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# Global Aerospace Industries: Rapid Changes Ahead? (Abridged)

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## Global Aerospace Industries: Rapid Changes Ahead? (Abridged)

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# Preface & Acknowledgements

Welcome to our Ninth Annual Acquisition Research Symposium! This event is the highlight of the year for the Acquisition Research Program (ARP) here at the Naval Postgraduate School (NPS) because it showcases the findings of recently completed research projects—and that research activity has been prolific! Since the ARP's founding in 2003, over 800 original research reports have been added to the acquisition body of knowledge. We continue to add to that library, located online at www.acquisitionresearch.net, at a rate of roughly 140 reports per year. This activity has engaged researchers at over 60 universities and other institutions, greatly enhancing the diversity of thought brought to bear on the business activities of the DoD.

We generate this level of activity in three ways. First, we solicit research topics from academia and other institutions through an annual Broad Agency Announcement, sponsored by the USD(AT&L). Second, we issue an annual internal call for proposals to seek NPS faculty research supporting the interests of our program sponsors. Finally, we serve as a "broker" to market specific research topics identified by our sponsors to NPS graduate students. This three-pronged approach provides for a rich and broad diversity of scholarly rigor mixed with a good blend of practitioner experience in the field of acquisition. We are grateful to those of you who have contributed to our research program in the past and hope this symposium will spark even more participation.

We encourage you to be active participants at the symposium. Indeed, active participation has been the hallmark of previous symposia. We purposely limit attendance to 350 people to encourage just that. In addition, this forum is unique in its effort to bring scholars and practitioners together around acquisition research that is both relevant in application and rigorous in method. Seldom will you get the opportunity to interact with so many top DoD acquisition officials and acquisition researchers. We encourage dialogue both in the formal panel sessions and in the many opportunities we make available at meals, breaks, and the day-ending socials. Many of our researchers use these occasions to establish new teaming arrangements for future research work. In the words of one senior government official, "I would not miss this symposium for the world as it is the best forum I've found for catching up on acquisition issues and learning from the great presenters."

We expect affordability to be a major focus at this year's event. It is a central tenet of the DoD's Better Buying Power initiatives, and budget projections indicate it will continue to be important as the nation works its way out of the recession. This suggests that research with a focus on affordability will be of great interest to the DoD leadership in the year to come. Whether you're a practitioner or scholar, we invite you to participate in that research.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the ARP:

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We also thank the Naval Postgraduate School Foundation and acknowledge its generous contributions in support of this symposium.

James B. Greene Jr.
Rear Admiral, U.S. Navy (Ret.)

Keith F. Snider, PhD
Associate Professor

# Panel 8. Assessing Defense Industry Health in a Constrained Fiscal and Global Context

| Wednesday, May 16, 2012 | |
|---|---|
| 1:45 p.m. – 3:15 p.m. | **Chair: James E. Thomsen,** Principal Civilian Deputy, Assistant Secretary of the Navy (Research, Development, and Acquisition)<br><br>***An Aerospace and Defense Industry Market Index for 1950–2012 and the Connection With Defense Spending***<br>Robert Bruce Williamson, *National Defense Business Institute, University of Tennessee*<br><br>***The Impact of Macroeconomic Forces and Changing Trade Winds on the Global Defense Industrial Base***<br>Nayantara Hensel, *National Defense University*<br><br>***Global Aerospace Industries: Rapid Changes Ahead? (Abridged)***<br>Raymond Franck and Ira Lewis, *Naval Postgraduate School*<br>Bernard Udis, *University of Colorado at Boulder* |

**James E. Thomsen—**Mr. Thomsen is currently the principal civilian deputy assistant secretary (RD&A). His responsibilities include leadership of the acquisition workforce and systems engineering. Previously, Thomsen served as the program executive officer for littoral and mine warfare (PEO LMW). As PEO LMW, he had life cycle responsibility to design, produce, field, and support warfighting capability for the littoral battle space and for the global war on terrorism. Mr. Thomsen led seven program offices that comprised 224 programs ranging from ACAT I through ACAT IV and included several developmental programs that addressed urgent warfighting needs for Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF). In 2003, Mr. Thomsen was selected as the executive director for the Program Executive Office, Littoral and Mine Warfare, where he executed the Navy's material acquisition programs for integrated undersea surveillance, naval EOD/JCREW, naval special warfare, mine warfare surface and aviation, unmanned maritime vehicles, naval anti-terrorism/force protection ashore and afloat, and LCS Mission Modules for anti-submarine warfare (ASW), Mine Warfare, and anti-surface warfare (ASUW).

