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ABSTRACT: Recognized as mature within typical industry lifecycle standards, the aircraft industry is healthy, profitable and postured for continued growth well into the next decade. In a "boom or bust" market where profitability and market share are unquestionably the ultimate objectives, differentiating technology and market advantage is driven by intense market competition with an increasing focus on cooperative teaming among prime manufacturers. Within an ever expanding global market, the commercial aircraft sector provides contributions to national GDP growth, export balance of trade, industrial infrastructure and a uniquely skilled labor workforce. Although it provides the same contributions to the national economy, the defense sector faces a flattening defense budget, complex trade laws that limit export defense sales, and an increasing reliance on global suppliers in what has historically been categorized as a distinctly sovereign production arena. To reconcile the implications of globalization on the economic and national security aspects of the industry's defense sector, government policy action targeted at balancing the tenants of free trade while also protecting critical defense technology are vital to US national security interests.

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Domestic:
Aerospace Industries Association, Arlington, VA
Aurora Flight Sciences Corporation, Manassas, VA
Bell Textron, V-22, Eagle Eye UAV, UH-1, Armed Recon Helicopter, Fort Worth, TX
Boeing Commercial Airplanes Division, B-747/777/787 Production Facilities, Everett, WA
Boeing Commercial Airplanes Division, B-737/P-8 Production Facilities, Renton, WA
Boeing Rotorcraft, Philadelphia, PA
Capital Hill, US House of Representatives Committee on Transportation and Infrastructure, Washington, DC
Capital Hill, Congressional Research Service, Washington, DC
EADS North America, Arlington, VA
General Atomics Aeronautical Systems, Inc, Predator UAV Flight Test Facility, Gray Butte, CA
Lockheed Martin Advanced Development Programs (Skunk Works), Palmdale, CA
Lockheed Martin Aeronautics Company, F-16, F-22, JSF Production Facility, Fort Worth, TX
Lockheed Martin Corporation Fighter Demonstration Center, Crystal City, VA
Northrop Grumman Integrated Systems, Global Hawk UAV, JSF, UCAS and B-2, Palmdale, CA
Pratt & Whitney Aircraft Engines, Middleton, CT
Sikorsky Aircraft Corporation, H-60, SH-92, X-2, Stratford, CT

International:
Aerospace & Defense Industries Association of Europe, Brussels, Belgium
AgustaWestland, EH101 Production and Training Facility, Yeovil, United Kingdom
Airbus Production and Operations Facility, A300/310/320/380, Hamburg, Germany
BAE Systems, Eurofighter, JSF, Samlesbury, United Kingdom
BAE Systems plc Corporate Headquarters, London, United Kingdom
Directorate General for Enterprise and Industry, Brussels, Belgium
EADS Corporate Headquarters, Paris France
EADS, Headquarters, Berlin, Germany
European Defense Agency, Brussels, Belgium
Groupement des Industries Francaises Aeronautiques et Spatiales (GIFAS), Paris, France
Rolls Royce Defense Aerospace, Bristol, United Kingdom

INTRODUCTION

Despite the shockwaves suffered by the global economy since the worldwide financial crisis of 2008, the aircraft industry—a subset of the larger aerospace and defense industry—enjoyed record growth in 2009 for the sixth consecutive year in a row, posting a profit of $214 billion, a four percent increase over 2008.[1] Given its proven track record as a stable growth market, the aircraft industry's economic, as well as military, contribution to US national security is clear. The industry provides enormous value to consumers by facilitating global business and fostering economic growth in today's interconnected world and provides over half a million jobs in the US. The industry also makes a significant contribution to the nation's GDP. This contribution is no small matter considering the American prime contractors' importance to the US defense industrial base, the domestic economy and the Nation's position of strength across the international spectrum.

The aircraft industry is marked by two important features: its broad and deep influence on the national economy and its contribution to national security. Given the effects of globalization and the reality of uncertain future defense spending, reconciling the industry's overriding goal of providing return on investment and the government's goal of ensuring national security poses a significant challenge. The military is in the midst of shifting its priorities from a Cold War construct with large complicated systems designed for state on state warfare to one more focused on today's non-state threats. Consequently, industry is struggling to adapt to these evolving priorities. We are at a critical juncture—the commercial aircraft industry is healthy, with record revenue and order backlogs generated by robust competition, however the defense segment faces risks from flattening defense budgets and rising costs due to complex new technologies and smaller procurement numbers. To maintain the strategic capability to produce defense aircraft necessary for national security, the US government (USG) should provide clear guidance to the industry as to future needs and support innovation in these areas with specific fiscal policies, including tax incentives and targeted investment in research and development (R&D). At the same time, industry must proactively contribute to the pursuit of innovative technologies. Both must recognize the globalization of the industry and look to engage globally, avoiding strictly protectionist postures and encouraging collaboration and technology sharing consistent with national security requirements.

As new systems evolve and become increasingly complex, they become more expensive, are produced in lower numbers, and are operated for extended time periods. The aircraft industry is adjusting to the new reality while maintaining the specialist skills required to design and produce state-of-the-art technology. At the same time, large, diversified firms have many options in deciding which markets to enter to meet their goal of providing the best return on investment. Without a strong partnership between the Department of Defense (DoD) and industry where industry has clear guidance—as well as the opportunity for growth and profit—the industry will necessarily make independent decisions about where to invest. Absent DoD participation, the aircraft industry may walk away from traditional defense programs, resulting in the loss of an indigenous capability to design, produce, and sustain the defense aircraft necessary for our national security.

Since World War II, the USG has assumed private industry could and would support the nation's defense requirements. The lack of a national policy for the defense industrial base meant the USG's policy has been to allow market forces to sustain and shape the industrial base.

Today we are seeing the results of this “non-policy.” As the defense budget shrinks and the government buys fewer aircraft at longer intervals, the clear outcome is

that the market forces created by the government are not large enough to sustain or shape the market. If we continue on the same glidepath, there is real danger the domestic aircraft industry could move away from the defense market, and lose the capability to design and produce combat aircraft, undermining our national security. A comprehensive national industrial strategy would go a long way toward addressing this threat.

