aircraft such as the F-35. Sweden is confident that it can win more contracts in Asia, as well as Europe, South America, and sub-Saharan Africa. The Gripen contract with Brazil is the largest Swedish export deal to date. Brazil's Project F-X2 fighter replacement program picked the Gripen over Boeing's F/A-18 Super Hornet and Dassault's Rafale. The agreement allows technology transfer of everything to Brazil so it can develop its own next-generation military jets. This is a long-term strategic partnership that includes a wide range of areas ranging from defense to civilian industry efforts.[187]

IHS Jane's conducted an audit of current fighters in the market and considered the Gripen to have lowest flight hours costs behind the well-established F-16. It is a fraction of the cost of its competitors and the F-35. With modern focus shifting away from performance machines towards versatility, Gripen's low cost and moldable nature could see it steal a few more contracts from competitors (See Figure 4-11, Gripen, F-16 and F-35 Specifications).[188] For many countries with limited defense budgets, cost is a significant factor for their procurement agencies. They will choose advanced, but inexpensive or cost effective products. For example, one of the reasons Brazil did not choose Rafale is the uncertainty of their cost projections.

Figure 4-11: Gripen, F-16, and F-35 Specifications Comparison[189]

Specification	Gripen	F16	F35
Length	26′	49′5″	51′3″
Wingspan	39′	32′8″	35′
Crew	1	2	1
Builder	SAAB	Lockheed Martin	Lockheed Martin
Power Plant	VOVVO Aero RM 12	One Pratt & Whitney F100	One F135 Pratt & Whitney turbofan orone
Thrust	18,000 pounds	27,000 pounds	40,000 pounds
Speed	Mach 1 at low altitude Mach 2 at high altitude	1500mph Mach 2 at high altitude	1200 mph
Max Takeoff Weight	27,557 pounds	37,500 pounds	60,000 pounds
Armament	Internally mounted 27mm gun; AMRAAM Sidewinder or SRAAM anti-ship missiles; Air to ground weapons; active/passive electronic warfare systems; 3 external fuel tanks	One m-61A1 20mm cannon w/500 rounds; Up to six air-to-air, air-to-surface and electronic countermeasure pods	One 25mm aircraft cannon w/180 rounds; 2 internal weapon bays; 2 underwing missiles; transport pods

Figure 4-12: Gripen Prime Contracting Companies[190]



The JAS-39 Gripen is a single-seat, single-engine, supersonic, multi-role fighter aircraft manufactured by the Swedish aerospace company Saab Group. The Gripen is a delta wing-canard configuration with relaxed stability and fly-by-wire flight controls. Sweden's defense industry self-sufficiency remains a great strength, however it needs to attract more cooperation and improved partnerships with other defense industries such as the American defense companies. Thus, in order to survive with a dwindling defense budget, Swedish defense industry needs to continue to innovate and to expand globally by strengthening partnerships/alliances and an open transfer technology policy with friendly nations' defense industry. The Gripen is the most significant export product for Sweden and it has many companies involved in providing components and services.[191] Conversely, the Swedish Saab products, such as the Gripen, provides an affordable product for those countries that cannot afford to procure the more

expensive F-35, Eurofighter, or Rafale. The Gripen individual unit cost is $60 million.[192] Primary users are the Swedish Air Force, South African Air Force, Czech Air Force, the Hungarian Air Force, and the Brazilian Air Force.

Figure 4-13: Saab Gripen[193]

5. EUROPEAN ROTORCRAFT

Understanding the European military helicopter market requires first gaining an appreciation of the basic framework of variables as with any structure in terms of who is involved, what are they doing, when and where they are doing it, and why. Economists Glenn Hubbard and Anthony O'Brien define a market as, "a group of buyers and sellers of a good or service and the institution or arrangement by which they come together to trade."[194] The helicopter market comes together as a segment of a larger aerospace, defense and security industry that is highly complex in composition with an evolving behavior that adapts to changing environmental conditions. National security policy makers should be aware of the conditions of these complexities and evolutions to look for advantages before setting a course that commits national resources into the market.

Economics Professor Keith Hartley, from the University of York, in the United Kingdom, developed a framework for evaluating the economic structure of an industry for the purpose of informing public policy viewed through the lens of that industry's structure, conduct, and performance (SCP).[195] Hartley suggested that an industry's structure comprises the "number of firms and their size together with entry and exit conditions for the industry."[196] Further, Hartley's framework considers the market conduct where price competition "comprises advertising, marketing, political lobbying, research and development and product differentiation."[197] Thirdly, Hartley's framework assesses market performance in terms of efficiency and profitability.[198]

Four types of markets exist on a spectrum between extremes consisting of a perfect competition on one end, and a monopoly at the opposite end. The perfect competition includes a large number of relatively small firms benefiting from free entry and exit conditions allowing them to earn normal long-term profits. The monopoly consists of a single firm industry which profits abnormally for the long-term because existing barriers prevent competition entering the industry. The European military helicopter market is in the middle of that spectrum with an oligopoly consisting of just a few highly competitive large manufacturing firms, each able to collude with another on selling price, and all vying for the market share where national governments often have a triple role as buyer, regulator, and sponsor.[199]

Following Hartley's SCP framework, this section examines in closer detail, two of the largest firms: Leonardo (formerly branded as AgustaWestland under Finmeccanica) and Bell Helicopter.[200] First, this section looks at the structure consisting of market players, market segment competition and government roles. Second, this section looks at the market conduct in terms of the forces where power lies affecting the market, strategic choices these firms are making, and their objectives. Finally, this section looks at the market performance by reviewing available financial data along with an assessment of each firm's strengths, weaknesses, opportunities, and threats. This SCP framework will indicate that the helicopter segment of the global aerospace, defense and security industry is declining and that the Leonardo and Bell Helicopter are destroying value and must adapt their strategies to compete in emerging

commercial markets to ensure firm survival. This is a set of conditions favorable to the U.S. DOD as it enters development of the Future Vertical Lift (FVL) program.

Rotorcraft Structure

The structure of the market centers on the market players consisting of helicopter sellers, those setting the economic supply side, and helicopter buyers, those setting the economic demand side. Five large manufacturing firms, Leonardo, Bell Helicopter, Boeing, Airbus Helicopter, and Sikorsky dominate the military helicopter industry. Each, with the exception of Boeing, also maintains a balanced portfolio of commercial helicopter offerings. Combined, this oligopoly of just five prime contractors holds 96% of the global helicopter market shares with many buyers.[201] For the scope of this paper focused on the European military helicopter market, this section looks at Leonardo, a leading supplier in Europe compared with Bell, a leading supplier in the United States.

Leonardo, rebranded last month from AgustaWestland a subsidiary of Finmeccanica S.P.A., is an Anglo-Italian helicopter company. The company manufactures commercial, government and military single-engine, twin-engine, and medium twin-turbine helicopter systems.[202] Leonardo operates in the United Kingdom, the United States, Italy, Australia, Belgium, Brazil, China, Japan and Malaysia. The company is headquartered in Cascina Costa, Italy and employs about 12,850 people.[203] Leonardo revenues increased 8.1% in FY 2014 ($5,816.8 million) but profits declined 0.7% since FY 2013.[204] Leonardo's helicopter division product lines include ten Commercial Helicopters (SW-4, AW119Kx, AW109 Power, Grand New, AW169, W-3A Sokol, AW139, AW189, AW101, AW609); 13 Government/Military Helicopters (SW-4, AW119, AW109, AW109 LUH, T129, Super Lynx 300, AW159, W-35 Sokol, AW139M, AW149, Apache, NH90, AW10); and one tiltrotor (AW609 Tiltrotor).

Leonardo's history reflects a firm that survives changing economic conditions through multiple mergers, acquisitions and joint ventures. The company is it appears today, started as a merger between two helicopter companies, Agusta in Italy, and Westland in the United Kingdom. In the 1950s, both, Agusta and Westland entered into rotary wing aircraft production. In 2001, Finmeccanica S.P.A. and GKN form a 50:50% joint venture to combine the two entities into AgustaWestland. Three years later in 2004, Finmeccanica acquired GKN's 50% stake in AgustaWestland. Through 2006 to 2013, AgustaWestland signed five cooperative agreements with Mitsui Bussan Aerospace of Japan, Boeing in the U.S., Tata Sons in India, Russian Helicopters, and Embraer of Brazil. In 2016, Finmeccanica in a streamlining measure to unify its portfolio of seven differently named divisions acquired as separately named companies each with different market products, including AgustaWestland Helicopters, becomes a single family named Leonardo.[205]

Bell Helicopter, a subsidiary of Textron Inc., is based in Fort Worth, Texas. Like Leonardo, Bell also manufactures commercial and military, single-engine and twin-engine turbine helicopters, manned and unmanned vertical-lift aircraft and is the industry pioneer of revolutionary tiltrotor aircraft. Bell operates in more than 120 countries and employs more than

9,100 employees.[206] To date, the manufacturer has delivered over 35,000 aircraft.[207] Bell's revenues declined 5.9% in FY 2014 ($4,245 billion) and profits declined 7.6% since FY 2013.[208] Bell's product lines include seven commercial helicopters (Bell 206, Bell 407, Bell 412, Bell 429, Bell 505, Bell 525 Relentless, Bell Huey II); four government/military helicopters (Bell AH-1Z, Bell UH-1/212/412, Bell UH-1Y); and two tiltrotors (Bell V-280 Valor, Bell/Boeing V-22).[209]

Bell's history reflects a firm that survives the test of time with world-record setting innovation and by remaining a critical supplier to the U.S. Department of Defense (DOD). Established in 1935, in Buffalo NY, Bell Aircraft Corporation spent its early years focused on fixed-wing aircraft until building the first helicopter in 1941 with the Bell Model 30 and eventually gaining the "world's first commercial helicopter license," in 1946 with the Bell Model 47B.[210] Bell's innovation achieved a historical milestone in 1949 by breaking the sound barrier for the first time ever with the XS-1.[211] Through the 1950s, Bell innovation achieved other flight milestones with the first turbine helicopter (Bell Model XH-13F), the first convertiplane (Bell XV-3, a precursor to the modern V-22), and providing reaction controls to NASA's Project Mercury.[212] As the 1960s started, Textron, Inc. purchased Bell and witnessed Bell's overseas sales grow especially with its UH-1 for the U.S. military war in Vietnam.[213] In the mid-1970s, Bell innovation resulted in the first flight of a tiltrotor aircraft with the XV-15 setting the stage for the 1982 ground-breaking agreement between Bell and Boeing starting the Bell/Boeing joint venture on V-22.[214] Since the turn of the century, Bell has developed an unmanned helicopter and invested heavily in the V-280 Valor to compete for the U.S. Army FVL Program, along with entering into the "super mediums" helicopter category with the Bell 525 Relentless.[215]

Leonardo and Bell, as well as the other three major original equipment manufacturers (OEM), each compete in an oligopoly for the attention of buyers around the globe. According to IHS Jane's Defence, the U.S. leads the Top 10 list of nations with the largest defense budgets for 2015, with 36% of the total global defense spending. More than the remaining nine countries combined which consists of China at 12%, followed by the UK at 4%, then France, Russia, India, Japan, Saudi Arabia, and Germany each with about 3% of the aggregated global defense budgets. South Korea completes the list with 2% of the aggregate global defense expenditure.[216] Of these Top 10 nations, the western European countries of United Kingdom (UK), France, and Germany, as members of the NATO, maintain a pledge of spending 2% of their national Gross Domestic Product (GDP) towards defense. The UK is the only one of these to reach or surpass the goal in the past six years of generally declining defense expenditures.[217] However, Jane's IHS also anticipates that each of these three countries will increase their defense budgets into the next five years due to increasing regional instability.[218]

Major UK helicopter procurement programs published as part of a 10-year equipment plan for the time period from 2015 to 2025 includes 10.6 billion GBP ($15.32 billion USD) on "helicopters, including Chinook, Apache, Puma and Wildcat," according to Jane's IHS.[219] France will spend "up to a billion USD" on its major helicopter procurement program for the "multinational European NH90 multi-role helicopter," of which France is a participant through

Airbus Helicopters.[220] Germany's Air Capability Strategy includes procurement program objectives that include NH90 upgrades, procuring a light utility helicopter, and potentially procuring a multinational medical evacuation helicopter fleet.[221] According to a recent Defense News article in January 2016, Germany will select either the Sikorsky CH-53K or the Boeing CH-47F as a "potential successor to its aging fleet of CH-53 heavy lift helicopters."[222] Although France seems to only consider procuring new military helicopters with a large French stake in their manufacture, both UK and Germany seem open, if not inclined, to consider buying U.S.-made military helicopters. These forecasts of European military helicopter procurement are a critical opportunity in a tight competition within the market segment.