Prior to this position, Mr. Thomsen was assigned as head of the Naval Sea Systems Command (NAVSEA) Dahlgren Division's Weapons Systems Department, directing over 550 scientists, engineers, and technicians and advancing key technical achievements in naval surface weapons systems. Mr. Thomsen was selected as a member of the Senior Executive Service (SES) in November 1998 and then named as head of the Coastal Warfare Systems Department, directing all of the littoral warfare research, development, test, and evaluation (RDT&E) programs at the Naval Surface Warfare Center (Panama City), which included 360 scientists, engineers, technicians, and military personnel.

Prior to November 1998, Mr. Thomsen served as program manager for mine warfare programs, for which he was awarded the National Defense Industrial Association (NDIA) Bronze Medal for his achievements in mine warfare; senior systems engineer for the Shallow Water Mine Countermeasures program; project manager for the ACAT 1D Joint US/UK Surface Ship Torpedo Defense (SSTD) program, for which he received the Commanding Officer/Technical Director Award for special achievement in technical management; and head of the Torpedo Defense Systems Development Branch and served as the system integration agent in submarine torpedo defense countermeasure programs for PMS 415.

In the early years of his 27-year career, Mr. Thomsen held engineering positions including design engineer, test engineer, project engineer, and systems engineer for several undersea warfare programs at Carderock, Panama City, and NAVSEA headquarters.

Mr. Thomsen received his bachelor's degree in ocean engineering from Florida Atlantic University in 1981 and his Master of Science degree from Florida State University in 1986.

# Global Aerospace Industries: Rapid Changes Ahead? (Abridged)

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## Abstract

This paper is prepared for the Ninth Annual Acquisition Research Symposium, as an abridged version of a longer report. We focus on certain key aspects of the EADS–Boeing rivalry—which, among other things, is one of the major features of international firmament of defense industrial affairs. We discuss selection of the Boeing KC-46 over the EADS KC-45 in 2011, seeking to understand connections among the associated events. We also seek to find useful explanatory models for Boeing's success, discussed in Chapter II. In Chapter III, we consider the narrow-body airliner market, currently a Boeing–EADS duopoly. It has been a centerpiece of the firms' rivalry, as well as a major source of profits for both. As such, these narrow-body families have provided resources for a number of wide-body developments, some of which have become part of the defense marketplace. The narrow-body market has been so profitable that other firms are positioning themselves to mount challenges to the two incumbents. These outlying firms have already made the market more competitive in a real sense. And, if these potential challengers become successful entrants, then Boeing and EADS will have lower profits, with major repercussions for both firms and their defense customers.

## Chapter I: Introduction

This report continues an ongoing project aimed at contributing to a better understanding of the international defense marketplace—an increasingly complex environment. Our intent has been threefold: to understand current defense industrial developments, place those developments in context, and find paradigms suitable for better explanation of those ongoing developments.

Our first report in this series, *Echoes Across the Pond: Understanding EU–U.S. Defense Industrial Relationships* (Franck, Lewis, & Udis, 2008a), considered three current episodes in the transatlantic defense-industrial complex: F-35 Joint Strike Fighter (JSF), the UK Defense Industrial Strategy, and the European Aeronautic Defence and Space Company (EADS)-Airbus KC-30 aerial tanker proposal. We also discussed three well-known analytical perspectives as candidates for understanding those cases: offsets in international

defense trade, Transaction Cost Economics (TCE), and Corporate Strategy models. In the style of Graham Allison (1977, 1999), we essayed explanations of all of our "cases" using all three paradigms.

Our second report, *New Patterns of Collaboration and Rivalry in the U.S. and European Defense and Aerospace Industries* (Franck, Lewis, & Udis, 2008b), emphasized defense industrial firms—with consideration of Boeing's Model 787 development and production; the KC-45 (or KC-X) competition (through the summer of 2008), which involved the EADS–Northrop Grumman alliance and the Boeing Company; and European defense firms' strategies (BAE Systems, EADS, Finmeccanica) for entering the North American defense market through direct investment. Two major themes that emerged were the increasing technical and managerial complexity in modern aerospace systems, and the increasing power of relatively agile defense suppliers relative to their increasingly bureaucratic customers.