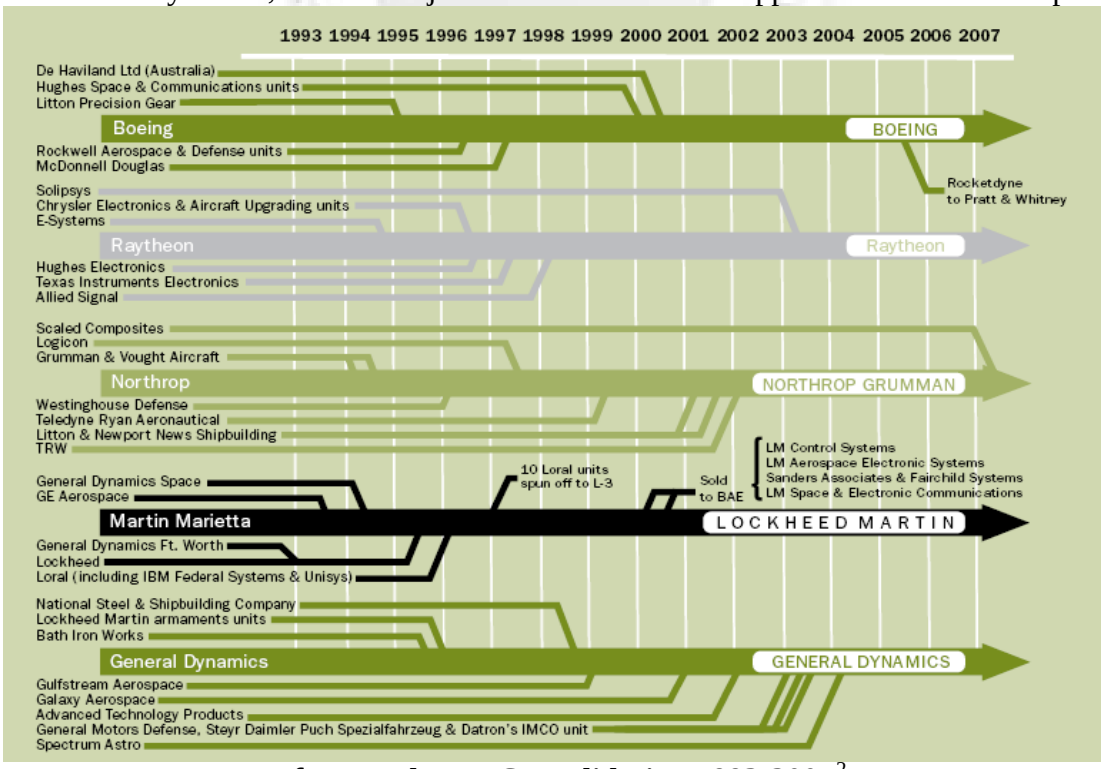
This paper reviews the structure of the aircraft industry, highlights its associated challenges, provides an industry outlook, and policy recommendations to align US national security concerns with the industry writ large. While greatly influenced by the global nature of the industry, the scope of this paper is intentionally limited to focus on the domestic component of the industry. Additionally, this paper addresses related interests in the areas of unmanned aerial systems, the industry's ability to surge production and a review of the F-35 Joint Strike Fighter program, the largest procurement program in DoD history.

INDUSTRY DEFINED

The aircraft industry is a subset of the broader aerospace and defense industry. The aircraft industry is divided into two main segments, commercial and defense, with some overlap, especially for transport aircraft. The commercial and defense sides of the market are very different, and must be analyzed independently. Only one company, Boeing, has significant presence in both markets. The commercial and defense markets are further divided into rotary wing and fixed wing segments. Finally, each of these markets is differentiated by aircraft type, such as tactical, light, medium, and heavy transport with any number of even smaller segments, which are further defined by aircraft mission.

Industry Structure

In the early 1990s, over 50 major defense contractors supplied aviation-related products



Defense Industry Consolidation 1993-2007[2]

to DoD. Today, the US defense aircraft industry comprises five large prime contractors. This striking consolidation is attributed to the 1993 "Last Supper," when then-Under Secretary of Defense Perry informed his guests that the end of the Cold War would translate to dramatically reduced spending on defense.[3] Over the next decade, the defense giants quickly consolidated to retain a share of increasingly scarce DoD dollars. Currently, Boeing, Raytheon, Northrop Grumman, Lockheed Martin, and General Dynamics remain.[4] Of these, only Boeing and Lockheed Martin actually manufacture manned aircraft, but they rely on hundreds of second and third tier suppliers for parts and components. In 1998, alarmed that consolidation had gone too far—and would inhibit competition—DoD intervened to prevent a planned merger of Northrop Grumman and Lockheed Martin, two of the four largest defense contractors.[5]

With the USG as the sole buyer, the domestic defense aircraft market is categorized as a monopsony. A monopsony is similar to a monopoly in reverse—because there is only one buyer, competition is limited, and the buyer can demand a lower price than would be available under conditions of perfect competition. The market also has characteristics of an oligopoly, since there are only two domestic aircraft manufacturers, which further reduces efficiency and distorts the market by limiting the benefits of competition.

The commercial market for large aircraft, on the other hand, is a duopoly—meaning there are only two firms, Boeing Commercial and the European Airbus, a subsidiary of European Aeronautic Defence and Space Company (EADS). In this market, fierce competition drives prices down. As in the defense market, the two competitors share and depend on both domestic and international suppliers.[6]

Industry Conduct

As the only major aircraft manufacturer in both the commercial and defense markets, a significant component of Boeing's strategy is to split its efforts evenly between the two sectors. Boeing's 2009 year-end statement reported revenue of $34.1 billion from its commercial aircraft division and $33.7 billion from its defense division, a 51% to 49% split.[7] Of note, 90% of Boeing's commercial sales (by revenue) were to international customers, making a large positive contribution to the Nation's trade balance.[8] Aircraft manufacturing is notoriously cyclical, with defense procurements frequently peaking out of cycle with commercial procurements. With significant presence in both markets, and cushioned by a large order backlog of several years, Boeing is well positioned to weather procurement declines in one sector or the other.

The purely defense contractors in the aircraft industry, on the other hand, do not have this luxury, and exceedingly high barriers to entry prevent them from establishing a presence in the commercial aircraft market. The strategy for the large prime defense contractors such as Lockheed Martin and Northrop Grumman centers on diversifying and partnering with other defense contractors to spread risk. Northrop Grumman, for instance, has been very successful as an integrator, with expertise in developing and producing manned and unmanned aircraft, spacecraft, weapons, information systems and submarines. In 2008, Northrop Grumman generated over 90% of its revenue from its sole customer, the USG.[9] Similarly, Lockheed Martin sold approximately 84% of its products to the USG.[10] These primes' reliance on contracts with the USG drives their strategy to focus on a single customers' requirements. In addition to partnering with domestic firms on defense hardware and software, some primes are following defense dollars away from traditional products to emerging defense-related services outlined in the 2010 Quadrennial Defense Review (QDR).

The 2010 QDR commits DoD to provide "ministerial-level training," as a way to build the capacity of partner states. This training role is a new mission for the military, and several major defense firms have already secured contracts to provide these kinds of services. Lockheed Martin is responsible for training prosecutors in Liberia's Justice Ministry, and Northrop Grumman contractors trained Senegalese peacekeeping troops.[11] If defense procurement budgets flatten as expected in the coming years, this kind of diversification will help offset a loss of revenue for defense firms, however policy-makers should be more concerned with the health of the *aircraft industry* than the health of *individual defense firms*.

Industry Performance

A brief analysis of the aircraft industry follows, using Porter's Five Forces Model, considering the threat of new entrants, the threat of substitution, the power of suppliers, the power of buyers and rivalry among existing competitors.