Seven market segments comprise the Aerospace and Defense industry consisting of civil helicopters, military helicopters, space, security, defense electronics systems, military aeronautics, and civil aeronautics. According to industrial analysis produced by Finmeccanica (now Leonard) reported to investors at a 2015 conference in London, the worldwide industry is expected to grow at a compound annual growth rate (CAGR) of 4% overall based on growth in six of the seven segments. Only the military helicopters segment will decline.[223] The main trends identified in that report suggest that aeronautics will continue to grow in the commercial segment at a compound annual growth rate (CAGR) of 2.4% between 2014-2023 along with the military aeronautics segment at a CAGR of 8.4% for the same time span, "driven by deliveries of main programs such as the Eurofighter, the F-35 Joint Strike Fighter, and the A400M Transporter."[224] The report also indicates that defense electronics systems will remain stable at 2.5% CAGR throughout the "USA and UK while growing in the emerging countries."[225] Similarly, the security segment increases with "demand due to growth of the asymmetric threats, now also extended to cyber domain" which will result in a 6.3% CAGR.[226] Space sees a 3.9% CAGR with an emphasis on bundled solutions. The civil helicopter segment is expected to grow moderately with a 2.1% CAGR. However, the most important trend identified in the report is with military helicopters which will decline sharply at -6.3% CAGR, according to the same report, "due to the completion of current productions."[227] With tight competition within the helicopter segment, firms are offering more than just goods to include aftermarket services just in order to ensure firm survival.

Within the military helicopter market segment, both Leonardo and Bell offer attack platforms, tiltrotor models and other small platforms for the basic purpose of creating value for their shareholders. Additionally, Leonardo offers medium and large rotorcraft platforms for military buyers which Bell does not offer. Neither firm offers specific transport or anti-submarine warfare platforms.[228]

Both firms perform maintenance, repair and overhaul (MRO) at multiple global locations. Leonardo boasts a wide international presence that includes, "10 industrial manufacturing locations in Italy, UK, Poland and USA, regional headquarters across the globe, more than 100 customer support and service centers on 5 continents, 7 supply centers and 4 training academies worldwide."[229] Bell, likewise, maintains "more than 100 customer service facilities," around the

globe all authorized to perform MRO including locations in Asia, South America, North America, Europe, Africa, and the Middle East.[230]

Government involvement in the structure of the military helicopter segment affects the market competition. Hartley suggests that national governments affect the demand as the buyer through their "procurement choices," they regulate the suppliers by "specifying entry conditions and determining firm size," and by determining whether the state will own part or whole of the industry.[231]

In Italy, ownership of firms is significantly influenced by law and government attitude towards foreign direct investment. Leonardo benefits from the Government of Italy retaining "a controlling interest" in Leonardo of approximately 30% according to the U.S. Department of State (DoS). Additionally, DoS notes that the, "Italian government may block mergers involving foreign firms if it is determined to be essential to the national economy or if the government of the foreign firm applies discriminatory measures against Italian firms."[232] Leonardo therefore, is a national champion for Italy serving the best interests of the Italian economic prosperity. However, Italian programmed helicopter acquisition plans seemed to have overlooked Leonardo since Italy is committed to spending more than $900 million USD to buy as many as 20 U.S.-made Ch-47F Chinooks to replacing an aging fleet.[233]

Bell likewise, is significantly affected by government procurement decisions and regulation. Although the company's largest military rotorcraft buyer is the U.S. Government, Bell's product lines of the H-1 and CV-22 are in production phase with no new U.S. orders for more. The result is that Bell increasingly relies on Foreign Military Sales (FMS) that endures congressional scrutiny and legislative timing all of which exacerbate uncertainty.

Conduct Within the European Rotorcraft Market

After understanding the basic variables (who, what, where, when, and why) regarding the military helicopter segment structure, the next logical step is to understand how the sellers compete for value creation. Profitability for shareholders boils down to the microeconomic decisions that Leonardo and Bell make. Hubbard and O'Brien define microeconomics as, "The study of how households and firms make choices, how they interact in markets, and how the government attempts to influence their choices."[234] Economist Michael Porter pioneered a methodology for evaluating "five competitive forces that influence profitability within an industry," for the purpose of developing a firm strategy.[235] Porter suggested that firms could "position themselves where the forces are weakest to exploit changes in the forces," and thereby "reshape the forces" towards the firm's favor.[236] Porter's five forces are: rivalries, the bargaining power of buyers, the bargaining power of suppliers, the threat of substitutes, and the threat of new entrants into the industry.[237] This methodology is useful for assessing the military helicopter market as well.

Overall, the market segment consists of a competition rivalry that exists among all five of the top prime helicopter vendors of Leonardo, Bell, Airbus, Sikorsky, and Boeing. The threat of

new entrants is low due to existing economies of scale and extensive capital requirements to produce helicopters. Incumbents with long histories in the industry, enjoy significant advantages because of the highly technological nature of the industry including the requirement for infrastructure peculiar to the manufacturing of helicopters. The buyer bargaining power is high due to the enormous government expenditures for military and non-military aircraft, as well as the resources of corporations and businesses requiring organic commercial aviation. The threat of substitutes is medium to low considering military aircraft fleets of most nations include fixed wing aircraft, land combat vehicles, and unmanned-aerial vehicles (UAVs). Local governments also tend to maintain fixed-wing and UAV platforms while commercial entity fleets often include watercraft and automobiles supplemented by fixed-wing aircraft. Supplier bargaining power is low for the simple reasons that suppliers concentrate on producing components peculiar to helicopters and the industry is reciprocally dependent on their supplies. Industry substitutions for helicopters are unlikely because of the unique nature of vertical take-off and landing capabilities that helicopters provide to the buyers.[238]

Of these five forces, the buyer bargaining power is the one competitive force that invokes the greatest risk for Leonardo and Bell. Firm profitability is determined by the market structure. In the industry segment of military helicopters, the market favors the buyers. This fact is great news for the U.S. DOD, with the largest national defense budget, and a desirable condition for future military helicopter acquisitions with either or both firms. For Leonardo and Bell, each firm's strategic game board choices for where, when, and how each strives to create value should include decisions based on the other four forces.

The strategic game board for Leonardo should include increasing sales and its international presence in the emerging markets of Brazil, Russia, India, China, and Turkey whom all have growing national economies, as well as remaining viable for new buyers in Asia and sub-Saharan Africa where Leonardo has the supplier advantage. Leonardo should also pursue additional trade with the UK, Europe's leading defense expenditure, together with France where national service life extension programs and modernization upgrades to aging fleets are likely rather than new model acquisition, or a substitution threat, in times of slow growth. The best possible time for Leonardo to compete is now through the next decade (2016–2026) as the U.S. will continue to procure new helicopters in the future-years defense program (FYDP) between Fiscal Year 2016 throughout FY 2020 for upwards of 28 different helicopter models.[239] Leonardo should compete further by positioning itself in the aftermarket service segment with emphasis on commercial helicopter related services and reinforcing its position in the export markets of China and India thereby further barring new entrants into those markets. Other considerations for Leonardo include improving international presence through allowing technology transfer and partnership arrangements with local players, and developing, or leveraging, dual use (Civil–Military) helicopters for nations with less than 1% GDP defense spending. Additionally, Leonardo should initiate marketing campaigns to stimulate demand for its tiltrotor (AW609) where Leonardo is a late-comer in rivalry to Bell.[240]

Bell's strategic game board choices should center on leveraging its pioneering groundwork and intellectual property (IP) gained from over 35 years in developing tiltrotor technology. This is where Bell has the best bargaining power in the entire rotorcraft market. This IP, proven with over 99 deliveries to the U.S. DOD over the past nine years, gives Bell a competitive advantage over Leonardo who is a new-comer to the tiltrotor market.[241] Bell should also continue development of its new "clean sheet design" Model 525 Relentless fulfilling Bell's absence in the "super medium" commercial helicopter category. The current timing of the 525 development is optimal, since global fuel prices are low thereby driving fewer new helicopter orders from offshore petroleum exploration and development corporations. This will enable Bell to attempt to catch up to Leonardo in this category overcoming the entry barrier.[242] With a well-established global presence, Bell should leverage its overseas sales and service network for both civilian and military helicopter sales race reducing any threat to new entrants in Asia and sub-Saharan Africa regarding MRO. Additionally, Bell holds the bargaining power as a supplier of its V-22 Osprey as demand through Foreign Military Sales increases such as that which Bell enjoyed with Japan's recent receipt of five Ospreys.[243]

Performance within the European Rotorcraft Market

A review of the 2015 Annual Reports of both Finmeccanica (for Leonardo), and Textron (for Bell) provide insight into whether the firms are creating value or if the market favors the buyers. The industry standard key performance indicators, such as the firm's revenue, the earnings before interest, taxes and amortization (EBITA), the firm's net profit margin, new orders, and aircraft backlog indicate that the military helicopter sector is in decline.

For 2015, Leonardo posted a slight revenue increase at EUR 4.479 million (approximately $5.12 million) up 2.4% from EUR 4.376 million for 2014. Leonardo's EBITA for 2015 were 558, up 2.8% from 543 for the previous year. However, net profit margin remained steady up only 0.1% from 2014. Leonardo explains this is due to the significant market decline of the Oil & Gas industry for which the success of is a key driver for new helicopter orders. As a result, new orders for 2015 amounted to 3,910, down 14.2% from 4,556 in 2014. This is in spite of Leonardo reducing its order backlog by 4.3% down from a value of EUR 12,249 million in 2014 to EUR 11,717 million in 2015. These key performance indicators are bad enough. However, the same indicators for Bell describe a far worse situation.

For 2015, Bell posted a revenue drop with $3,454 million down 19% from $4,245 million for 2014. Revenue for the V-22 alone declined drastically from $1,771 million in 2014, down 33%, to $1,194 million in 2015. Bell's annual report also cites the decline of new orders from Oil & Gas corporations. However, with the V-22 and the H-1 programs both in production phase, the lack of new orders severely affects Bell's profitability. Bell's net profit margin of $400 million for 2015 declined 25% from the previous year of $529 million. New orders for 2015 amounted to 3,910, down 14.2% from 4,556 in 2014. Similarly, Bell reduced its order backlog by 4.3% down from a value of $5,525 million in 2014 to $5,224 million in 2015.

The data from these self-reported performance indicators are likely to remain somewhat the same into the future. According to a Teal Group overview of the world's rotorcraft, Leonardo will surpass Bell in revenues each year for the next 10 years.[244] This forecast is likely to remain true unless the conditions of each firm's internal strengths and weakness, combined with the opportunities presented to each and the threats facing them change. An analysis of those strengths, weaknesses, opportunities, and threats (SWOT) provides insight where changes are required.