Our third report, *Global Cooperation and Competition in the Defense and Aerospace Industries* (Franck, Lewis, Udis, 2010), continued inquiries along the same general lines of this overall project. We continued our exploration of the international defense industrial "terrain," and our search for useful paradigms. The KC-X competition (third installment) considered the explanatory power of two views of the defense establishment customers in the defense marketplace: the traditional model of the sovereign monopsonist versus the Governmental Politics perspective (Model III) offered by Graham Allison (1977, 1999). We considered the remarkable travails of the A-400M military transport development effort—which came in very late and much over budget. The A-400M (military) was a useful companion piece with our previous Boeing 787 (commercial). Both cases illustrate the increasing complexity of large, international development projects—and the problems that can emerge. A potentially significant change in the structure of the international defense marketplace is the possibly emerging Nordic defense bloc. In this instance, we found a rather complex story, with significant attractions to the other Nordic states, but also close and useful relationships with partners outside of the Nordic region (especially the United States).

Our fourth report (Franck, Lewis, Matthews, Udis, 2011) concerned three topics with the same general aims as above: the ongoing KC-X story, the C-27, and Unmanned Aerial Vehicles (UAVs). The prolonged KC-X source selection was clearly not a matter of difficulties arising from technical immaturity. This case continued to illustrate the bureaucratic, legal, and political obstacles to acquisition in the United States, as well as their potential for sidetracking the acquisition process.

The C-27, a small air transport of Italian design, is a good example of increasingly international projects in the aerospace industry and the sometimes complicated relationships between aerospace enterprises and their defense customers. It remains a good example, even though the U.S. version (called the C-27) has been cancelled.

Unmanned Air Vehicles (UAVs) involve a range of designs for reconnaissance, or both reconnaissance and strike. We attempted to place the rapid growth of UAVs in context, both as a major development in military affairs, and for the defense industrial base. UAVs are an important part of the two ongoing Revolutions in Military Affairs (RMAs). Within that context, UAVs are an important continuation of the reconnaissance-strike embodiment of the information technology (IT)–enabled RMA first demonstrated in the Gulf War of 1991. They are also useful countermeasures against the IT-enabled RMA practiced by terrorist and insurgent groups such as Al Qaeda and the Taliban.

The effect on the international defense marketplace has, quite possibly, been even more profound. The relative simplicity and cheapness of UAVs means that these systems can be developed with company resources outside the "normal" defense acquisition system, with its highly complex and potentially burdensome processes. A closely related point is that defense systems in this realm are open to a much wider range of suppliers. In fact, a large number of enterprises have been able to finance UAV development projects with their own funds. Also, technically adept smaller countries, such as Israel, are world leaders in unmanned systems.

In this report, we continue our inquiry into the international defense marketplace and industrial base by focusing on the less-than-cordial rivalry between the European Aeronautic Defence and Space (EADS) Company and Boeing. The two have competed strenuously in the commercial transport aircraft market, with Boeing's 737 series against the Airbus A320 family being a centerpiece of that rivalry.

Moreover, the competition extends into military hardware. The EADS Eurofighter (*Typhoon*) and the Boeing F/A-18 (*Super Hornet*) both submitted unsuccessful proposals for the next Indian tactical fighter. Also, the EADS A-400M has taken dead aim at the Boeing C-17 military transport aircraft (as well as the Lockheed C-130).

However, the largest military aircraft contest involving Boeing and EADS was the prolonged source selection process for the KC-X. In 2011, the prolonged story of KC-X source selection apparently ended with the Boeing KC-46 being chosen. We consider the issues associated with this last source selection attempt in Chapter II. Among other things, it appears that the "quarrelsome committee" (especially the industrial players) so evident in previous iterations (Franck, Lewis, Udis, 2010, 2011) had grown weary of conflict—or perhaps the Air Force and the DoD had become more adept at working around the dynamics of that committee.

In a larger context, the Boeing-EADS rivalry has become one of the major features in the structure of the global aerospace industry. But that ground may be shifting, as we discuss in Chapter III. The most profitable product lines for both companies have been the narrow-body airliners, the Boeing 737 and the A320 (manufactured by Airbus, an EADS division). Although this part of the EADS–Boeing rivalry has been pursued as strenuously as the others, the international market has provided ample opportunities for both. In fact, narrow-body sales have provided profits that enable wide-body commercial developments, such as the A350 and 380, and the B787 and 747-8.