Porter's Five Forces Model for Industry Analysis[12]

The threat of new entrants to the aircraft manufacturing industry is low, due to high barriers to entry. Because aircraft are enormously complex—integrating multiple subsystems, weapons, datalink systems and communications architectures—they are extremely expensive, and few firms today have the resources to build them. Government limitations on technology transfer also serve as a barrier to entry for new firms, while simultaneously constraining the export of defense aircraft and their subsystems. Finally, within the defense sector, producing combat aircraft for national security limits the customer base to sovereign nations. Despite nearly insurmountable barriers to entry, positive economic growth and long-range forecasts in both China and India indicate the likelihood that each country will pursue sovereign defense and commercial aircraft within the next two decades.

The threat of substitution in the aircraft industry is low. There are no real substitutes for defense systems manufacturing, and although commercial customers could opt for alternative

modes of transportation in some circumstances, air transport will remain the primary means of moving people over long distances. Airbus analysts predict a requirement for 25,000 new commercial passenger and freighter aircraft over the next 20 years,[13] while Boeing's estimate over the same period is slightly larger, at 29,000 new aircraft.[14]

The power of suppliers for the aircraft industry is moderate overall. Aircraft manufacturers rely on high quality components in relatively low quantities for their final products. Suppliers often serve a range of industries, which reduces their dependence on the aircraft industry. With the financial downturn, some suppliers are facing difficulty financing their operations. Although the DoD office responsible for overseeing industrial policy has not seen critical failures of suppliers to date, they note the health of the supplier base is heavily dependent on the length of the current economic downturn and the depth of future cuts to defense procurement.[15]

The power of buyers in the aircraft industry is also rated moderate. In the commercial sector, Boeing and Airbus hold nearly the entire market, limiting buyer's choices. Consolidation in the defense sector also limits buyer options, however this is partially offset by the fact that governments are the only buyers for defense aircraft. In addition to producing aircraft, suppliers also maintain and sustain them through aftermarket support, which increases switching costs, further decreasing buyer power.[16]

Analysis of these forces converges upon the final force in Porter's framework, the degree of rivalry among incumbents. In the aircraft industry, rivalry is strong, with firms competing intensely for a limited number of high value contracts. The large aircraft manufacturers are diversified within the defense industry, and some of them have expanded into other traditional and non-traditional markets involving defense services—including training foreign governments. Because the intervals between defense aircraft procurement programs are widening, competition for the few remaining contracts is fierce. In addition, airlines—the biggest customers for commercial aircraft—are losing money, forcing commercial aircraft manufacturers to compete by producing new aircraft and upgrading existing models, to make them more efficient and cheaper to procure and maintain.[17]

Benefit to the Nation

In a report to Congress on the aerospace industry, the Congressional Research Service observed, "aircraft and automobile manufacturing are considered by many to be the technological backbones of the US manufacturing base."[18] The aircraft industry also provides tremendous value to consumers who are increasingly reliant on air travel for personal and business travel. The recent interruption of flights between Europe and North America due to the Icelandic volcano underscores the profound effect air travel has on the economy. Airlines alone reported losses of $200 billion per day, which does not account for opportunity and real costs to consumers from missed travel and late merchandise.[19] The aircraft industry is also critical to the US trade balance, as well as the American workforce. In 2008, US aircraft manufacturers exported over $95 billion and imported over $37 billion in aerospace products, contributing $57 billion to the positive side of the US trade balance.[20] Considering the overall US trade deficit of $816 billion,[21] aircraft manufacturing alone was responsible for 1.4% of the nation's GDP in 2008.[22] In addition, the industry employed over 500,000 highly skilled, highly paid workers in 2008, with an average wage of $79,700; nearly double the average US manufacturing wage.[23] In spite of the global economic downturn, which began in mid-2008, the US aerospace industry saw record profits ($214 billion) in 2009 for the sixth year in a row, a 4% increase in

revenue over the previous year.[24] By all indications, the industry is profitable ovrall; however, uncertainty regarding future US defense budgets, combined with new priorities focused on irregular warfare capabilities may cloud an otherwise sunny forecast.

INDUSTRY OUTLOOK

Defense Industrial Base

Despite a positive 10-year economic outlook for the commercial aircraft market, trends within the defense sector are more troublesome. Influenced by a competitive global market, industry consolidation during the past 20-years has negatively influenced the relative strength of the US defense industrial base. While consolidation afforded reduced costs and increased efficiency within industry, it also limited competition and inhibited innovation, with long-term national security implications. Complex technical demands and performance expectations have redefined the role of prime manufacturers increasingly toward the role of systems integrators, delegating traditional development, design and production roles to second and third tier suppliers. Given this transition and the effects of industry consolidation, the defense industrial base faces long-term uncertainty. Exacerbating this uncertainty is the dynamic nature of perceived USG international threats which drive both US defense strategies and the defense hardware markets supporting the strategies. By consolidating and eliminating excess capacity, the Nation assumes a degree of risk within the industrial base. Several factors magnify this risk:

- the lack of new aircraft acquisitions over the next decade
- further reduction of infrastructure and surge capacity
- uncertain DoD commitment to R&D processes which support globally competitive innovation
- inability to sustain a generation of skilled technical workforce members

Cumulatively, these factors risk the loss of an institutional skill design and development knowledge base[25] that will be difficult, if not impossible, to recover. The USG must decide how much risk it is willing to assume and what cost it is willing to bear to mitigate that risk.

Large Commercial Aircraft (LCA)

Based on the correlation between increasing global travel demands and new aircraft production, the LCA market outlook is optimistic over the next decade. Projecting comparable 10-year forecasts, both Airbus[26] and Boeing project demand for as many as 29,000 new passenger aircraft, valued at $3.2 trillion through 2028.[27] Forecasts also indicate an additional 850 new cargo aircraft and 3,130 converted passenger liners will be required based on service life projections suggesting that 72% of today's cargo fleet will be retired during this same period.[28] Although Airbus has led the LCA market duopoly since 2004, Boeing is forecast to reclaim market leadership with a projected 55% market share during the next decade, hinging on the successful introduction of its B-787 Dreamliner.[29]

Regional, Business and General Aviation Aircraft

Dominated by foreign competitors Embraer and Bombardier, the regional jet sector was greatly impacted by the recession; best illustrated by Bombardier's decline from 72% market share in 2003 to 31% in 2009.[30] Recognizing difficulties competing with government subsidized foreign competitors, US manufacturers have vacated the market in search of greater profitability, leaving only second and third tier US suppliers in this sub-market. Projecting meager production within the market, an overall annual growth of 1.7% is forecast through 2025. Despite its small

size, this market represents a significant part of the overall industry, providing components (engines, landing gear, avionics) for deliveries valued at $115 billion over the next decade.[31]

Hardest hit by the global recession, the general aviation and business jet sectors also face very limited growth opportunity in the coming decade, in which six major manufacturers compete for a profitable, albeit limited, market share. Despite recent declining performance punctuated by a 30% overall decrease in utilization during 2009,[32] sales and production are forecast to grow in 2012 with a modest 1% annual expansion through 2025.[33] Projecting demand for 9,300 aircraft valued at $153.9 billion through this period, industry analysts forecast US-based Cessna and Gulfstream, along with Canadian Bombardier, to earn 68% of overall market profits.[34] Although reflecting only a small portion of this sector, the more affordable turboprop general aviation aircraft market is expected to outpace the more exclusive business jet market with an annual sales growth expected to exceed 3%.[35]