According to a November 2015 MarketLine Advantage company profile on Finmeccanica, Leonardo's strengths include a strategically balanced business portfolio, with a strong focus on research and development (R&D), and geographically diversified operations.[245] Leonardo's weaknesses consist of increasing indebtedness, difficulties in managing the company effectively as a real "domestic player" in the U.S. market, and continuing reduction in volumes (approx. -50% from 2009), also due to the U.S. Defense budget reduction.[246] Leonardo also suffers from a product portfolio that is too diversified. Leonardo's opportunities to create value include a robust order backlog and new contracts to aid in business expansion, a growing civil aeronautics market, and a worldwide UAV market poised for strong growth.[247] Leonardo's threats consist of intense competition, stringent environmental regulations, issues arising from fixed-price contracts, and falling global gas prices.[248]

According to a January 2016 MarketLine Advantage company profile on Textron, Bell's strengths are highlighted by a good mix of civil and military product lines, the industry-leader expertise regarding helicopters and tiltrotors, a robust worldwide sales and service network with MRO to support more than 13,000 helicopters, and high personnel efficiencies.[249] Bell's weaknesses include Bell's relative position of "3rd place in Europe," the majority (62%) of its revenue comes from the U.S. DOD, and Bell's military product lines are in their final delivery phases with no new orders.[250] Bell's opportunities are several and significant, beginning with the firm's entry into super medium market with it developing 525 Relentless, followed by its early involvement in the U.S. Army FVL program offering its prototype tiltrotor V-280 Valor.[251] Other major opportunities exist with Bell developing the V-22 for future U.S. Navy aircraft carrier onboard deliveries (COD), and V-22 FMS.[252] Bell's threats include intense competition with Bell losing market share to Leonardo in Europe.[253] Other threats include the low demand for new helicopter orders due to low oil prices and budget deficits worldwide.[254]

Overall Assessment of European Rotorcraft Market

The overall health of the helicopter segment is declining in the Aerospace, Defense and Security Industry. Leonardo and Bell Helicopter firm strategies are unsuccessful and are destroying value. They will continue doing so until both firms start to improve their international footprint, extend their reach, and optimize their portfolios. Both firms are surviving only because they are divisions held by parent conglomerates. Leonardo and Bell Helicopter are missing opportunities in the growing civil rotary aeronautics and UAV markets. Leonardo has survived through consolidation but resulted in redundant corporate structures and unsatisfactory return on investment. Bell has survived by building consistent growth in the civilian market to manage the lulls of government contracts.[255] Leonardo has a competitive advantage over Bell in large helicopter offerings to military and civilian buyers. Increased global competition forces Bell into a position of being immediately dependent on a future military orders for the V-22 through FMS. The future of Bell military helicopter production hinges nearly entirely on winning the FVL contract from the U.S. Army.

6. EUROPEAN TRANSPORT/TANKER AIRCRAFT

The Lockheed Martin C-130 and the Airbus A400M can be seen as exemplars of structure, conduct and performance (SCP) of the U.S. and collaborative European systems, the defense and aviation industries, and increasing competition between the firms Lockheed Martin (LM) and Airbus Space and Defence (ASD) themselves. National, industry, and firm level determinants impact how Lockheed Martin and Airbus market these aircraft via competing business models in the both the domestic and export military airlift markets. In the hopes of supporting projects like the A400M, European Union members have collaborated to institutionalize and improve the European collaborative procurement process. At the firm level, both LM and ADS have leveraged relationships and capabilities from the defense and aerospace industries respectively to drive their C-130 and A400M business models. Finally, the firms themselves use technological improvements and diversified models and missions to compete their respective aircrafts.

The C-130, the "Hercules," represents the tested favorite, evolved incrementally through tough combat experience into a wide range of models for diverse military applications. "Although more than fifty years old, the venerable [C-130] is the mainstay of any modern airlift fleet and is the benchmark by which all other transport aircraft are measured."[256] The C-130's 1.2 million-plus hour operational track record is a testament to its performance and reliability.

The A400M business model represents a challenge to U.S. dominance of the military airlift sector, exceeding the C-130 in range, speed, and payload, with force-multiplying standard tanker capability. While the A400M demonstrates the best of European collaboration on airlift, the collaborative business model is fraught, and often drives increased total cost and longer timelines. Questions remain whether ADS has fully resolved significant developmental issues with the A400M.

U.S. National Defense Market and the C-130

Acknowledging the challenges laid out by Hartley in *The Political Economy of the Aircraft Market* regarding military aircraft markets, including domination by a single buyer, and expensive and project-specific high technology, the initial launch of the C-130A nonetheless seems to be a textbook case of an efficient and timely aircraft launch. The original C-130 had a fairly straightforward design and development phase, followed by a rapid production launch. After issuing a specification in 1951, the U.S. Air Force issued a production contract for two prototypes in 1952. A mere two years later, a Lockheed C-130A Hercules made its maiden flight.[257] The U.S. entry into the war in Korea, and the need for a plane able to manage take-offs and landings on "rough, unprepared runways"[258] may have played a role in accelerating the development and production of the C-130.

Structure and conduct elements suggested by Hartley may have smoothed the C-130's path to rapid production, and Lockheed's successful performance on this initial contract: The U.S. was and is the world's largest military aircraft market, providing sufficient production volume to ensure a successful launch, particularly during high tempo wartime. As was more common in this earlier era, the C-130 was designed by one prime contractor, Lockheed, for one customer, the U.S. Air Force, eliminating international collaboration, multiservice, or multi-

mission complexity and risk. Entering into the Korean War, there was likely a sense of urgency to produce the aircraft. The U.S. Air Force's contracting of prototypes suggests that the U.S. government assumed most, if not all, of the production risk for the new aircraft type. All of these elements appear to have come together to allow the C-130 to move from design to initial flight within three years.

The European Collaborative Defense Market and the A400M

In comparison with the path for the C-130A, structure, conduct, and performance within the collaborative European innovation system and multi-stakeholder ADS to produce the A400M was complex and often tortuous. From the outset, the A400M program was technically ambitious, but in practice, the institutional and policy components proved equally if not more challenging. Mawdsley explains that the A400M became intimately tied to the creation of a European Security and Defense Policy (ESPD), later the Common Security and Defense Policy (CSDP), as well as eventually to the creation of European-wise procurement institutions and policies. This tight linkage eventually became a heavy political weight for the project:

> The A400M is the most ambitious military acquisition programme in Europe. It constitutes a founding element in the European technological base and gives a decisive drive to a European defense and security policy. It is key to the aims and objectives of the CSDP (Common Security and Defense Policy) in that it would greatly improve the EU's capacity to move troops and military equipment to crisis zones around the world.[259]

Ultimately, Mawdsley noted, the A400M project "became seen as 'a litmus test of whether Europe is serious about ESDP.'"[260]

Even prior to the development of the A400M, Hartley conceived of international collaboration as a "distinctive feature" of the European aerospace sector, noting a history of "sharing of total R&D costs and the pooling of production orders between the partner nations."[261] The A400M was conceived and implemented as a collaborative European project involving seven nations: Germany, Belgium, France, Luxembourg, Spain, Turkey, and the UK. (A couple of additional launch customers also withdrew.) Their approach to the A400M business model involves shared manufacturing through an industrial collaboration (or "work share") program, for example, with wing boxes assembled in the UK, fuselage assembly in Germany, and final assembly in Spain. Europrop International, a consortium of UK, French, German, and Spanish firms, manufactures the A400M engines based on Snecma technology, while French firm Messier Dowty (Safran MBT) manufactured the landing gear, among numerous other systems shared out through industrial participation. Fly-by-wire flight control systems are derived from Airbus civilian aircraft.[262]

Competition at the U.S. and European Industry Level

Leveraging Industry Competencies

We now turn to the issue of competing business models for the C-130 and A400M as reflected in the structure, conduct, and performance at the industry level. At first glance, it would appear that the original equipment manufacturers (OEMs) for these aircraft, Lockheed Martin, and Airbus Defense and Space respectively, represent the same industry, as they both

manufacture highly sophisticated and specialized military aircraft. Hartley, however, brings greater rigor to our assessment.

Hartley defines Lockheed Martin, OEM for the C-130, as a defense firm, "where defence sales account for over 70 per cent of the business and firms provide a variety of air, land, and sea equipment."[263] On the other hand, Hartley defines Airbus, including subsidiary Airbus Defence and Space, OEM for the A400M, as a "specialist aerospace firm" that is, one of the "large firms based on a major civil jet airliner business with military markets forming less than 50 per cent of their business."[264] LM and ADS originate from different starting point, but both arrive ready to compete in the military aviation sector, airlift subsector. They both bring to bear the capabilities of their wider firms, whether defense or civil aviation-oriented, in their competing business models for the C-130 and A400M.

Lockheed Martin: Leveraging Defense Competencies for the C-130

Lockheed Martin's diversified defense base provides significant military relationships and technological capabilities to leverage in its C-130 business model. In marketing the C-130, LM points to more than 1.2 million flight hours logged by various C-130 models by military customers around the globe, and more than 2,500 aircraft sold. Diverse C-130 models currently operate in more than 68 countries, and hold more than 54 world records.[265]

LM also leverages capabilities throughout the firm in ensuring the C-130's adaptability and fitness for an enormous variety of missions. LM claims that the C-130 has taken part of more than 100 types of missions, with a proven track record in personnel transport, combat delivery, electronic surveillance, special operations, hurricane hunting, aerial firefighting, humanitarian aid delivery, medical evacuation, maritime surveillance, intelligence, surveillance and reconnaissance (ISR), VIP transport, and gunship/close air support (CAS).[266] In meetings, industry executives referred to the diverse stable to C-130 models as a "portfolio," an apt description given the diverse models of C-130, many of which now operate beyond the C-130's initial airlift remit. One illustrative example is further explored below:

LM's investment in the C-130 as a signals intelligence (SIGINT) platform is another element of its business model for this aircraft. In fielding this capability, LM leverages its C4ISR and tactical intelligence business lines,[267] a clear competitive advantage for the firm in marketing the C-130J to potential export buyers. In 2016, Janes's Defence assessed that at least nine countries likely had utilized the C-130 as a SIGINT platform, including the U.S., the UK, Egypt, Israel, France, Australia, Singapore, Taiwan, and likely even Iran with its 1970s era C-130s.[268] Jane's identified "eight military C-130 variants as having (or as having had) primary or secondary SIGINT roles," including Combat Talon I and II, which allowed Special Operators to undertake electronic taskings, such as reconnaissance functions such as helicopter escort jamming and generating electronic situational awareness data during infiltration or exfiltration operations. The " Senior Scout" ISR package "is used to "exploit, geo-locate, and report on" electronic signals of interest in carrying out both warfighting and law enforcement operations, including on "low power tactical targets that challenge U.S. intelligence efforts…"[269] While various planes could be used as a SIGINT platform if appropriately equipped, the C-130s long history of use as a signals intelligence platform provides a powerful tool in Lockheed Martin's C-130 business model, an element leveraged from the firm's broader defense sector capabilities.

Airbus Defense and Space: Leveraging Civil Aircraft Competencies for the A400M

Turning to Airbus Defense and Space, in its business model for the A400M, it seeks to leverage its substantial civilian aircraft expertise. Speaking to the internal re-organization which created ADS, Airbus notes a primary goal of the mergers was to develop synergies between its civilian aircraft platforms and its recently-launched defense business.

> This integration allowed the streamlining and simplification of the organisation while also better benefitting from the synergies in airframe designs between the commercial and military transport aircraft, as well as exploiting the potential military applications and derivatives of Airbus commercial platforms.[270]

Leveraging Airbus civilian aircraft design in military applications thus became not only a way to lower design and development costs, but also potentially a marketing advantage for Airbus, allowing it to offer a familiar design and flying experience for pilots. ADS touts the A400M's control system and configuration similarity to Airbus civilian aircraft as a selling point for potential export buyers, including its civil aircraft-derived fly by wire (FBW) capability. "Airbus Military has leveraged the civil side's extensive FBW experience to field a very capable airlifter that is undeniably an Airbus. Any current Airbus pilot would feel quite at home in the A400M's A380-derived cockpit," affirmed *Flight International*. Leveraging existing A380 civil certifications, the A400M is both military and civilian certified, and often features dual-systems, such as two crew oxygen systems, one a civilian full-face oxygen system, and the other a military system for use with helmets.[271]

Evolving Business Models: Competing through MRO and Related Services

Unlike the competing business model attributes outlined above, LM and ADS, in concert with much of the defense aviation sector, appear to have converging business models via their determinations to compete via Maintenance, Repair, and Overhaul (MRO) and related aftermarket services. MRO services represent a growing segment for defense aviation firms, regardless of the type of aircraft or subsector. LM military customers can purchase "sustainment packages" for the C-130. ADS markets the A400M with the potential for customers to purchase "Full in Service Support." Whether called "sustainment" or "FISS," competitors in the defense aerospace sector increasingly must offer MRO services simply to meet baseline expectations for the industry, and so remain competitive. Industry executives told Eisenhower School Aircraft Industry Study members that MRO services were increasingly being purchased not only by the U.S. military, but also by foreign militaries. In addition, the concept of military aircraft "services" continues to expand, encompassing not only traditional MRO activities, but also associated services such as Performance-Based Logistics, predictive maintenance, parts pooling, and fleet management.