But that narrow-body market is becoming more "contestable" (as defined in Baumol et al., 1982). A number of regional jet manufacturers in Brazil, Canada, China, and Russia are seeking ways to enter the market niche now thoroughly occupied by Boeing and EADS. If serious competition develops for the B737 and A320, then there are potentially big changes ahead for the aerospace industry (both civilian and military).

In Chapter III, we discuss the nature of the Boeing–Airbus narrow-body duopoly, the plans and progress of the aspiring new competitors, and also the incumbents' responses. Finally, Chapter IV essays some concluding comments, particularly on some useful explanatory models.

## Chapter II: The KC-X Saga (Continued)

Since power projection and long-range strike is a key feature of U.S. Air Force doctrine, aerial refueling is a key competency for that service. Having high confidence in this mission capability is accordingly a matter of high priority for military aviation.

The first non-experimental U.S. tankers were bomber derivatives—KB-29 and KB-50. These retired from active service by the mid-1960s. Variations of transport aircraft proved a better solution (Smith, 1998, esp. pp. 1, 43–47). For the U.S., this meant first the KC-97 (closely related to the Boeing Model 377 airliner), which served from 1950–1978, and then the highly successful KC-135 (first delivery 1957) which remains in service today (Smith, 1998, esp. pp. 43–47). What is firmly settled is that effective aerial tankers are more like transport aircraft than bombers.

Since the last KC-135 delivery occurred in 1965, the Air Force became concerned with problems of a large and important part of its force structure subject to risks associated with age. This motivated the first attempt to supplement (now) and replace (later) KC-135s with a newer design, the Boeing 767.[1]

### *Explaining the KC-46 Selection*

As the KC-X selection date neared, the EADS KC-45 was the clear favorite to win the contract (e.g., see Gates, 2010). But the expert consensus was dead wrong. How did Boeing's KC-46 become the Air Force's choice? Without full access to the selection process (and related events), it appears to be a rather complicated matter. Accordingly, we offer multiple explanations.

#### *Why the KC-46? The Story Viewed From the Request for Proposal*

The KC-46 is a tanker variant of the Boeing 767-200ER, whose 2012 "average list price" is $150 million (Boeing, 2012). The Boeing proposal was priced out at $21.4 billion (Butler, 2011b); this was a present value (PV) calculation of the stream of procurement costs associated with the program. This works out to an Average Unit Price (AUP) of about $145 million (in real terms). While posted prices are typically starting points for negotiating downward, this nonetheless seems a very low price per aircraft. And, when one considers the development costs attached to the KC-46, and included in the Total Procurement Price, Boeing's offer was indeed aggressive.

Similarly, EADS' final offer was calculated at $23.4 billion (Butler, 2011b); the AUP was about $160 million. The EADS KC-45 proposal involved an airframe based on the A330 MRTT (Multi-Role Tanker Transport). The January 2012 list price for the A330-200 is about $200 million (Airbus, 2012). Thus, if Boeing's final offer was aggressively priced, then so was EADS'.

According to the rules, the proposals were evaluated in three consecutive phases (Aeronautical Systems Center [ASC], 2010, Section M, esp. pp. 1–11).[2] The selection criteria (ASC, 2010, Section M, esp. pp. 1–11) were assessed in three phases. These are summarized in the following paragraphs.

First, proposals were screened for acceptability against 372 requirements, with an assessment of "acceptable" needed for all of them. (That is, any proposal which was "unacceptable" for any of those 372 was eliminated from further consideration.)