Rotary Aircraft

In a market where modernization has virtually stood still since 1970, the defense and commercial rotary wing segments commonly offset one another during cyclical downturns.[36] Forecasting limited success within the combined market during the next decade, strong performance measured in relative market share from Boeing (24.5%), Sikorsky (21.6%), and Eurocopter (21.6%), followed distantly by Bell and Agusta Westland (14% each) will satisfy forecasted demand for 6,200 military and over 9,000 commercial helicopters valued at $174.4 billion by 2018.[37] Although European manufacturers are forecast to lead the commercial sector of the rotary market, US manufacturers will continue to lead the defense sector. Adding a new dimension to the market, Boeing's V-22 tilt rotor technology is forecast to earn nearly 13.5% of defense market share within the combined market through 2019. Despite strong international competition, Boeing's AH-64 Apache (171 new units valued at $5.3 billon) will continue to lead the rotary attack sector; Sikorsky's UH-60 is forecast to dominate light/medium lift market (938 new units valued at $15.9 billion); Boeing's CH-47 (248 new units valued at $10.1 billion) will continue to stand alone as the large rotary transport market; and within the rotary maritime market, Sikorsky will sustain production superiority with its MH-60R/S line (409 new units valued at $8.3 billion) through 2019.[38] While competition is healthy and marginally profitable for US vendors, lack of design modernization within the market since the 1970s is a significant concern. To remain competitive, US manufacturers must design and produce a *next* generation rotary capability, rather than simply modernizing older airframes. Given the mature stage of the rotary market within the industry lifecycle, next generation developments must effectively target improvements in aircraft speed, lift payload and/or increased on-station duration.

Tactical Aircraft

The tactical, or combat, aircraft sector is characterized by industry analyst Richard Aboulafia as "a strong market, driven by aging fleets, high utilization…in which demand for fighters [supports] modest growth."[39] He projects requirements for 3,500 fighter aircraft worth $174 billion over the next decade with the introduction of the world's initial fifth generation fighters, the F-22 and F-35. The F-35 Joint Strike Fighter (JSF) is forecast to dominate rapidly the fighter market, capturing over 50% market share after 2016 if Lockheed can overcome current delays and cost overruns.[40] Although international fighter production presents a competitive threat to US manufacturers with less sophisticated, but more affordable fighters for export,[41] the US will continue to dominate the tactical market through 2019, capturing an estimated 53% market share while European manufacturers combine for 35%.

Despite projections of domestic fighter market growth, however, the American Institute of Aeronautics and Astronautics voiced concerns over a "US tactical aircraft crisis."[42] Not unlike other industry submarkets, US fighter primes have declined from six to two manufacturers in the last two decades in which only Boeing and Lockheed remain, amid speculation of further reduction to an end state where only one US prime remains.[43] Although potential international sales of either Boeing fighter (F-15 or F/A-18) may extend production lines to 2020,[44] the loss of future sales will likely signal the end of Boeing's legacy as a fighter manufacturer, negatively impacting an already fragile US defense industrial base and the capability to develop a tactical aircraft.

Defense Transport and Special Mission Aircraft

Within the transport market, Lockheed (C-130), Boeing (C-17) and Airbus (A-400M) are predicted to dominate market share for the next decade, despite extremely limited demand forecasts.[45] Lockheed's C-130J will garner nearly one third of intra-theater lift sales through 2019, despite Embraer's KC-390 defense entry in 2013. Notably absent from DoD's long-term aircraft acquisition forecast through FY20 are plans for the next generation of strategic lift aircraft.[46] Despite termination of Boeing's C-17 production line and uncertainty regarding Lockheed's C-5 recapitalization plans, the C-17 will dominate the strategic lift market, earning 47% market share until 2015 when production lines close.[47] At that time, the Airbus A-400M, projected to enter service in 2013, will challenge the C-17 as the world's dominant strategic lift capability—although it arguably falls short in strategic reach—with a projected 46.5% average market share of those remaining defense transport aircraft in production during the last three years of this decade.

Within the special mission aircraft market, opportunity in the coming decade is sparse. Boeing's P-8 Poseidon, replacing the aging P-3 Orion, will account for 117 Navy aircraft through 2020,[48] while DoD's follow-on KC-X tanker represents production of at least 179 aircraft through 2027.[49] As potential foreshadowing of capability integration within this sector, the P-8 will operate under a "family of systems" concept, leveraging the Broad Area Maritime System, an RQ-4 Global Hawk derivative, for additional long-dwell surveillance capacity. Since Air Force RC-135, E-3 and E-8 reconnaissance aircraft are forecast to remain in service past 2040, DoD has not committed to specific replacement platforms. Within the specialty Intelligence, Surveillance and Reconnaissance market, possibilities exist for unmanned replacements for one, if not all, of these aircraft.[50] Further evaluation on the unmanned aerial vehicle market is provided later in this paper.

CHALLENGES FACING THE AIRCRAFT INDUSTRY

A review of the most prominent issues facing the aircraft industry over the past several years reveals recurring challenges. First, concerns over the sustainment and replenishment of an aging and highly technical workforce have been a consistent theme during the past decade and remain high on the list of industry issues. Secondly, as a result of the effects of globalization, firms must manage international customers, suppliers and partners. Finally, potential decreases in defense spending and a changing acquisition strategy provide peculiar challenges to those firms that support the defense aircraft sector.

Workforce Issues

Workforce issues remain among one of the most highlighted challenges of the entire aircraft industry. Despite repeated concerns by firms and industry associations and as a recurring topic in numerous aircraft industry historical reports, the significance and magnitude of this issue for the industry remains unchanged. There are essentially three components to this issue: the increasing age of the workforce, an inadequate replenishment program, and the loss of critical program experience over time. However, only these last two components may truly constitute a valid concern. While the average age of the aerospace workforce has continued to increase, the dire projections of the percentage of the workforce anticipated to retire has failed to materialize to the degree expected. What is more important to address is the fact that US institutions graduate approximately 70,000 engineers each year of which only 44,000 are eligible for aerospace careers.[51] This inadequate level of new technical talent in the aerospace industry is a result of two conditions. First, there are an insufficient number of students pursuing degrees in science, technology, engineering and math (STEM) fields of study – an estimated 1.7% of US students will graduate with an engineering degree.[52] Secondly, especially applicable to the defense sector, nearly half of all graduates with degrees in STEM fields are foreign nationals and therefore not eligible for approximately two thirds of all aerospace and defense positions, which require US citizenship and security clearances.[53]

Equally concerning, the retention of critical skills and lessons learned due to the large gaps in time between new aircraft developmental programs poses another major workforce challenge. For example, in the tactical fighter industry there was nearly a 30-year gap between the development phases of the F-16 and the F-22. The impacts in the defense rotorcraft industry are even more notable, with only one new successful aircraft development program in the past 36 years and no new developmental programs currently planned. The lack of continuity and stability in new DoD aircraft programs has already led to a decline in critical engineering capabilities in advanced defense aircraft design and development.[54] Government can mitigate these shortfalls through policy that incentivizes and retains a skilled workforce.