Industry executives told Eisenhower School Aircraft Industry Study members that MRO services were rapidly growing both in terms of percentage of overall defense business, but also in terms of profitability (return on investment). An executive with whom Eisenhower School Aircraft Industry Study members spoke told us that "services" now account for at least half the firm's military aircraft profits. The MRO business model is impacting firm structure as well:

aiming to capitalize on MRO profitability, Industry Study members also learned a firm was restructuring its defense enterprise to better cluster "centers of competence," bringing previously stove-piped Production and MRO units together under a unified "Operations" mantle.

Industry executives also noted the trend for MRO services to be offered via "Performance Based Logistics," (PBL) contracts. In a PBL contract, a government, typically via a department or ministry of defense, contracts with a firm for a specified level of aircraft availability, rather than for purchase of parts or specific repair services. For example, a government could contract for a C-130J or A400M to be available on a 95% basis. Most industry executives with whom we spoke were positively inclined towards PBL, believing it lowered cost and decreased aircraft performance challenges. One firm noted that PBL increased flexibility for the military customer, while decreasing the government's risk and capital commitment.

PBL was typically coupled with programs and even technology on the aircraft itself which allows the contractor to perform predictive or preventative maintenance, rather than repairing an aircraft after a component may have exceeded its service life or even broken. The goal remains maximizing aircraft availability within agreed parameters, and minimizing service interruptions or aircraft breakdowns. Firm executives also mentioned increasing interest in "pooling," for spare parts, on a regional or even on global basis, to minimize the capital that militaries or defense firms were required to keep tied up in maintaining large numbers of spare parts. Another firm explained the concept of "fleet management," as key to service life extension. Through fleet management, the contractor could, for example, rotate the most frequently used aircraft out of forward bases, replacing them with aircraft with fewer hours, and hence extending the service life of the overall fleet.

Some Aircraft Industry Study members expressed unease that PBL or global parts pooling would provide adequate supply, flexibility, and turnaround time in the event of an operational surge. Another industry executive admitted that lean supply chains, by whatever name, remained susceptible to supply shocks such as natural disasters. Finally, OEM executives appear to be considering additive manufacturing, but with issues such a certification for military aircraft largely unresolved, they are not yet stepping out to utilize this technology.

In considering the expansion of military aircraft business models into MRO and other services, one executive surmised that "Customers want to focus on core tasks." Combat operations, all agreed, remained an inherently governmental task. Many other aftermarket services, from MRO to fleet management, increasingly seem up for grabs in the midst of rapidly evolving business models. That said, it remains difficult for a potential customer to distinguish between the various firms offering MRO and related services, as they do not yet appear significantly differentiated.

Competition at the Firm Level: Lockheed Martin versus Airbus Defense and Space

Finally, coming down to the firm level, LM and ADS compete vigorously to win and retain the business contracts from militaries globally. Within Porter's Five Forces Model[272], Airbus Defense and Space is a relative new entrant to the defense aerospace industry, albeit based on a merger of Airbus' EADs, Astrium, and Cassidia divisions. As such, Airbus's A400M is likely to place competitive pressure on the Lockheed Martin's core C-130's business model.

Lockheed Martin's C-130 Business Model

The C-130 is now oldest military plane in operation, grandly christened by *Forbes* magazine as "The Most Successful Military Aircraft Ever."[273] The first C-130A made its maiden flight in 1954. Since then, the U.S. military alone has fielded more than thirty configurations of the plane. Lockheed has invested significantly in keeping the C-130 up-to-date and technologically relevant, while ensuring it remains inexpensive and reliable to operate. Two major updates, the C-130H, and the second-generation C-130J, launched in 1974 and 1991 respectively.[274] The latter, called the Super Hercules, is able to transport 44,000 pounds, or about 20 tons.[275] Forbes reported that the "Super Hercules provides a 40% gain in range over previous variants, a 20% gain in maximum speed, and needs only 60% of the runway distance to get airborne."[276] LM has manufactured more than 2,271 C-130 aircraft, and there are now four major variants and dozens of sub-types in operation, including a civilian variant, the L-100.[277]

As noted above, proliferation of C-130 missions and capabilities, a "portfolio," appears to be central to LM's C-130 business model. While the C-130 is first and foremost considered a medium range transport aircraft, its use by dozens of the world's militaries for decades across multiple missions underscores its flexibility for potential buyers. Export sales of the C-130 commenced in 1965 with Lockheed's sale of a C-130H to New Zealand, and there are now more than sixty militaries operating C-130s.[278]

In conversations with Eisenhower School Aircraft Industry members, industry executives described a strong backlog of C-130 orders, indicating it remains a robust competitor in the military aviation sector. Executives consider the current pace of C-130 production, about 24 aircraft a year, to be "stable and efficient." The C-130, in the parlance of the Boston Consulting Group," is LM's "cash cow," throwing off a large stream of revenue which the firm can invest into more cutting-edge technologies.

Adapting the C-130 for the Modern Era

Given the many models of C-130s which remain in service, including older C-130s provided as foreign assistance to developing nations, there is a robust market for C-130 modernization through firms such as Boeing, Rockwell, and ARINC. Boeing, rather than OEM LM, won a U.S. Air Force-sponsored modernization programs to extend the service life of C130s by up to thirty years. In 2006, Boeing launched a Total Life Extension program, which includes the avionics upgrade, the "Aviation Modernization program" (AMP). The AMP was designed to address "aircraft modernization needs, including avionics, wiring, structures and systems."[279] Boeing claimed to be able to upgrade C-130s at one-seventh the cost of a new aircraft.[280] That

said, the AMP proved controversial, and some studies have indicated that investing in newer C-130s was a more prudent financial choice.

> In fact, some studies indicate that the current upgrade program would only improve mission readiness by a paltry 1%—at a cost of over $10 million per plane. So given budget constraints, the Air Force has concluded it needs to scale back the upgrades and forge ahead with buying replacement aircraft.[281]

Longer term, another challenge to the C-130 may be the increasing size of military equipment, including helicopters and armored vehicles, which cannot be accommodated in the C-130's cargo hold without increasing the diameter of the aircraft. As Jane's notes:

> The main issue facing the C-130, however, is that as military hardware becomes ever larger, the Hercules will "bulk out before it weighs out." In simple terms, this means that the aircraft's ability to transport loads will be limited by the physical size of the cargo rather than by its weight…According to Jim Grant, vice-president of air mobility and special operations at Lockheed Martin, the company predicts that the C-130J will be unable to accommodate around 10 per cent of tactical loads within the 2015-2020 timeframe.[282]

France, for example, initially opted to order A400M's when C-130s proved unable to load outsized equipment for their operations in Mali:

> France does have a tactical fixed-wing transport force comprising five Lockheed Martin C-130H and nine C-130HJ-30 Hercules…but these are not capable of carrying much of the outsized cargo, such as armoured vehicles and helicopters, needed to conduct an operation such as the current one in Mali.[283]

Despite these concerns, LM now appears to have dropped earlier plans to develop a larger sized fuselage for the C-130 ("the C-130 XL"), "claiming the aircraft's current cabin cross-section is adequate for customer requirements."[284] The reasons for LM's apparent reversal of its decision to pursue a larger cross-box for the C-130 are unclear, but its executives may have been concerned that such extensive modifications would not provide an appropriate return on investment. Alternately, they may have been concerned that the market entry of the A400M may have introduced sufficient competition to preclude healthy returns on investment for a wider-130. LM's decision to forgo development of a wider C-130 XL is likely to cede some portion of the airlift market for outsized equipment transport to its competitors, including the A400M.

In a perhaps unexpected bonus to the C-130 business model, LM continues to gain sales from delays in rolling out the A400M. Ironically, in 2016 the French military, despite having opted for the A400M, was forced to order four additional C-130J Super Hercules to fill an unacceptably long air transport gap created by delays in the European airlifter. The new French C-130s will be delivered between 2017 and 2019.[285] That said, the comparative advantage to LM on this point is likely to be transitory, as ADS gears up to produce larger numbers of A400Ms, including more for export sales.

Airbus Defence and Space's A400M Business Model

The A400M is a multi-mission airlifter, designed for versatility, ruggedness, and survivability under austere conditions. ADS's A400M business model positions the aircraft as both a strategic and tactical airlifter/tanker, offering "delivery to the point of need."[286] It promises to blur the line between strategic and tactical capabilities, offering militaries the ability to quickly transport outsized equipment directly to forward operations, without having to do cumbersome transfers, or maintain a separate strategic airlift fleet. *Flight International* concluded, "Aimed to fill the void between the C-130J and C-17, the Airbus Military's first clean-sheet offering may be just right."[287] Its speed, range, and payload exceed those of the C130. In sum, *Military Technology* identified the A400M as a likely robust competitor to the U.S.-produced planes such as the C-130. "The A400M has notched up impressive advance orders…and is certain to make rapid inroads into a market traditionally dominated by the Americans."[288]

The ADS business model for the A400M positions its airlift capacity midway between those of the C-130J and C-17, a decision that Jane's Defence notes was "probably no coincidence."[289] The C-130J model can transport 44,000 pounds, or about 20 tons, while the A400M can transport almost double that, 81,000 pounds, or 37 tons. (By comparison, a true strategic air transport plane, the C-17, can transport 170,000 pounds, or 77 tons.)[290] *Flight International* was favorably impressed, noting, "In terms of range and payload, compared to the C-130J the A400M excels. In general terms the A400M can carry the same payload twice as far or twice the payload the same distance."[291] On pallet capability, "The A400M can carry up to nine …cargo pallets, one more than the C-130J, and nine fewer than the C-17."[292] *Flight International* also notes that increasingly the true test of an airlifter is its ability to manage "outsized loads."[293] The A400M can a carry outsized loads such as the Eurocopter or armored vehicles, beyond the capacity of the C-130J.

The A400M is also outfitted as a tanker. As defense budgets come under increasingly pressure from slow global growth and surging technology costs, militaries around the world are likely to welcome this feature. Pointing to budgetary and procurement program constraints, Jane's concluded in 2009 that "…it is no longer viable for most air forces to operate exclusive aerial refueling and strategic transport fleets. Affordability and flexibility are the current watchwords."[294] *Flight International* further claims that the A400M is more capable of refueling tactical jets than is the C-130J, as the A400M can match jets at speeds up to M0.72.[295]

Flight International notes the A400M features the "largest Western turboprop engines to date, swinging massive eight-bladed scimitar propellers… The propeller-driven A400M was built for speed.[296] It also notes that its unique down-between-the–engine configuration provides better handling with less drag. In essence, the DBE configuration allows for propellers 1 and 3 to rotate clockwise, while propellers 2 and 4 rotate counterclockwise, providing enhanced performance.[297] Turning to the A400M's military capabilities, *Flight International* generally had highly positive reviews, including its full authority digital engine controls (FADEC). "The type looks more than ready to fulfill the logistical mission specified by its initial operators. The powerful FADECs and the Y*FCLs in particular made the A400M fly like a jet…it is well on the way to meeting its tactical requirements."[298]

The A400M is outfitted for survivability and operations in combat conditions. Remarking favorably upon the A400M's performance in a preview flight, *Flight International's* tester Mike Gerzanic assessed, "The A400M's handling qualities and excess power as well as the availability of chaff and flares will surely enhance its survivability in combat conditions."[299] ADS claims that with "minimal infra-red signature EPI TP 400 turboprops, highly responsive FBW flight controls, four independent control computers, comprehensive defensive aids and damage tolerate controls, the A400M is hard to find, hard to hit, and hard to kill."[300]

C-130J: Export Market Efforts

Lockheed Martin does not need any advice on future export opportunities for the C-130; it has managed an incredibly successful export component of the C130 business model since its first international delivery in 1965. To date, 68 countries have operated C-130s for over 1.2 million flight hours, and 16 countries operate the most recent model, the C-130J.[301] The C-130 enjoys a healthy backlog of orders, and a robust secondary market.

Looking to the future, there are of course vulnerabilities. The C-130, despite its many updates, is an aging platform. As per LM's own admission, the C-130J likely will not be able to transport an increasing portion of military equipment in the future. It may be useful for LM to do some additional analysis to determine what percentage of standard military equipment the C130's cross-box will be unable to accommodate in coming decades. In other words, will this remain an annoyance around the margins for the current C-130 business model, or will it eventually fundamentally disrupt it?