Second, the Total Proposed Prices associated were adjusted for (a) operational effectiveness, (b) fuel costs, and (c) basing infrastructure costs. The superior proposal in each category received a downward adjustment to reach a Total Evaluated Price (TEP). If the lowest TEP differed by more than 1% from the other, then the award would go to the

[1] A number of good syntheses of these concerns are available, such as Gertler (2010).
[2] The phases were executed consecutively in the sense that proceeding to the next (N+1) phase could occur only if both proposals were still in the running after phase N.

proposal with the lowest TEP. (This is what happened—with Boeing's TEP being about 9% lower than the EADS'.) The adjustments were determined as follows:

- Both aircraft were assessed for *operational effectiveness* with respect to an operational scenario (taken from the 2005 Mobility Requirements Study). The comparison was based on the number of aircraft needed to meet peak requirements in the scenario. The AUP adjustment was calculated with the following formula for the more effective entry (KC-45):

  AUP % adjustment = 1 – [(least effective candidate rating)/(evaluated candidate rating)]. For example, if the KC-45 received a 1.62 rating and the KC-46 a 1.35 rating, then the KC-45 would receive a 17% price adjustment [1-(1.35/1.62) = 17%].

- *Fuel adjustment* was based on expected annual flying hours per aircraft over a 40-year operational life. The candidate with lower estimated fuel costs (KC-46) received an adjustment to reflect the discounted fuel savings.
- *Base infrastructure* cost comparisons were based on a notional set of 10 bases with a notional deployment schedule. The candidate with lower infrastructure cost (KC-45) received a credit based on the discounted savings in military construction costs.

Third, if the TPPs were within 1%, then the evaluation would proceed to the last phase—something of a tie breaker. Both candidates would then be assessed with respect to 93 "non-mandatory" requirements (an apparent oxymoron).

As the evaluation played out, the adjustments to the TPPs were reported as stated in Table 1.

**Table 1. Getting to Total Evaluated Prices (TEPs) for the KC-46 and KC-45**
(Butler, 2011b, 2011c)

| CATEGORY | BOEING (KC-46) | EADS (KC-45) |
|---|---|---|
| TOTAL PROPOSED PRICE (TPP) | 21.4 | 23.4 |
| FUEL SAVINGS | (0.5) | 0 |
| BASING INFRASTRUCTURE | (0.3) | 0 |
| WARFIGHTING EFFECTIVENESS | 0 | (0.8) |
| TOTAL EVALUATED PRICE (TEP) | 20.6 | 22.6 |

However, suppose the estimated operational effectiveness of the KC-45 were indeed 20% more than the KC-46 (as was widely reported),[3] then the KC-45 should have received a 17% [1-(1/1.2)] reduction due to greater operational effectiveness. That would have been an adjustment of $3.9 billion—leading to a TEP of $19.5 billion, or a clear win for the EADS KC-45. The $800 million actually attributed to the KC-45 implies operational effectiveness of only about 4% more than the KC-46.

The point of this discussion is not to critique the Air Force selection process. For a number of good reasons (to include protection of proprietary information), complete disclosure of the mechanics of the selection process is impractical at best. However, it is

[3] For example, Belote (2008).

worth noting that the public record so far leads to a number of questions, but provides fewer answers.

***Why the KC-46? Changing Criteria***

Some commentators (e.g., Drew, 2011) attributed changes in the selection criteria (2010 vs. 2007) for Boeing's selection. There's something to be said for this perspective. Some examples of how the revised selection criteria could have improved the KC-46's chances follow.

The 2010 selection criteria reportedly included a harder look at basing (primarily ramp space) limitations for the KC-45 and KC-46. If so, this undoubtedly favored the smaller KC-46, and would have reduced the KC-45 operational effectiveness rating, due to longer transit distances to accomplish the aerial refueling mission. As one informed observer put it, the Air Force realized back in 2008 "that the A330 could not perform some wartime refueling missions in a scenario-based analytic model due to lack of adequate space at forward bases. The Air Force should have recognized the drawbacks of using such a big plane at that point, but under pressure from politicians to keep Airbus in the race, it chose to modify the model so the Airbus tanker could use bases off limits to the Boeing plane"[4] (Thompson, 2011).

The (relatively) short list of "mandatory requirements" included satisfactory or unsatisfactory assessments for each of 372 items. One item in that list was technical risk. And less technical risk was stated to be a major sorting factor for the Air Force in its KC-45 source selection of 2008. In the revised rules, both proposals were assessed as having "acceptable" risk—with no sorting beyond that (ASC, 2010, Section M). Moreover, given the fixed-price nature of the contract this time, the contractor would bear more of that risk—making program risk a matter of less import to the Air Force (Butler, 2011c).

Extending the evaluated operational life from 25 to 40 years was an advantage to the smaller KC-46 (Drew, 2011). The fuel expense difference was considered over a longer period. However, this stream of cost differences was discounted (to a Present Value) in calculating the Total Evaluated Price (ASC, 2010, Section M).