Globalization

Recognizing the global and complex nature of the aircraft industry and leveraging US dominance in technology and production help to secure national interests. Failure to exploit the opportunities in an international market and address the threat from current and emerging international competitors could be costly and potentially harmful to US national interests. Building a new aircraft is a complicated and capital-intensive project requiring a global technological base, a global supply chain and risk-sharing with global partners. Globalization connects the aircraft industry to foreign markets and provides opportunities to lower production costs through outsourcing parts and labor.[55]

Firms must drive the industry with an agile and global perspective. Prime contractors readily partner with firms on some projects and simultaneously compete with their “partners” on others. Firms are already open to this on a global scale and should expect this practice to expand. One side effect of these international partnerships is the requirement for offsets in order to increase a company’s chance of securing large contracts. Offsets may involve transferring jobs or technology and/or a requirement to build portions of the aircraft in country.[56] While this has been typically more evident on the commercial side of the industry, there is a growing trend toward greater global partnerships within the defense sector as well.

The JSF program illustrates an example of the US defense industry reaching out to international partners to share risk in financing and program development.[57] However, these

partnerships increase the likelihood of technology and intellectual property transfer, raising the need for USG vigilance through export controls to prevent the loss of sensitive American technology.[58]

Globalization trends increase firms' reliance on global suppliers as they attempt to spread risk. During industry field studies, some firms disclosed that nearly 75% of the parts for their engines come from international suppliers. Because of this increased reliance, firms must closely monitor and carefully manage their global supply chains to ensure critical parts are on hand when needed. For example, the extensive delays with the Boeing 787 Dreamliner program have been attributed in large part due to problems managing the global supply chain.[59] Additionally, the viability of international suppliers must be monitored as they encounter capital shortfalls, increased demand for their products from other markets, or other challenges due to regulatory or trade restrictions, which could have significant impact on the performance of the supply base.[60]

Unique Challenges

A review of the 2010 QDR provides additional insight into the challenges that lay ahead for the aircraft industry, particularly those that support the defense sector. While the defense aircraft industry has enjoyed consistent and significant growth since 9/11, concerns over the federal deficit and rising national debt, coupled with rising non-discretionary spending, guarantee downward pressure on future discretionary spending, particularly defense spending. More importantly, due to rising defense personnel and O&M costs and significant requirements to recapitalize an aging wartime aircraft fleet, reductions in defense spending are most likely to affect procurement and R&D spending.[61] Recent program decisions in support of the 2010 and 2011 defense budgets reflect this changing environment, evidenced by the termination of the F-22 and C-17 programs and the cancellation of the VH-71 presidential helicopter and the Air Force Combat Search and Rescue X helicopter development programs. These terminations follow a continuing trend in aircraft programs of record marked by "decreasing numbers of systems, often with shorter production runs than anticipated."[62] This program instability, combined with projected reductions in defense RDT&E spending and the previously mentioned workforce issues could lead to further erosion of critical design team experience, greatly reducing defense-related innovation.

Finally, if current program instability and future defense spending levels were not enough to cause concern, aircraft manufacturers supporting the defense industry must also be apprehensive about proposed changes in DoD acquisition strategy. Comments from Secretary Gates in 2009 and subsequently, DoD and the Obama Administration, have called for significantly reforming the DoD acquisition enterprise.[63] At the forefront is the desire to move away from cost-plus contracts to fixed-price contracts, even for developmental programs.[64] Fixed-price contracts place most, if not all, the risk on the contractor, which is acceptable for mature programs, but even "commercial off-the-shelf" products adapted for military use generally incorporate significant changes requiring substantial development, as was the case with the presidential helicopter program. When Northrop Grumman CEO Wes Bush announced his firm would not re-bid on the new Air Force tanker, he cited a "fiduciary responsibility to our shareholders."[65] Loren Thompson, a respected aviation expert observed, "If you push a contractor too far, they don't have any incentive to bid because they don't expect to make any money. The lesson is, if you push contractors too far they'll lose interest."[66] There is also some indication of a preference to discourage sole-source contracts. All of these initiatives, while

intended to improve cost, schedule and performance objectives on DoD programs, individually and collectively place increased risk upon the contractor, especially in new product development, which is the lifeblood of industry innovation.

GOVERNMENT POLICY

If not based on clear, long-term analysis, government policy can ultimately harm American competitiveness and security interests. Similarly, the absence of policy can be just as harmful. According to the Aerospace Industries Association, "a significant gap has developed between DoD's view of industry as an always-ready supplier of defense capabilities and how industry actually makes decisions on what capabilities to offer. And the gap is widening."[67] The lack of an industrial strategy to guide industry causes both industry and government frustration and weakens the US's ability to lead in the aircraft industry.

The CBO reports that of the 9.4% total discretionary spending—in terms of GDP—DoD claimed 4.7%.[68] Since the attacks of September 11th, defense budgets have increased, both as a percentage of GDP as well as in actual dollars. However, the surge in defense spending since 2001 is ending. The forecasted real growth of the base defense budget is 1.0%, coupled with static contingency funding programmed to remain at $50 billion per year through FY 2015.[69] The CBO's 2019 outlook predicts defense spending at 3.4% of GDP.[70] The relative decline of defense budgets, despite DoD projected real growth of 1%, and an expected increase in inflation will force policy makers to make hard choices regarding defense budgeting priorities. Policy makers should also consider the consequences for the defense industrial base when they make these hard choices.

Export Control Regulations

US firms are finding that export controls, known as the International Traffic in Arms Regulations (ITAR), are becoming an increasing impediment to global partnerships. In principle, too broad a refusal to share technical knowledge encourages—and even forces—others to develop technologies without United States participation or access. In practice, securing export approval for defense or dual-use goods has proved to be a lengthy process lacking transparency and predictability.[71] Due to the time required and the ambiguity surrounding our export regime, some international customers actively seek military components *without* US content. This unintended consequence of our export controls has the effect of denying market entry to US firms while simultaneously reducing the opportunity for interoperability between the DoD and foreign militaries. No one advocates removing all export controls, but sensible proposals include sunset provisions that force regular reviews of the restricted technologies for continued relevance, and release of technologies already available outside the United States.[72]

Buy American Act

A component of the complex challenges posed by globalization is the desire to sustain key national industries. Some assert that left to solely economic market forces, the Nation's specialized defense industrial base and its workers may be lost and only recoverable at great cost. However, DoD's mission is to defend the nation and its interests. Political considerations that saddle the military with considering economic impact on contractors and regional job creation distort that core mission.