Looking to the future, India and its Asian neighbors, including relative newcomers to the market such as Vietnam, would appear to be candidates for future C-130 exports. India has a history of procuring C-130s, and now has a fleet of eleven, including six purchased in 2014.[302] That said, India remains tough on firms desiring to penetrate its market, for example by demanding challenging levels of offsets, according to industry executives who spoke with members of the Eisenhower School Aircraft Study group. Hartley considers offsets to be "potentially economically inefficient, and some might not represent genuinely new business."[303] LM appears to have arrived at a better solution for penetrating the Indian market by negotiating a joint venture (JV) with Tata Advanced Systems, a form of international collaboration:

> Today, Lockheed Martin's largest program in India is the C-130J Super Hercules, the first major military contract between the U.S. and India in more than 40 years. India has joined the growing list of first time C-130 operators with 72 countries now operating the aircraft. In addition, Lockheed Martin and Tata Advanced Systems have formed a joint venture company in India, Tata Lockheed Martin Aerostructures, for manufacturing airframe components for the C-130J.[304]

The JV with Tata likely will allow LM to grow its relationships inside India, providing a firm foundation to learn about this significant but challenging market. It offers opportunities to access skilled engineering talent, and lower-cost manufacturing labor. Finally, while this JV is starting with airframe components, it has the potential to provide LM a broader manufacturing base for future Asian exports.

Airbus A400M: Export Market Efforts

Developing an export market for the A400M is likely to be critical to ADS and its European partner nation's ability to lower the costs of the airlifter and to the project's ultimate financial viability. As defined by Keith Hartley, aerospace is a decreasing cost industry: "Quantity is a major determinant of unit costs and competitiveness. Long production runs allow fixed R&D costs to be spread over greater volumes. There are also economies of learning leading to productivity improvements with greater cumulative output."[305]

Hence, securing additional export sales is likely an extremely high priority for ADS. Unfortunately for ADS, the A400M's first export country, South Africa, cancelled its purchase in 2010. Malaysia purchased four A400M's, the first delivered in March 2015.[306] Since then, there had been no additional export sales, but on May 11 2016, Indonesia announced it would procure an unspecified number of A400Ms.[307]

ADS has indicated it will aggressively market the A400M in Asia, the Middle East, and Latin America.[308] With China otherwise likely to purchase defense technology from Russia, or rely on its own indigenous production capabilities, one of the largest potential prizes in the future airlift market likely is to be India, assuming that they can be turned away from their traditional defense supplier, Russia, and/or convinced to augment their existing C-130s.

LM and ADS are likely to do significant battle in coming decades for the Indian airlift market, the latter of which has India in its sights as a potential A400M buyer: "India is one of the key customers for this plane," said the head of Airbus Military, Domingo Urena-Raso, at the Berlin Air Show late last year. "Once certified, it is our intention to bring this aircraft as soon as we can to India…We know that they need this plane, especially in the north of the country."[309]

Comparing the A400M's capabilities with those of the C-130, an Airbus executive touted the A400M's benefits for an emerging power such as India:

> For an increasingly powerful country like India, undertaking a diverse range of missions in a variety of challenging operating conditions, there will be many occasions when a tactical airlifter is needed with much greater payload/range than the C-130, and also when a strategic airlifter is required with the ability to operate close to the scene of military action or humanitarian relief. Only the A400M can provide that.[310]

That said, it remains to be seen whether ADS can break into the Indian market. Industry executives told Aircraft Industry Study members that "India remained a very difficult country in which to do business," particularly with respect to its complex and onerous offset policies.

Despite potential challenges in the Indian market, ADS seems to have chosen a prudent middle path for the A400M which may find willing buyers among the many nations which want nationally-owned strategic transport capabilities, but which neither seek to project power globally, nor have the capability to support both strategic and tactical air fleets.

> Airbus has chosen the middle way, fielding an aircraft that is much more capable than the largest Super Hercules, and yet less so than the turbojet-powered C-17. The A400M's

> engines, scimitar propellers and supercritical wing help it deliver near jet speeds with turboprop fuel efficiency. Its cargo hold is sized to carry medium-lift helicopters as well as other outsized cargo. Its inherent air refueling capability is a genuine force multiplier.[311]

In effect, the A400M may allow purchasers to obtain some elements of a strategic airlift and tanker capacity, without having to commit to a dedicated fleet of either. For the many militaries around the world, the vast majority in fact, which lack the financial capacity to support dedicated strategic airlift, tactical airlift, and tanker fleets, the A400M offers a financially viable way to move heavy military assets. The A400M would allow such a military to move large helicopters and armored vehicles up to 3,450 nautical miles (nm) with a 20-ton payload, (or 2,450 nm with a larger 30-ton payload),[312] rather than relying on allies or contracted aircraft. Given the near-universal desire among sovereign nations, when financially feasible, to own indigenous transport capacity, the A400M could represent an attractive model.

During discussions between industry executives and Eisenhower School aircraft seminar members, the executives noted that the A400M's capabilities allowed French military forces operating in remote areas of Mali to shave a couple of days to a week off of transport to forward operating areas. Rather than flying a strategic transport plane to the capital Bamako, then transferring cargo or personnel to a tactical airlifter, or even land-based transport for a five day overland journey, the A400M allowed France to fly its personnel and cargo directly into the forward operating area. France's Mali operations with the A400M are likely to be closely assessed by potential international airlift customers as evidence of the aircraft's operational capabilities under austere conditions.

Another significant consideration for potential A400M export customers is range. The U.S. past reliance on strategic transport fundamentally is an artifact of two factors: our location far from the Eurasian land mass—we need strategic transport to go anywhere other than the Americas—and our superpower commitment to global power projection, a legacy of the Cold War. For European nations whose primary areas of potential military concern lay within the Middle East, North Africa, and Russia, within range of the Airbus aircraft, the A400M's 3,450 nm range likely represents a "good enough" military solution, at a significantly reduced cost compared to a true strategic airlifter. Likewise, for emerging economy nations in Asia, whose primary military concerns are with China or other neighborhood rivals impeding free sea lanes of communication (SLOCs) for trade, the A400M could represent a "good enough" airlift solution without the inaccessible price tag of a strategic airlifter.

During a session between industry executives and members of the Eisenhower School Aircraft seminar, an executive expressed a view that the A400M is too expensive to operate, due to fuel consumption rates almost double those of the C-130. Again, fuel consumption for trans-Atlantic or trans-Pacific flights may be a more relevant concern for the U.S. than for European or Asian nations whose primary military concerns lay in their regional backyards. Depending on a potential customer's operational patterns, potential higher fuel expenses will also need to be weighed against ADS's claims that the A400M has lower total lifecycle costs than the C-130. In short, potential export customers will need to carefully evaluate all aspects of their own needs, as well as the capabilities of the C-130 and A400M, before making a procurement decision.

7. IMPLICATIONS FOR U.S. GOVERNMENT AND DEPARTMENT OF DEFENSE

Emerging Implications from Changes in the European Industrial Base.

Although Europe hosts advanced defense industrial firms, structural problems keep it from attaining a DTIB comparable to that of the United States. Unless the strongest European countries (in terms of economic, industrial and military strength) shed more nationalism in favor of collective security and industrial development, **the high and low ends of the transatlantic military aircraft market will continue to favor the United States indefinitely.** This situation undermines the long-term health of transatlantic collective defense under the NATO construct and U.S. national security and DTIB health. Notwithstanding opportunities for deeper cooperation on RDA between the United States and Europe, **a protracted period without strong *competition* between U.S. and EU firms in critical defense industry sectors like military aircraft will diminish innovation and affordability on both sides of the Atlantic Ocean**.

Europe's lack of a cohesive DTIB results from a combination of complex structural misalignments due to internal and external factors. The EU's strongest military-industrial member states foster a technologically advanced, high-capacity defense industry, even though the patchwork of firms and collaborative projects are not on par with the U.S. DTIB and do not efficiently serve either the internal European defense market or the global export market. However, the reconsolidated European defense industry is gaining momentum, and the structure added by EDA goals, projects and regulations will help Europe build a more cohesive DTIB over time. It is still unclear when a more distinct European DTIB will emerge and whether it will produce defense articles on par with those of the U.S. DTIB. What implications do these conditions have for the transatlantic military aircraft sector?

In a 2001 article, Hervé Dumez and Alain Jeunemaître used cycle metaphors to model the interaction between defense markets in the U.S. and Europe.[313] The cycle models are useful for analyzing the potential future of not only the transatlantic defense industry in general, but also its military aircraft segment. The authors reviewed the "dynamic equilibrium produced by demand (public procurement) and supply (the defense industry) and the interactive framework between supply and demand (the regulatory process)."[314] The possibilities discussed ranged from largely separate defense markets in the U.S. and scattered around Europe, dubbed "monocycles" under the metaphor. Next came the "high-wheel bicycle" model, depicting continued size and driver dominance by the United States. A third possible interaction was the "velocipede," with more equal strength in the United States and Europe, but with the United States government and U.S. firms still drivers of overall market demand, supply and direction. This model involves cross-ocean mergers, collaborations and joint ventures between major prime manufacturers in the United States and Europe, which had already begun by 2001.[315] According to Dumez and Jeunemaître, for the velocipede model to come to fruition, "the European member states have to align themselves with products and technologies which will emerge from a competitive process driven by the U.S. Department of Defense."[316]

The fourth and perhaps least likely outcome for the transatlantic defense market is the "bicycle" model. Here, Dumez and Jeunemaître depict a transatlantic monopsony, with NATO being the single consumer and suppliers from both sides of the Atlantic competing for sales.[317] Because NATO would be a supranational governing body and customer driving a single market, firms and joint ventures on both sides of the ocean would have equal footing when competing for sales. A fifth model would be a "tandem bicycle," with suppliers and buyers on both sides of the Atlantic, but with relatively common requirements and equal competitive footing.[318] This model appears to be the most plausible and efficient of the five described by Dumez and Jeunemaître.

Although written in 2001, the article by Dumez and Jeunemaître remains instructive in 2016. Of course, the transatlantic defense markets still represent a collection of variously sized monocycles plus a high-wheel bicycle (NATO). The most efficient trend the European industry could hope for in the near term is to continue reducing the number of monocycles and to shrink the relative size of the high-wheel. This will be difficult in the face of the heated export competition in which European firms are currently embroiled with each other and the U.S. The European defense industry will have to drastically reduce its fragmented, nationalistic tendencies and the U.S. would need to further relax its export controls and foreign ownership rules for the transatlantic market to resemble a tandem bicycle in the future.

Emerging Implications from the JSF's Entry into Europe.

Maintaining balance between the international partners with respect to work shares and technology transfer emerges as the overarching challenge for the U.S. government and Lockheed Martin with the introduction of the JSF into the European fighter market. Both the United Kingdom (Level 1) and Italy (Level 2) joined the program as partners in order to sustain their domestic fighter aircraft industry while getting access to key technology they did not have the current capability or existing knowledge to produce (i.e. fifth-generation fighter).

As Lockheed Martin prepared for production, partners were offered a chance to compete for work based on Lockheed Martin's best-value resourcing methodology. As partners competed, Lockheed Martin's criteria were challenged by virtually every partner as too limited in focus (i.e. too business centric). Both the United Kingdom and Italy pressed for a more holistic viewpoint which considered social benefits (i.e. jobs) and other political realities. This resulted in Lockheed Martin resorting "to 'strategic best-value sourcing methodologies' to keep [countries] in the program."[319] The end result is something between the traditional work shares of European consortiums, where countries simply get a production value equal to what they are investing (with little to no currency actually crossing borders), and Lockheed Martin's original plan which was purely market focused.

When the dust finally settled on 'strategic best-value sourcing', the United Kingdom did quite well, earning 24.2% of the contract awards with only 6.2% of the development costs. This is in spite of the fact Rolls Royce lost out on a 40% partnership with General Electric when the F136 alternate engine program was canceled; however, Rolls Royce is still involved in the JSF program as it produces the lift fan for the F-35B valued at $1 billion over 10 years. Italy also did well securing the $796 million Final Assembly and Check Out (FACO) facility at Cameri in

northern Italy which will be also be used for maintenance, repair, overhaul, and upgrade of European F-35s throughout their lifetime.[320] With production ramping up and most, if not all, sourcing decisions made, Lockheed Martin needs to maintain awareness on its supply chain and prevent this challenge from reemerging.