Also favoring the KC-46 was the changing airlift picture. With continued procurement of C-17s, the Air Force turned out to have more-than-adequate airlift capability. The most significant capability gap revealed in the Mobility Capability Requirements Study (MCRS-16) was relatively minor refueling shortfalls in two of three evaluation scenarios (DoD, 2010, esp. Figure 1).

That refueling capability shortfall was undoubtedly a matter of less concern than the fact that most aerial refueling capability currently resides in aging KC-135s. This could well have shifted attention toward the need to simply recapitalize the aerial tanker fleet (replace the KC-135s), and away from the KC-45s greater airlift capabilities (part of the rationale offered for the EADS KC-45 selection in 2008).

Indeed, some commentators noted that the Air Force shifted from "best" to "good enough"—or from modernization to recapitalization of its aerial tanker fleet. The fixed-price contracting approach was certainly consistent with this sort of change in acquisition strategy. As one observer put it, "[The DoD is] not going to pay for bells and whistles. That's the clear message here, and everyone should be heeding that message" (Censer, 2011).

[4] This is a striking indictment of the 2008 source selection process, and should not necessarily be taken at face value. Corroborations of Thompson's hypothesis by disinterested observers in the open literature are sparse, to put it mildly.

We have reservations about this last hypothesis. If the Air Force were simply looking to buy replacements for KC-135s, it seems unlikely that the operational effectiveness adjustment to Total Proposed Price would have been an adjustment in reaching the Total Evaluated Price.

### *Why the KC-46? Politics*

A separate, and not inconsistent, view is that the competition was really predetermined by political considerations.

For example, a blogger with *The Economist* (a respected British news magazine) took a full-fledged Euro-chauvinist view (M. J. S., 2011). The basic argument was that the only way the obviously superior KC-45 could be turned down in favor of the KC-46 was that EADS was *home-towned* in the source selection process—to include the selection criteria. EADS, of course, got kudos for a gallant performance in a rigged game.

On this side of the pond, political figures stepped up to claim full credit for steering the KC-X contract to Boeing. Particularly noteworthy was Rep. Norm Dicks (D-WA), who insisted that fuel savings should be assessed over a 40-year operational life, versus 25 years (Drew, 2011). As Rep. Dicks put it, "I got them to change the lifecycle costs from 25 years to 40 years. When you take 179 planes, and with the Airbus burning 24 percent more fuel than the Boeing plane, that's a big number. It could range from a $4 billion to $10 billion difference. That had to help them in a big way" (Hotakainen, 2011).

While Dicks' taking a lead in the 25-to-40 change is certainly credible, it is not clear that his efforts "steered the contract to Boeing," as some reports have stated (Hotakainen, 2011). Boeing's TEP included a $500 million credit for lower fuel costs. But even without this fuel credit (or that credit going to the KC-45), Boeing would still have been the winner (as reference to Table 1 makes clear).

The most persuasive point in the politics hypothesis is that choosing the KC-46 was likely the path of least political resistance. Most observers assessed the Boeing delegation in Congress to be larger and more powerful than EADS' (e.g., Butler, 2011a).

### *Why the KC-46? A Note From Allison's Three Models*

The previous discussion provides separate (but not necessarily conflicting) explanations for the rather surprising selection of the Boeing KC-46. These map rather nicely to some standard models of organizational behavior, including those found in Allison and Zelikow (1999): Model I (Chapter 1) posits decisions by a unitary rational actor; Model II (Chapter 3, organization behavior) is about action taken within a bureaucracy, following established rules and processes; and Model III (Chapter 5) concerns governmental politics—with outcomes determined by the interaction and bargaining among various governmental agencies and personalities.

The first explanation offered in this section was that the Air Force simply followed the rules laid out in the RFP. This is a Model II explanation: a bureaucracy proceeded according to a set of agreed rules and processes. It is also the official explanation from the Air Force and the DoD.

The third explanation involved governmental politics. That is, the KC-46 selection was really the result of contending factions within the U.S. Government—some favoring the EADS KC-45, and others favoring the KC-46. Viewed from this perspective, the main cause for the KC-46 selection is that the Boeing faction had more power than the EADS supporters.