Enacted in 1933, the Buy American Act's intent was to stimulate the economy by

protecting US jobs. It required the government to procure raw materials used for road and bridge construction that were mined or produced in the United States.[73]

The opposing views on the relevance and effectiveness of Buy American policies fall into two categories. Supporters agree with the original intent—to protect American jobs and ultimately strengthen the domestic economy. Buy American policies aim to reduce American dependence on and potential vulnerability to foreign suppliers. In turn, the heavier focus on US firms contributes to the ability to maintain the technological edge in critical areas. Having a technological edge helps strengthen the industrial base and contributes to a strong economy.

Criticism of the Buy American Act revolves around the benefits of free trade and allowing market forces to shape the economy. Opponents of Buy American argue that the world is linked economically, and protectionist economic policies ultimately interfere with free trade, thus disrupting the market's ability to add value, spur innovation and fix prices. Further, the argument pronounces that if American companies cannot produce products at competitive prices, then those companies must restructure to become more efficient or close their doors. As one of the world's strongest advocates of free market capitalism, the US risks its credibility by pursuing protectionist policies. These policies could also provoke trade wars in high technology sectors. In the end, potential gains may be offset by the high cost of protectionism.

In today's global economy, the Buy American Act could drive a situation where there are few, if any, competitors able to compete. In the KC-X example, it is possible that Boeing could be the only company that can meet the Buy American standard. If so, the question becomes, would Boeing (or any other firm) take advantage of having no competition by arbitrarily increasing its profit margin? Competition naturally drives down prices. In a monopolistic situation such as this, it is safe to assume the government will not enjoy the financial benefits of competition. However, preserving US jobs, furthering R&D and sustaining the defense industrial base may be worth the additional cost. A refinement of the Act should avoid overly protectionist effects on industrial competition and not unduly close the American market to international competitors.

RECOMMENDATIONS

Although the future of the commercial aircraft sector is healthy, the outlook for the defense aircraft sector is less certain. The USG can take actions which would increase the likelihood of the defense sector's success. These actions could help prioritize and focus R&D, define critical industrial base requirements, bolster a skilled workforce and engage globally by revising the ITAR.

Aircraft manufacturers, both domestic and international, continually call for more specific government guidance on how to dedicate their dwindling R&D dollars. Aircraft manufacturers referenced the 2010 QDR as an example of governmental R&D guidance which is simply too broad. The QDR states "the Department of Defense must balance resources and risk among four priority objectives: prevail in today's wars, prevent and deter conflict, prepare to defeat adversaries and succeed in a wide range of contingencies, and preserve and enhance the All-Volunteer Force."[74] This wide range of missions provides little specificity for future R&D investment dollars. The QDR does, however, address the need to preserve the industrial base.[75] The connecting link between R&D, the industrial base and US defense capabilities could be a defense industrial strategy.

DoD documents such as the Guidance for Employment of the Force and the Guidance for Development of the Force ostensibly assume the defense industrial base is, and will always be, capable of answering the call to provide goods and services necessary for national security. DoD requirements and required industrial capabilities must be coordinated, not assumed. In order to better coordinate industry and defense requirements, the US should follow the model set by the United Kingdom's 2005 Defense Industrial Strategy White Paper, an overarching document which provides a strategic overview (to include both military and defense industry reviews and export information), an industrial sector review (broken down by sectors such as air, land, sea, C4ISR, etc.), and an implementation section.[76]

The ICAF Aircraft Industry Seminar recommends the following specific actions:

- **Develop a National Industrial Strategy with the following major elements:**
  - Define critical industrial base capabilities requiring USG support
  - Prioritize and focus R&D
  - Implement policies to shore up the defense skilled workforce
  - Promote engagement with globalized industry and revise ITAR
- **Identify future capability requirements to guide industry.** The DoD should identify capabilities (for example, next generation technologies) the US will need for executing its future missions. This identification will allow industry to focus its R&D efforts.
- **Further identify future capability requirements providing critical strategic advantage.** The USG should consider focused support measures to retain these capabilities in the US: narrowly-defined Buy America provisions, control on transfer of associated technologies, and regular prototype contracts to keep associated production lines operational.
- **Coordinate DoD requirements and required industrial capabilities**. A healthy dialogue between government and industry is required to align government's interest in providing national security with industry's interest in earning a reasonable return on investment.
- **Promote innovation in defense industry through targeted fiscal policy**. The USG should explore both general tax incentives for R&D spending in fields designated as critical and maintain spending of small grants and X-prizes to support innovative research, especially among individuals and small entrepreneurs.
- **Incentivize studies in critical engineering and scientific fields**. The USG should enact educational measures—science project contests, scholarships, student loan forgiveness—that reward study in key fields related to critical industrial capabilities.
- **Revise immigration procedures to recruit and retain excellent talent.** Legislation should revise the immigration process to facilitate US study by foreign engineering and science students, adopt a points-based immigration system emphasizing critical skills, and add fast-track naturalization for immigrants with expertise in critical fields.

- **Encourage US industrial engagement with globalized industry.** American firms already regularly engage with international suppliers, partners, and customers. The USG should intensify its championing of foreign sales of US-produced defense aircraft as appropriate. It should also encourage partnering with firms of allied nations.
- **Revise the ITAR regime.** Advances in anti-tamper technology can allow export of sensitive systems to a broader range of allies and partners. The export process should be streamlined to control only specific technologies identified as supporting critical industrial capabilities. The regime should also provide for frequent review of listed technologies for continued relevance. The licensing process needs to provide prompt, predictable, consistent answers to export requests.

SPECIAL INTEREST AREAS

Unmanned Aerial Vehicles (UAV)

The unmanned aircraft sector of the industry arguably holds the greatest potential for growth and innovation in the near-term. Recent data suggests the ascent of the unmanned aircraft market will continue, driven mainly by USG UAV acquisitions for defense applications. Future prospects of the unmanned aircraft market are strong, although some significant challenges remain, and USG policy actions are needed to enable UAV market growth to full potential, as well as maximizing benefit to the aircraft industry and the entire defense industrial base.

Driving growth in the UAV market has been a pull by the USG toward dominating the information warfare arena, as well as the need for tying systems together in a net-centric matrix to aid prosecuting current conflicts and peacekeeping operations.[77] Forecasters throughout the aircraft industry predict continued growth, even as defense spending will flat-line in coming years. For example, Larry Dickerson, the senior unmanned systems analyst for *Forecast International*, writes, "An insatiable demand for unmanned air vehicles is fueling massive growth within this market … No matter how many UAVs are built, military agencies want more."[78]

The Teal Group's forecast for future spending illustrates a sizeable projected increased requirement for UAVs, further suggesting the US will account for about 64% of total worldwide defense RDT&E spending and 38% of procurement spending on UAVs for military applications over the next decade.[79] Other sources provide additional evidence to support the notion that the current recession has not, and will not, have the same impact on the UAV market as it has on the rest of the aircraft industry. As written in *Aviation Week & Space Technology's* Aerospace 2010 issue, "At one time the US had only a few hundred unmanned aircraft in service, flying about 1,000 hr. a year. Now the Pentagon's UAV fleet numbers in the thousands, with more than 600,000 flight hours accumulated in 2009."[80] With overall production value of these systems estimated to be over $26 billion in that timeframe, most analysts see continued growth as inevitable.[81]

The next decade within the defense UAV market will be dynamic. Technology may be available to pull the military toward unmanned air refueling vehicles and combat aerial vehicles (systems capable of performing the entire spectrum of the manned missions currently flown by

manned refueling, fighter and bomber aircraft), but what remains to be seen is the desire (or fiscal ability) of the DoD to pursue them.