The unresolved challenge stemming from international collaboration is the sharing of sensitive technologies. The United Kingdom and Italy joined the program to gain access to technologies they did not have. U.S. export control and technology transfer regulations (International Trafficking in Arms Regulation [ITAR]) have created significant concerns for countries, like the UK and Italy, desiring to work collaboratively with the U.S.[321] Specifically, U.S. regulations restricted foreign firms from gaining "insights, knowledge, and experience" that would benefit their companies.[322] "As Pierre Chao and Robin Niblett put it, if 'the United States and the UK, the two closest of allies, are unable to overcome the continuing obstacles to the efficient sharing of defence-related technologies, what hope is there for broader transatlantic defense industrial and technical cooperation?'"[323] For example, the United Kingdom desires access to software code necessary to integrate domestically produced weapon systems, like the Meteor.[324]

While the U.S. government wants partners' militaries to benefit from fifth-generation fighter technologies, the U.S. government has been slowed to share these technologies with partners' defense industrial bases. Thus, differing viewpoints about access to sensitive technologies, and how the technologies can be used, has been a major sticking point within the program. Given the fact the United Kingdom and Italy are both politically oriented, any change in their calculation about the risks of continued limited technology transfer could significantly impact their willingness to remain a part of the JSF program.[325]

If the U.S. government and Lockheed Martin successfully manages the challenges, existing partners will remain in the program and additional countries will join. Any additional market share captured by the JSF program would lower unit prices even father as the design, development, and other fixed costs are spread across additional units.

The U.S. government realized from the development and production of the F-22 that costs would need to be shared with allies and partners if an affordable fifth-generation fighter was to become a reality.[326] **With international commitments for the JSF at now over 700 aircraft or 30% of the total production, the U.S. is likely to achieve the initial intent of an international program: affordability.[327]** Assuming no major obstacles are encountered in the next one and half years of system testing, Lockheed Martin expects unit flyaway cost to continue to decrease from approximately $110 million today and settle around $85 million by 2018.[328] This compares quite favorably with the current costs of fourth-generation aircraft currently in production: Dassault's Rafale, $80 million; Eurofighter's Typhoon, $87 million; and Boeing's F/A-18E/F, $60 million.[329]

Additionally, if the program produces all 3,190 aircraft planned today and sends 727 aircraft abroad, a new level of interoperability becomes possible with respect to the employment of combat air forces. With major maintenance, repair, and overhaul facilities placed around the

world in the U.S., Italy, Japan, and Australia, a global distribution network emerges providing parts and service anywhere in the world. Assuming parts pooling and other sharing arrangements materialize, the U.S. and other JSF partners can utilize this support network for deployed operations.

Will the United Kingdom and Italy be placated with 'strategic best-value sourcing' and accept the technology transfer limits the U.S. government has imposed? Will the U.S. government ease the technology transfer restrictions over time? Or will the United Kingdom and Italy be forced to pursue an alternate path towards obtaining fifth and sixth-generation fighter aircraft technologies?

Germany will also play a key role; **Germany's future decision with respect to fighter aircraft will provide a bellwether for the European market as they have been involved in every major European fighter consortium until the JSF.** Will Germany eventually decide to buy the F35 or pursue some other path? Will European governments who are purchasing the F35 pursue a high/low mix with a purely European-designed fighter for the low end to complement the F-35?[330] With France and Sweden content to continue their niche products (the Rafale and Gripen, respectively), the British, Italian, and German governments' responses over time to the F-35's entry into the European market will determine what lies ahead for Europe.

The Joint Strike Fighter program has profoundly impacted the European fighter market. The program successfully broke the stranglehold on European governments' preference for European consortiums for fighter aircraft. With over 700 aircraft destined for international partners and no fifth-generation fighter program in development in Europe, the program has successfully captured the high-end, fifth-generation fighter market.

However, the program still faces potential challenges if the U.S. government and Lockheed Martin are not able to carefully balance international partners' desires for technology transfer with the U.S. government's technology control regulations. So far, the balance has been struck by politically-astute, international partners demanding additional work shares above those warranted using a strict, best-value sourcing methodology. **These concessions have preserved the industrial, technical, and occupational capacities in the United Kingdom and Italy allowing them to remain an empowered player into the future.**[331] However, frustrations could return as these countries demand access to the aircraft's software for country-specific changes in the name of national security.

Individually, the United Kingdom and Italy have benefited significantly from the program. The F-35 provides both nations with a desperately desired combat capability—interoperability with U.S. forces in a contested environment. The program also enriches each country's industrial base as both have a significant roles in the current production. The British and Italian governments' strategic calculus concerning these benefits and limitations and the alignment of interests, will determine the future fate of the European fighter aircraft market.

Emerging Implications from Dassault's Rafale. How should the U.S. view this turn of events in the European combat aircraft industry? I would suggest looking at it from governmental, operational and industrial perspectives. Politically, the ties between France and

the U.S. have never been stronger, and are characterized by the fact that we have similar values and a collaborative partnership, but we don't always agree on tactics.[332] That said, France does not view itself as a junior partner in the bilateral relationship, as could be seen at various points during the negotiations that led to the JCPOA with Iran, and the critical comments of outgoing Foreign Minister Lauren Fabius, who was harshly critical of the Obama Administration's policy in Syria. Diplomatically, France punches above its weight in terms of influence, which can be a source of rivalry and occasional irritation for Washington decision-makers, and a great benefit to the Unites States. We also benefit from French audacity, and their willingness to take military risks when needed, as in Mali and Libya.

At the operational level, our intelligence sharing and military to military cooperation, both in the Sahel and in Syria, has probably never been better. The French intervention in Mali began a new chapter in our bilateral military cooperation, which only increased in the aftermath of the terrorist attacks in Paris in February and November 2015. At the tactical level, the Rafale is the only non-U.S. produced fighter aircraft cleared to land on and launch operations from U.S. carriers. More importantly, the Rafale is the product of an ecosystem of innovation that has largely circumvented ITAR-controlled products, giving it a different DNA and behavioral characteristics from U.S.-made or ITAR-heavy products. This can be a substantial benefit in limited operations, as was demonstrated in the opening days of the Libya campaign, but its potential benefits in the event of major conflict with Russia or China should not be underestimated: while it is not a full stealth aircraft, **the Rafale's electronic warfare, radar and weapons packages are substantially different from what our enemies would confront in a "high-low" mix of exclusively U.S.-produced 4th and 5th generation fighters.** Effectively countering the Rafale as part of a NATO response force, or a more limited combined action with the U.S., will consume both planning and tactical resources by potential enemies, which is a direct benefit to us. Finally, the U.S. has dominated the skies for so long that our pilots are at risk of combat complacency—they are more accustomed to casualties caused by accidents than by combat.[333] Unlike American pilots who entered Libyan airspace only after launching 119 Tomahawk missiles to neutralize air defenses, French combat pilots appear more willing to confront tactical combat risk in non-permissive environments precisely because they do not have the SEAD capabilities that the U.S. does, nor do they appear to expect to have it to operate.[334]

In terms of reciprocal procurement, the French government has procured U.S. weapons systems, like the C-130 and MQ-9 mentioned above, and U.S. producers have cooperated with the French in allowing them to modify them with indigenous ISR technology. **One option for increasing transatlantic defense industrial cooperation would be for the U.S. to apply the same standards for procurement from French or European producers when it has a requirement that national platforms do not meet.** With a 37-ton payload capacity, the A400M appears to have been designed to fill the requirements gap for an air mobility capability between the C-130J's 22-ton and the C-17's 77-ton capacity.[335] As it matures as a platform, the A400M's speed, capacity and range give it substantial advantages over the C-130. This is especially true in the Pacific, where Malaysia has already ordered 4 aircraft.[336] An A400M procurement might build goodwill, and following on recent French purchases, establish a principal of reciprocal procurements of major platforms when there is a legitimate need on either side. The concept of reciprocal procurement would move both sides away from the predisposition to feel that money spent on the other's platforms is essentially wasted: If one ally

has already endured the sunk costs of developing a platform that meets the requirements of the other, there is a clear economic benefit in not duplicating the other's effort.

In terms of industry to industry cooperation, to say there is a lack of trust between the U.S. defense industry and their French counterparts would be an understatement. The close cooperation between the French government and its defense industry extends to its intelligence services as well, and as France has shaped its domestic industry so that its major defense companies occupy complementary rather than competing roles, there is no conflict about privileging one domestic entity over another, as would be the case in the U.S. A Government Accountability Office report from 2005 states that after China, France, Israel and Russia appear to be tied for second place in industrial espionage targeting the U.S. defense industry.[337] As one analyst put it, "France lacks a domestic defense market large enough to support cutting edge development so it opts to steal American military technology in order to save R&D costs and enjoy advanced weaponry for its own military and competitive exports abroad."[338] Examples of this activity abound in the public record, from a French employee at the U.S. Embassy in Paris who was fired in the recent past over turning over hotel reservations of American VIP visitors to the French government, to Air France infamously bugging its first and business class sections to pick up indiscreet comments from competing executives.[339] France's industrial espionage has not been limited to its American friends: A German executive, quoted in an alleged U.S. diplomatic cable divulged by Wikileaks famously said, "France is the Empire of Evil in terms of technology theft, and Germany knows it."[340]

Contributing to this lack of trust is the cut-throat competition for foreign sales of fighter aircraft among U.S. primes, France, Sweden and the Eurofighter Group for foreign sales. The Rafale not only competes with "legacy" platforms in the U.S. and Europe, but its price forces it to compete with the F-35 in any market where ITAR rules would permit its sale, and the Rafale has consistently lost. One U.S. industry official expressed a common frustration recently, referring to the current competition in for 4th gen fighters in India, saying that he "questioned the ethics" of some of his non-U.S. competitors who are not forced to live under the strictures of the Foreign Corrupt Practices Act.[341] There is also some frustration on the U.S. side about the competitive advantages their French counterparts receive: The sale of F-18s or F-16s to India are important for the defense industrial base, so they receive facilitating support from the State Department and DOD. As mentioned above, Rafale sales are treated as an existential issue for Dassault and the entire French state: Fighter sales are signed in the Elysee Palace, and French presidents, from De Gaulle to Hollande, **use state visits and every lever of national power—including financing—to influence a favorable outcome for their national champions.** As could be seen in the recent sale of French submarines to Australia over a U.S.-backed bid by the Japanese, the French state and its monopolist defense contractors make for a powerful combination in a competitor.[342]

Despite growing trust at the military operational level based on the successful combined deployments mentioned above, the mistrust in the U.S. defense industry that has been engendered by both competition and espionage activities is also shared by U.S. military procurement officials. One industry official commented recently that when choosing an international air show to debut the F-35, DOD procurement officials made it clear that Paris would be a non-starter.[343] Interestingly what we seem able to tolerate from our Israeli allies—

espionage, independence of action and fierce competition in military exports—we seem to find intolerable in the French.

Does the U.S. have a strategic interest in the French maintaining an independent defense industrial ecosystem? This depends on the kind of ally we wish to have in the future. It clearly has costs at the tactical level: U.S. prime contractors will occasionally lose sales that would help their bottom line and reduce overall program costs to the U.S. taxpayer. In the case of Boeing, which is confronted with exiting the combat aircraft market in the next four years if sufficient commercial F/A-18 orders are not found, the impact could be substantial. While those losses certainly may cause indigestion, what would we stand to gain strategically if France is able to maintain its national defense ecosystem over the next forty years, despite winning occasional sales over U.S. producers?

France's industrial base should be viewed as a U.S. strategic asset, in that it empowers a capable ally who is prepared to engage both independently and jointly with the U.S. to shape world events. Over our long history we have competed vigorously and disagreed over tactics, but we have never fought a war, and our values over time have remained remarkably similar. Put simply, would we prefer an ally that occasionally disagrees with us but is capable of independent action, or one that relaxes under our strategic umbrella and needs constant prodding to act after obtaining permission from its parliament for every tactical airlift?

If we choose the former, what might the U.S. do to help shape the French industrial base in a way that would be most beneficial to us? In the realm of combat aircraft, one option might be to encourage strategic specialization. France has largely ceded the SEAD role to the U.S., which will be filled by F-22s and F-35s in the future. Where it excels is in electronic warfare, ISR, radar and missile technology. It might be possible to build on French modifications to the MQ-9 to enhance other platforms, or to offer the "French model" for sale to other allied customers.

If the Rafale is, as some analysts describe, the "last vertically integrated French fighter,"[344] what will happen to the French industrial base once it finishes its production run? One option might be to suggest a Franco-German partnership to mutually invest in R&D to develop a fifth or sixth generation combat aircraft capability. What this might look like is a Dassault/Airbus Defense and Space joint venture, similar to the Eurofighter. While this would be an obvious arrangement, skepticism on both sides would have to be overcome. When asked about the prospect of a joint project with Dassault, a senior European industry official commented, "They think the French government will protect them. As long as they believe that, cooperation will be difficult."[345]

Even if the way forward may not be clear, a logical first step might be for DOD decision makers to begin to appreciate the French DIB as a strategic asset for the U.S. A second step would be to search for complementary areas of industrial cooperation, and encourage industry on both sides to overcome their reluctance about working together. Finally, we might use political influence with **France and Germany to encourage them to pool R&D resources and begin work on a joint future combat aircraft or UAV program.**

Friederich Nietzche expressed the dilemma well: "If one would have a friend, then one must also be willing to wage war for him: and in order to wage war, one must be capable of being an enemy." Put bluntly, when thinking of the French as military partners and competitors, are we better off helping France to maintain its improbable capabilities and willingness to deploy them, or would we rather have another Germany in NATO?

Emerging Implications from Rotorcraft Sector. The most prosperous future environment for the military helicopter segment lies with the U.S. Army FVL. According to an August 2015 Frost & Sullivan report of the U.S. DOD Helicopter Market, "The only new start on the horizon is the FVL program which aspires to replace the OH-58, AH-64, UH-60, and CH-47 platforms."[346] Competition for any new start long-term defense contract is typically fiercely contested resulting in a single winner and several losers. **Neither Leonardo, nor Bell can afford to lose the FVL business.** However, there is an alternative arrangement that potentially benefits Leonardo, Bell and the U.S. DOD.

Frost & Sullivan predict that, "The entire FVL contract will not be won by a single team/design."[347] There are six reasons why this will be welcome news to all participating parties. First, **the U.S. is already a late-comer to the modern European Aerospace and Defense Industry business model trend towards multi-national collaborative partnerships that build end products with multinational content, that meet the inherent interests of multiple nations** as evident with the F-35 Joint Strike Fighter, Eurofighter Typhoon, LH90, and Airbus A380. Second, if the U.S. DOD awarded the FVL contract to a new partnership arrangement between Leonardo and Bell, similar to the successful Bell/Boeing V-22 work-share arrangement, then both firms prosper. Third, such an arrangement would evenly distribute, or perhaps eliminate, the five forces pressures between the suppliers Leonardo and Bell, as well as for the U.S. DOD their principal buyer, resulting in efficient trade. Fourth, firm consolidation tailored toward FVL also has additional potential efficiencies as both firms realize additional return on the capital investments of their defense industrial base infrastructure and corresponding supply chains. Fifth, an FVL burden-sharing partnership can leverage the extensive MRO service centers both firms established around the globe. Fifth, this potential partnership fosters the transatlantic strategic partnerships such as that of the fragile NATO by increasing warfighting interoperability through future FMS. There are existing precedents for each of these implications already occurring in Europe with demonstrated success.[348] Reinforcing these concepts is an observation published in a recent article by Josselin Droff and Renaud Bellais writing on European military helicopter support, whereby the authors noted that, "The joint maintenance of defense materiel may not perhaps capture the imagination like the joint deployment of military units during operations, but it is in precisely this area that cost savings can be achieved through economies of scale."[349] Each of these six reasons tie back to Porter's five forces model that suggests that Leonardo's and Bell existing robust economies of scale will continue that bar new entrants to the military helicopter segment thereby ensuring their firm's survival.

A new transatlantic partnership of the scale described above would add enormous complexity to an already complicated structure, conduct and performance model. The inherit

implication for the U.S. DOD is to mitigate this risk by viewing this new environment through a systems thinking approach. Author Jamshid Gharajedaghi defined systems thinking as, "the art of simplifying complexity. It is about seeing through chaos, managing interdependency, and understanding choice."[350] The European helicopter segment is but one independent adaptive variable interrelated with many other independent adaptive variables as part of a much larger holistic system that must be considered for firm profitability and U.S. National Security interests.

Emerging Implications from Transport Sector. With the A400M finally moving into full production, a decades-long European effort to mount a unified challenge to U.S. sway in the military aircraft sector is finally bearing fruit. This does not imply that the U.S. will immediately cede share in the airlift sector, but it **no longer enjoys unchallenged dominance**. Looking to opportunities for the C-130, the U.S. should continue to support LM's marketing efforts through robust diplomatic and security cooperation channels, including with India and its Asian neighbors. As China's neighbors become more concerned with its attempts to assert sovereignty in the South China Sea and elsewhere in the region, purchases of the C-130 offer the benefit of solidifying a desirable strategic relationship with the United States.

As the A400M becomes a factor in the market, LM may want to develop diversified marketing strategies as part of its C-130 business model. For example, the C-130 may be marketed in one way to a country with limited funding, which must choose between the C-130 or A400M. It may be marketed in another manner to those countries with the need and funds to make use of both C-130 and A400M in a complementary manner. And it may be marketed in yet another way to those countries with the ability to maintain both C-130's and a strategic airlift fleet.

Looking to opportunities, it is worth asking if the U.S. military would consider procuring the A400M. On the surface, the answer would appear to be a firm "no." The U.S. "Buy America" law[351] and a strong preference to maintain the U.S. defense industrial base would set DOD against acquiring the A400M. That said, there may be prudent reasons to consider acquiring some A400Ms. Some analysts have expressed concern about a possible U.S. airlift gap over the medium term. The U.S. Air Force plans to divest 26 "legacy C-5A aircraft beginning in FY14," as well as divest "47 legacy C-130H aircraft," bringing inventories down to 275 strategic airlifters, and 328 intra-theater airlifters.[352] While analysts generally assess U.S. airlift capacity is sufficient for the immediate future, there appear to be emerging questions over the medium to long term.

Jane's Defence assesses it as likely that the U.S. will acquire A400Ms over the medium term, likely to complement its C-130s. While ADS has been coy about the details, the firm may have had discussions with the U.S. Air Force on just this topic:

> Although the company would not say with which potential customers it might enter into negotiations, Jane's understands that the U.S. has shown interest in the (A400M) platform as a successor/complement to its C-130 fleet. While a sale of foreign military equipment to the U.S. on this scale might seem a tough nut to crack, it is not without precedent…[353]

Jane's Defence generally assesses the financial viability of the A400M project would be vastly improved by possible U.S. sales. Jane's also notes that over the medium-term, the USAF could face the type of medium-heavy airlift gap which would be neatly filled by the A400M:

> If Airbus is to achieve its ambitious goals for the A400M, then it will probably have to find a buyer with a requirement that, if not for hundreds of aircraft, at least stretches into the high double digits. The only customer that could come close to this, at least in the West, is the USAF. Although the USAF's current fixed-wing transport needs are more than adequately met by its fleet of 428 Lockheed Martin C-130 Hercules, 221 Boeing C17 Globemasters III, and 52 Lockheed Martin C-5M Galaxy airlifters, it could face a medium-heavy capability gap as tomorrow's outsized cargo becomes harder to transport by C-130 and as early-model C-17s are retired from service.

As noted, any U.S. acquisition of the A400M is likely to be as a complement to the C130, and perhaps eventually as a partial replacement for some of the older C-17s. (The 2015 closure of C-17 production could also play a role in creating a medium-term airlift gap which the A400M could help address.) Acquiring some A400M's would also allow the U.S. military and defense sector to better understand the A400M's cutting-edge technology and capabilities, and how we might take utilize them, operating on our own or with our European allies. Acquiring A400M's would allow the U.S. military to experience and learn first-hand, about ADS and the collaborative European business model, both from the perspective of an ally, but also as a competitor in the military airlift sector.

Finally, the U.S. should also consider its own renewed interest in supporting the European defense industrial base (DIB). In a world with a resurgent Russia, conflict in the Middle East and North Africa impacting international stability, and a rising China, the U.S. also has a strong interest in our most stable allies maintaining a robust DIB. Much as the U.S. post-WWII supported the Marshall Plan and helped birth NATO to create a European bulwark against the Soviet Union, we may today need to look beyond the immediate profit and loss of our own firms in considering our long-term national interest. We benefit immeasurably when our allies are equipped - financially, commercially, and technologically, and at the national, industry and firm level, to help share the burden of global security.

8. CONCLUSION

Visits to major military aircraft manufacturers in the United States and Europe in the Spring of 2016 have revealed useful insights into the transatlantic military aircraft market. Firms on both sides of the Atlantic Ocean show many similarities. They have access to a world-class pool of engineering talent and a highly trained production workforce due to historical market position as well as national economies and education systems that are stronger relative to much of the world. They also maintain modern facilities and equipment capable of efficient production. Not surprisingly, sagging demand has caused capacity to outstrip demand by more than two-to-one among U.S. and European producers. Military aircraft makers draw from hundreds of skilled and efficient internal and global suppliers, which are increasingly squeezed by prime contractors trying to win price wars in the worldwide competition for defense budgets.

Europe risks falling further behind the United States in military aircraft production due to continued low demand from European buyers. Because of flagging internal demand for defense articles, European military aircraft firms such as Eurofighter (Typhoon II), Dassault (Rafale) and Saab Group (Gripen) have fought fiercely over export sales of fourth-generation fighter aircraft to countries in the MENA and Indo-Asia-Pacific regions. U.S. manufacturers Lockheed Martin (F-16) and Boeing (F-15 and F/A-18) also have invested heavily in this competition. Dumez and Jeunemaître discussed in detail the negative aspects of this fierce competition for defense exports, including how increases in defense exports delay needed defense industry restructuring to better match internal demand and the welfare loss among suppliers in exporting countries as prime contractors cater to customer industrial offset requirements.

Collaborative efforts between and among buyers and suppliers in the transatlantic military aircraft market have had a significant impact over the past decade, and this trend will continue indefinitely, perhaps at the expense of smaller, more nationalistic producers. The most expensive and, therefore, most influential military aircraft program in history is the F-35 Joint Strike Fighter Program (JSF). Awarded to Lockheed Martin as prime contractor in 2001, 80% of JSF development funding was to be paid for by the United States and the other 20% would be divided among the United Kingdom, Italy, the Netherlands, Australia, Canada, Denmark, Norway and Turkey. Israel, Singapore, Japan and South Korea have since joined the program in varying export arrangements. The JSF program currently is slated to produce over 2,400 aircraft by the time production is due to end in 2037. The JSF is the only fifth-generation aircraft available on the international market, and the European defense industry long ago decided not to compete against it. The best chance European military aircraft producers have to profit from the JSF program is through industrial participation, including subassembly supplier agreements with Lockheed Martin or, in the case of Italy, a final assembly production line.

By capturing key European buyers early in the JSF's very costly development, the United States and Lockheed Martin essentially blocked European military aircraft producers from entry into the fifth-generation fighter market. The unit cost, volume and life span of the JSF program extends this effective blackout period well into the next generation of fighter aircraft. If European governments and defense firms were capable of embarking upon a fifth-generation fighter aircraft program in the 1990s, then the JSF program may not have had the extensive

European participation it has today. Meanwhile, European firms completed development on fourth-generation fighter programs, and are now scrapping among themselves and U.S. producers for a shrinking export market. Realizing what the JSF program has done to the European military aircraft sector, some have speculated that Europe, perhaps BAE and Dassault, will skip forward to a sixth-generation unmanned aerial combat vehicle (UCAV) platform. However, this would defy Dassault's nationalistic tendencies and no long-term commitment has emerged.