Data is mounting in support of government use of UAV for myriad non-defense applications. The Federal Aviation Administration is forecasting an increase in use of UAVs by federal agencies. They believe "State and local governments envision using UASs to aid in law enforcement and firefighting" as well as potential uses in "real estate photography or pipeline inspection" as the probable near-term applications.[82] The prospect of UAVs for civil use, though, uncovers the main barrier for unmanned systems: access to airspace.

Although J.E. Jewell, President of UAV MarketSpace, Inc. believes that "civil UAV spending for airframes, payloads, systems, and services has the potential to equal Department of Defense (DoD) UAV spending within 15 years,"[83] such a level of commercial demand for UAVs will likely take longer to develop. This is primarily due to the *rate* at which the FAA and the USG are addressing airspace issues surrounding the next generation Air Traffic Control system (NextGen would bring significant radar improvements allowing small-signature craft to present returns for Air Traffic Controllers) and integrating unmanned systems into the National Airspace System (NAS requires UAVs to possess detect/see/avoid capability not yet available on systems today). Europe will likely assume a leadership role in developing and employing unmanned systems for commercial use, and the US and other countries will take a wait-and-see approach, learning from the challenges and progress integrating UAVs in European airspace.

The 2009 Aircraft Industry Study report from the Industrial College of the Armed Forces states "The once rapid onset of modern UAVs has mellowed to a more modest trajectory. At the heart of this change is a reduction in innovation and an incremental mindset toward programs in the future."[84] Current projects underway would lead one to disagree, and suggest an avenue for innovation to be exploited by the aviation industry writ large.

Growth and innovation in the unmanned market has the potential to spur similar growth and innovation across the entire aircraft industry, and the entire defense industrial base by enabling technological advances while maintaining expertise in engineering, design and innovation. Thus, government policy actions should focus on possible solutions to clear the way for safe and efficient UAV airspace integration. While the trend of increasing defense spending probably stopped (for now), spending on UAV R&D may need to increase to support the aircraft industry. Expanding technology demonstration opportunities through additional funding will serve to ensure growth and innovation throughout the aircraft industry.

The Aerospace Industries Association contends that NextGen is a "shovel-ready" program.[85] Embarking on such a program will not only increase the likelihood of UAV integration into the NAS, but will serve to create jobs (win-win) in an economy struggling to recover from one of the worst recessions in US history. Immediate government action should be a priority.

Finally, as systems are procured for government applications, consideration should be given to the commonalities and synergies of systems (or lack thereof) across services and government agencies (both local and federal). Having systems is one thing, but having systems with commonality will be essential. Predicting exactly how systems will be used in the future is problematic, as many of the systems will likely be used in response to natural and man-made disaster, where ground-based entities will need to be able to work with different systems seamlessly.

The UAV sector likely has the potential for the most growth and innovation of any sector in the aircraft industry. At present, the both industry and government seem to be using a wait-and-see approach to airspace, ceding the initiative to the Europeans. Both industry and the USG must work proactively to take advantage of the opportunity presented by the potential explosive growth of the UAV market.

Surge Capability

The US aircraft industry demonstrated the true meaning of production surge capability during World War II. In the peak production month of March 1944, more than 9,000 aircraft came off the assembly lines. Today, aircraft take weeks and months to build. The ability to out produce our enemies played a key role in the Allied victory.

After World War II, the aircraft industry remained robust and healthy with relatively high production numbers due to a growing commercial aviation market as well as new defense aircraft production throughout the 1950s and 1960s. This paradigm remained until the consolidation of the 1990's, which drove the "leaning" of the production process. Outsourcing production in order to lower costs has resulted in an overall reduction in the aircraft industry work force by 58% since 1990. While the current workforce meets the needs of the industry, the lack of excess engineers and skilled laborers limits the industry's ability to surge. While facilities and production infrastructure are critical to the industry, manufacturers cannot afford to keep non-aircraft producing facilities open. Empty buildings are a huge liability due to the many requirements placed on aircraft production infrastructure. Another factor limiting surge capacity is strategic materials.

Strategic materials such as titanium and cobalt in the past have limited not only surge capability within the aircraft industry, but production capability as well. Titanium is lightweight, strong, corrosion resistant, and exhibits exceptional high temperature characteristics. For these reasons, one of titanium's largest uses is in the aircraft industry. In 2009 an estimated 76% of the titanium metal was used in aerospace applications. The United States produces titanium in two locations, Nevada and Utah. Cobalt is a strategic and critical metal used in both industrial and defense applications. The largest use of cobalt is in superalloys. In fact, 49% of the cobalt consumed in the United States was used in superalloys, mainly in aircraft engines. The United States is the world's largest consumer of cobalt, but currently has no domestic production. Therefore, the United States is 100% dependent on imports for its supply of primary cobalt. The global economic downturn that began in late 2008 resulted in reduced demand for and supply of cobalt. To ensure an adequate supply for defense, industrial, and essential civilian needs during a national emergency, cobalt metal is included in the National Defense Stockpile. Like titanium, the cobalt market continues making market corrections through deliberate reductions in production and delays in capacity expansion. Clearly production surge capability is critical to any industry; the aircraft industry is no different. It currently has a limited surge capability that allows manufacturers to address small increases in production. There is currently no capability to surge production lines to a strategic volume as the US did during World War II. Based on the cost required to achieve a surge capacity, this is a risk the USG seems willing to assume.

F-35 Joint Strike Fighter (JSF) Program

The F-35 Lightning II, or JSF, is touted by DoD leadership, the program office and Lockheed-Martin as the fifth generation fighter that will be the centerpiece of the United States' counter land and counter air strategy throughout the 21st century. Described as a game-changer

within service circles and the defense industry, the JSF brings "…advanced airframe, avionics, autonomic logistics, propulsion systems, stealth, and firepower…"[86] Between the F-22A and JSF, Lockheed has emerged as the only firm to produce a fifth generation fighter. The JSF program has spread risk by virtue that it originated as a joint program, while maximizing the capabilities of a global partnership and supply chain. Secretary of Defense Robert Gates recently stated the JSF is "…the biggest program the department has ever pursued, and that we have a great deal riding on this program."[87] The JSF development and production strategy is a business model challenged by regulatory measures, defining technology readiness and access in a global industry, and decline of the fighter industrial base. Additionally, with LM as the only US firm in fifth generation fighter market, the DoD is hedging its bets on a single firm, increasing risk to the future of the defense industrial base.