Collaborative projects within the European military aircraft industry are perhaps the best way to firmly establish a true European DTIB, but they have produced costly and mixed results to date. The Airbus A400M four-engine turboprop cargo aircraft and A330 Multi-Role Tanker Transport (MRTT) are products that fit an unserved slice of their respective markets. The A400M fits in size and capability between the Lockheed Martin C-130 and the Boeing C-17. The MRTT is larger and capable of carrying more fuel, passengers and cargo than the Boeing KC-46 under development, which beat out an MRTT variant for the ongoing U.S. Air Force tanker contract. Despite this loss, the MRTT has proven an export success for Airbus and a version may yet win a follow-on U.S. contract. Like the Eurofighter Typhoon II program, the A400M project has been marred by development delays and cost overruns. Thus, the A400M has been seen by many as a disastrous collaborative project that portends potential failure of the EU's approach to creating a European DTIB. Moreover, its unit cost of approximately $200 million is more than twice the cost of a C-130J. And, unlike the venerable C-130 platform, the A400M has not been in service long enough for buyers to understand its long-term maintenance, repair and overhaul (MRO) costs. To date, Airbus has not made inroads toward getting U.S. military aircraft buyers to consider purchasing the A400M, but such sales may be possible as the U.S. continues to try to shift its long-term military focus to the Indo-Asia-Pacific region.

The Airbus A400M, Eurofighter Typhoon II, Dassault Rafale and Lockheed Martin F-35 Joint Strike Fighter programs are emblematic of a transatlantic military aircraft industry struggling to find a viable way forward. For European producers the post-Cold War budget malaise continues, and it has become clear that their primary customers (European governments) are their biggest obstacle to growth and profitability. This is because governments have repeatedly agreed to launch projects with the promise of significant purchase volume, only to cut those orders in half or more as projects reach the production phase. This has happened also in the United States, although to a lesser extent. Lockheed Martin has been sharply criticized for the costly and delayed JSF. However, that program has absorbed such a large investment from so many countries with no viable fifth-generation alternative for customers that it is likely to continue forward to full rate production. According to Mawdsley, "collaborative procurement has all the complexities of a national procurement decision multiplied by however many states are involved in the project." By contrast, Lockheed Martin's evolutionary, non-collaborative C130J program generates steady profit and shows potential for cross-over commercial sales.

The transatlantic military aircraft sector of the global defense market has served as a bulwark of democracy and free markets for 100 years. The rise of the United States as a global power throughout the twentieth century depended increasingly over time on its robust defense

technology and industrial base, including maintaining the largest, most capable and most advanced military aircraft sector in the world. Along the way, Europe's defense industry and military aircraft sector always have produced innovative and capable products, but often not as quickly or as advanced as that of the United States. Whether or not it is biased by nationalism, a key structural aspect of the U.S. DTIB's supremacy in military aircraft technology, capabilities and production remains its high volume primary buyer and regulator: the U.S. government. With 28 governments, NATO and EU organizations providing diverse requirements, squeezing budgets, demanding "value," canceling orders and taking nationalistic approaches to defense industrial policy, European military aircraft producers continue to underfund research and development while they scramble for orders from MENA and Indo-Asia-Pacific countries just to survive. Before it is too late, EU members and the EDA need to step in—using increased funding and streamlined regulations and incentives—to blunt nationalism in favor of cohesive European technology and industrial base. With the many ongoing security threats around the world, both internal and external, the transatlantic and global order depend on a vibrant European DTIB, working in tandem with that of the United States.

9. APPENDIX A

Figure A1. Jane's IHS Summary of European Defense Budgets[354]

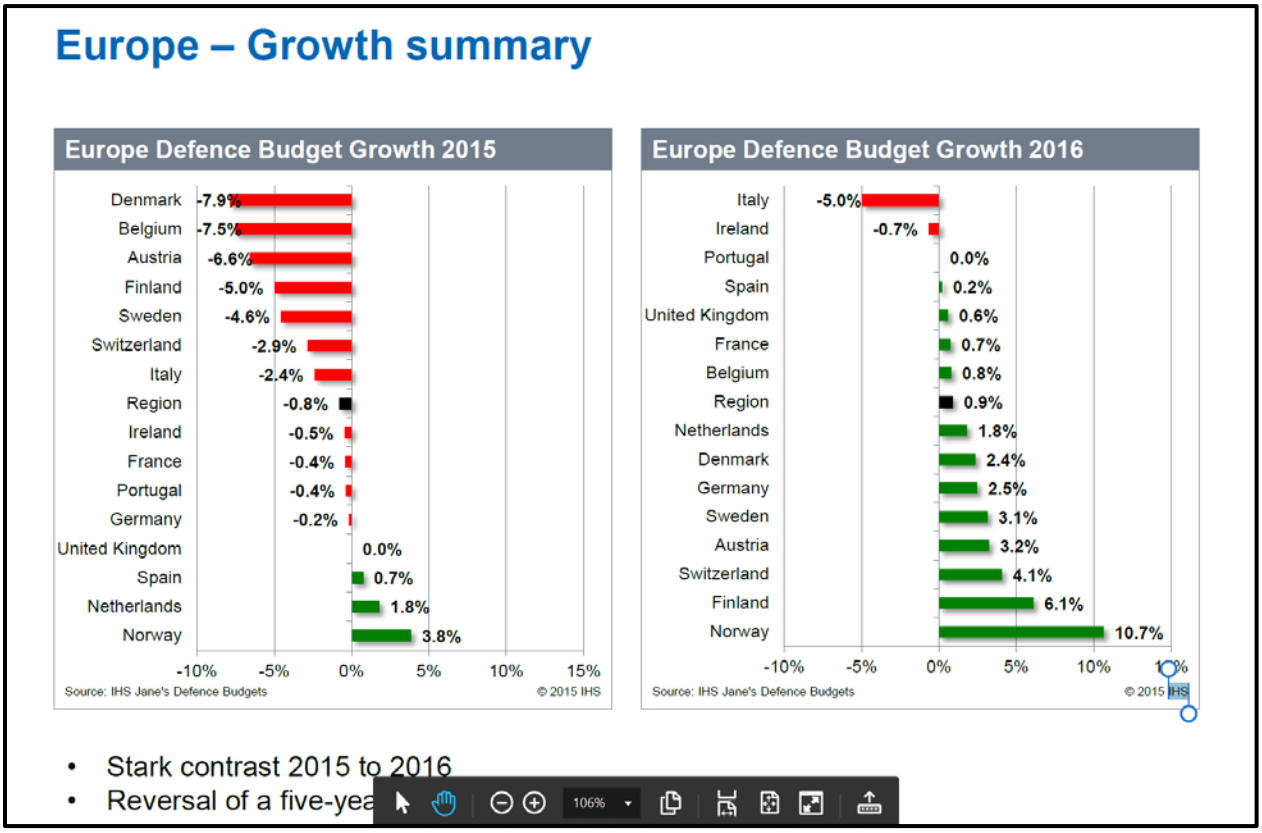
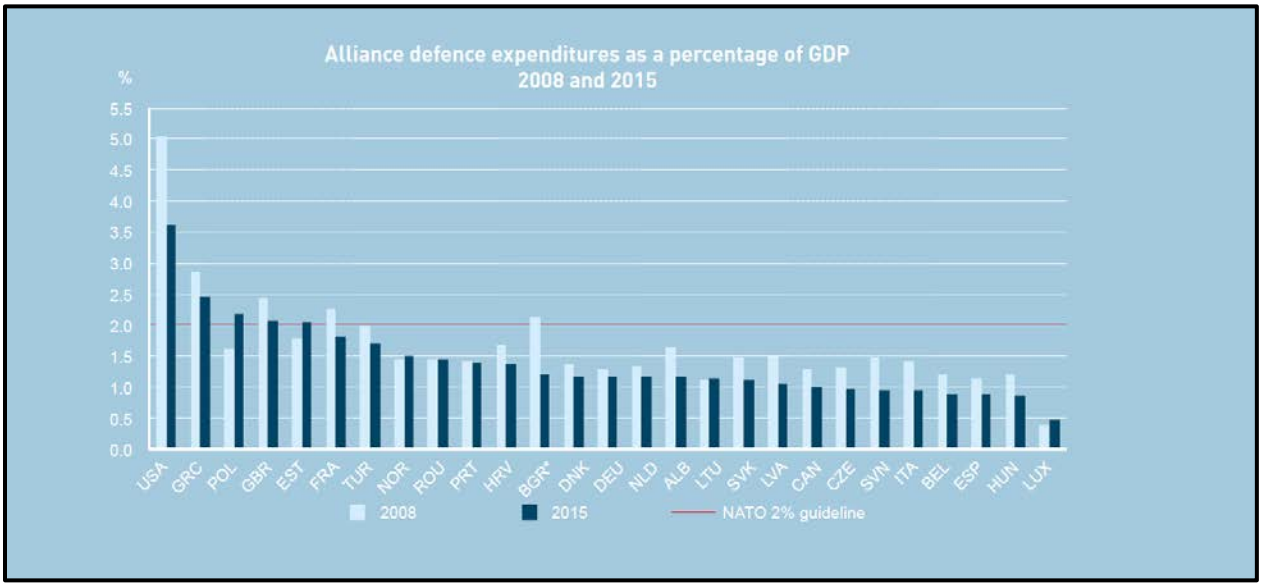


Figure A2. NATO's Secretary General's Report on Defense Expenditures[355]



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[35]
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[55] Porter.
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[58] Analysis of the attributes as applied to the U.S. DTIB discussed in the Background section generally would show strength across all eight, particularly during the Cold War. Arguable exceptions could include the impact of the Vietnam conflict in shifting defense procurement to support a losing strategy (chance, demand conditions and defense policy and international relations) and the post-conflict defense procurement slowdown that occurred in the United States in the late 1970s (demand conditions and government defense policy). These weaknesses were more than compensated by strength in the other attributes, including notably the many technological breakthroughs facilitated by the U.S. space program's successful quest to reach the Moon. After the Cold War ended, demand conditions took a sharp downturn and U.S. related and supporting industries drastically consolidated and shrank. In addition, demand conditions and government defense policy veered into a new direction and scale after the chance development of the attacks of September 11, 2001. The ensuing military operations in Afghanistan, Iraq and now Syria absorbed funding and delayed some defense recapitalization programs. However, these conflicts also have served as proving grounds for unmanned aerial vehicles, Global Positioning System (GPS) precision-guided munitions, advanced targeting processes and systems, broader satellite communications capabilities and network architectures.
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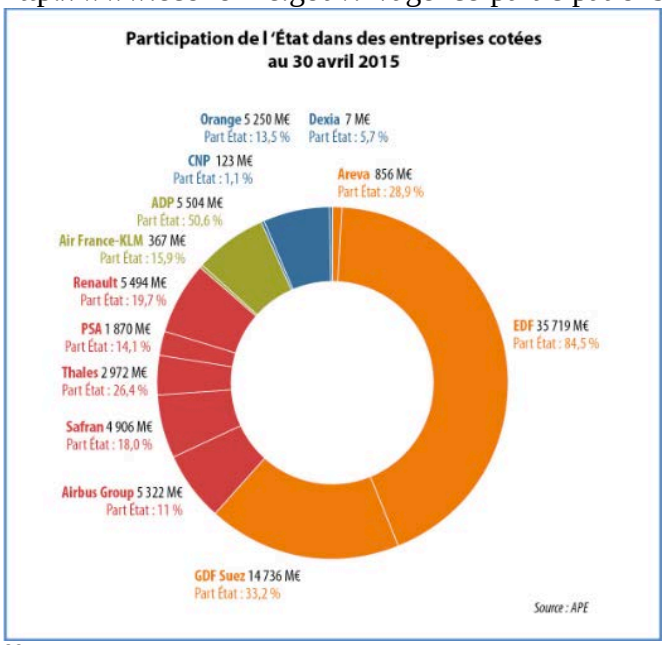

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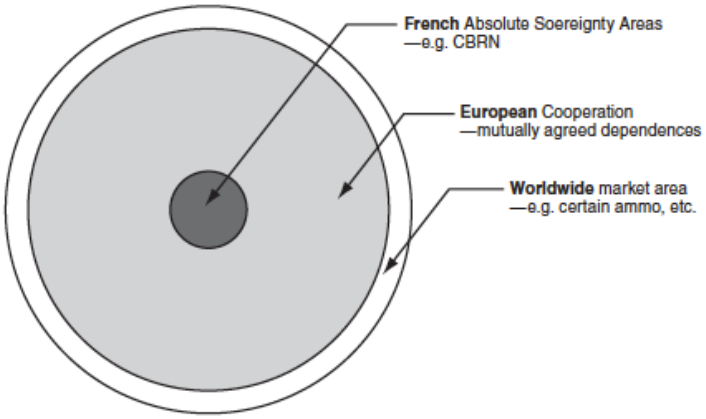
Figure 63 DGA Competitive Autonomy Strategy by Sector



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