Richard Aboulafia of the Teal Group puts the current state of affairs in stark terms stating in 2020 the F-35 would be the only competitive fighter in the global market, "unless some kind of new generation counterweight emerges."[88] Up front, it is acknowledged that the JSF program is facing significant risk due to technology readiness levels during the test phase, along with rising unit costs. Those issues aside, the JSF will be a game-changer much like the Boeing 787 in the commercial aircraft market. Since the mid-1990s, the US fighter market has been shrinking dramatically. Moreover, there is growing competition within the global arena from near-peer competitors such as the Chinese J-10C and Russian Sukhoi PAF-FA posing regional threats to security. With a goal to reduce risk, while competing for scarce dollars, even the fighter market is not immune to the effects of globalization, reflected in the JSF program's international complexion. Globalization does not mean the US is more dependent on another country's economy or technologies, but it does provide four key advantages from a strategic context. Those are labor force savings, innovation through competition, an extended supply base, and increased capacity for production, as seen in the JSF program. The health of the US defense industrial base is the primary concern when it comes to any model that involves aspects of globalized design, development and supply, such as the JSF. Dr. Ashton Carter, Undersecretary of Defense for Acquisition, Logistics and Technology, stated "globalization is the trend where leading technology companies are increasingly global, rather than purely American in their outlook, ownership, workforce, and markets.[89] With that there are two significant challenges: regulation and the global supply chain.

A major barrier to market entry, federal export regulations date to the Cold War, and were put in place to protect vital US technology from the Soviet Union and to maintain the advantage on the battlefield.[90] The first clear example of this challenge came to light during the Fighter Support Experimental (FSX) program, where there were issues with technology transfer and the airframe, avionics, software and engine, very similar to those challenges with the JSF. As such, there are threads that tie the FSX, F-22A and JSF programs with the fundamental question, "should US economic interests be given as much weight as traditional national security concerns in the making of US foreign policy?"[91] The foundation of this challenge is based on strict regulatory measures such as the ITAR, Arms Export Control Act, and the Berry Amendment. These regulatory measures are indicators of the conflict between exchanging technologies, protecting the US market and jobs, and foreign policies— which also may sacrifice opportunities for innovation. The second major challenge deals with the global supply chain— more specifically, second, third, and fourth tier suppliers. As noted by Mr. Brett Lambert, an official in the Office of the Secretary of Defense for Policy, "…the department has focused on competition among prime suppliers…we are seeing increasingly that all primes rely on a single

source that is down at the second, third, or fourth tier of the supplier base."[92] The three primary issues revolve around the lack of common processes and systems, the risk of counterfeit or substandard parts, and the threat of market exit by lower tier and second source suppliers, such as Alenia, a second source final assembly firm for the JSF in Europe. With the JSF, there are over 100 international firms participating, Italy alone is home to 19 firms who are involved as third and fourth tier suppliers.[93]

The DoD cannot lose sight of the value provided by the globalized development, production and sustainment program of the JSF model. However, allies and partners within the JSF program have taken a differing view towards future cooperation, based on roadblocks associated with the lack of transfer of technology due to ITAR. The implications of this viewpoint has a potential to weaken the industrial base and advanced generation fighter market due to a lack of commitment from partner nations in future programs. On the other hand, those same nations may be compelled to participate in the next generation of fighters for three reasons. First, no other nation or firm outside of the US, will have the technology, capability or revenue to independently produce a sixth generation fighter. This will entice them to continue to partner with the US out of necessity for the sake of national security, due to the threats from near-peer competitors such as Russia and China. Second, UAV platform capabilities have evolved significantly, but the technology and effort associated with producing a UAV and associated integrated combat, avionics and communications systems that are necessary to operate in a dynamic counter air environment are not forecasted for the foreseeable future. This further necessitates the continuing development of the next generation beyond the F-35. Third, international partnership and cooperation on advanced programs, such as the JSF, bolster economies of those countries involved with respect to growth of jobs, demand for additional second and third tier suppliers, and after market sustainment programs.

In conclusion, for a model of this nature to be successful, two key aspects must be addressed. First, process improvements in the global supply chain with respect to the tracking of cost, performance, and quality data associated with second and third tier suppliers. Second, and more importantly, federal regulation needs to be addressed with respect to our closest allies, while balancing release data associated with technologies critical to national security. As such, the JSF program is viewed more as an industrial strategy by our partners than a program designed to deliver a required combat capability.[94]

CONCLUSION

The aircraft industry is a dominant force in the international economy. In the commercial sector, the duopoly of Boeing and Airbus compete for share of a growing market boosted by long term rising demand for passenger aircraft. In the defense sector, on the other hand, most major defense contractors operate under monopsonistic market conditions with the USG as the sole buyer. In recent years of steadily growing defense budgets, these firms fared well in terms of profitability and market share. However, the likelihood of flattening defense budgets exacerbates the challenges already facing the defense aircraft industry.

Topping industry challenges is uncertainty regarding specific future aircraft requirements. In several defense submarkets—tactical aircraft, rotorcraft, transport—the years between new DoD projects has led to stagnation of the industry with no indication as to what the next project will be. Overall, this lack of clear direction of defense projects on the part of the United States is as detrimental as any actual declines in defense spending.

Compounding this uncertainty, the US lacks an overarching defense industrial policy to provide such guidance. Historically, the USG's practice has been to allow market forces to sustain and shape the industrial base. As a result of this "non-policy," the market forces created by a shrinking defense budget are not large enough to adequately sustain or shape the defense industry. For the small number of prime contractors that make-up the first tier of the defense industrial base, these challenges may prove to be too great, and consequentially drive some out of the business.

In our recommendations, we focus not on the health of individual firms but on whether the overall industry has the capabilities and capacity to meet the forecast need for specified requirements. These recommendations focus on four key areas critical to future success of the aircraft industry: defining critical industrial base requirements that merit policy measures to ensure appropriate capacity and capability; prioritizing and focusing R&D; implementing policies to ensure future depth within the defense skilled workforce; and promoting engagement with globalized industry while revising ITAR standards. Central to these measures is a defense industrial policy that gives specific guidance, and helps to make hard choices on the most likely need for future capabilities and provides a vector for industry. This same determination informs government measures related to everything from tax initiatives to educational incentives. Primarily, however, creation of a national defense industrial policy fills an existing gap in the American defense industrial posture and would significantly strengthens industry's role in supporting national security. The connecting link between R&D, the defense industrial base and US defense capabilities is a national industrial policy which effectively balances industry's quest for profitability, while also addressing impact to national security.

A nation's aggregate power is determined by its ability to wield the classic instruments of national power—diplomatic, informational, military and economic power. Since the end of the Cold War, the US has undisputedly been the world's most powerful nation, with a large margin in all instruments of power. The aircraft manufacturing industry plays a key role in both the nation's military power and its economic power. As such, it must be considered a critical component of US national security. Formulating a national industrial strategy to support and sustain the aircraft manufacturing industry is not a new idea. The commercial aircraft manufacturing industry is healthy, but the defense segment is in jeopardy. Failure to consider the defense segment may result in a domestic aircraft industry in 10-15 years that can produce state of the art passenger and cargo aircraft, and large defense primes able to produce armies of contractor-nation builders, but not combat aircraft.

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