Yet another explanation in this section is simply that Boeing decided to do whatever it took to win the competition. However, a business case analysis that would support the decision would seem to rest on Boeing's view of itself as a major military aircraft corporation—and the preferred supplier of tankers to the U.S. Air Force.

However, the changing selection criteria explanation cannot be categorized as cleanly. To the extent that the changing rules reflected changing circumstances (like more C-17s), we have a Model I explanation. To the extent that the changes were the results of political maneuvering, this is a Model III explanation. To the extent that the new selection criteria reflected a bureaucratic search for an executable (and protest-resistant) set of rules and processes, we have some variation of a Model II explanation.

## Chapter III: Airbus and Boeing: Beleaguered Duopolists?

Most short- to medium-range airline trips take place using a plane from one of two narrow-body aircraft families: the Airbus A320 and the Boeing 737. Over 7,000 examples of both families are currently in service, with order backlogs at both manufacturers still in the thousands, although these aircraft are no longer representative of state-of-the-art aviation technology.

Perhaps in response to perceived inertia against the two global giants of aviation, a number of aircraft manufacturers that have traditionally built smaller aircraft are introducing potential competitors to the A320 and Boeing 737. In this chapter, we will discuss the origins of today's narrow-body aircraft, as well as describe the key features of the products offered by the new entrants.

Our discussion begins with the lineage of the Boeing 737 and the development of the competing Airbus A320. We then continue by reviewing the aircraft developed by the new entrants into the mainline narrow-body market: Bombardier (Canada), Embraer (Brazil), Comac (China), Sukkhoi and Irkut (Russia).

Since World War II, aircraft, both military and commercial, have always been at the forefront in demanding the latest in information technology, propulsion systems, engineering, aerodynamics, advanced materials, manufacturing techniques, fuel efficiency, reliability, as well as minimization of capital and operating costs while allowing for varying degrees of passenger comfort. The advent of mass airline travel, which took place in two stages, following the introduction of the Boeing 707 in 1954 and the Airline Deregulation Act of 1978, has significantly increased the size of the airliner market while raising the stakes for any new model of aircraft.

The enormous success of the A320 and Boeing 737 (the latter being the most successful aircraft ever built) created a volume-oriented manufacturing culture at both Airbus and Boeing, which served to cross-subsidize the development and production of wide-body aircraft, produced in smaller quantities and more variants. The two global leaders may be facing a new era where this financial advantage is no longer as strong. However, the enormous number of Airbus and Boeing airliners in service has created a global system of aircraft support that any new entrant would find to be a formidable capability to match.

### *Assessing the Threats*

The aging A320 and Boeing 737 present an opportunity for market entry by new manufacturers into what has been an effective duopoly in the worldwide manufacture of mainline passenger jets since the absorption of McDonnell Douglas by Boeing in 1996.

All of the presumed new entrants—Bombardier, Comac, Embraer, Irkut, and Sukhoi—claim major advantages for their products over the two ubiquitous narrow-bodies

that have sold over 7,000 shipsets. The new players consistently mention capital and operating costs, fuel efficiency, emissions, turnaround time, range, and commonality within variants as reasons to leave the duopoly and try out something new.

Boeing executives, in a predictable but legitimate view, consider the in-service dates of all the new entrants unrealistic. They point out that the final evolution of the Boeing 737 fuselage, coupled with what may be the ultimate version of the CFM56, will save operators about $120,000 a year over current 737s. Finally, fleet commonality and technical support are not even issues when buying Boeing aircraft ("Boeing Skeptical," 2010).

The naïveté of some of the new entrants is surprising, particularly given the billions involved in developing any new aircraft. China may represent the largest emerging aviation market the world has ever seen, but cannot demonstrate adequate intellectual property protection. The People's Liberation Army stands at the center of the Chinese state and would certainly acquire any useful foreign technologies for its rapidly growing desire for global power projection.

The most surprising finding of our research is the lack of disclosure, or simply the outright absence, of the worldwide distribution and technical support networks that are necessary to support both aircraft and engines. A recent survey of airlines by CFM International indicated that fuel efficiency ranked fifth, with reliability a clear number one, in the decision to purchase a new airliner (Cohen, 2010). Only Airbus, Boeing, Bombardier, and Embraer have established the global infrastructure that is required to complement a very high degree of in-flight reliability.

Embraer currently appears to be pursuing a cautious course toward possible cooperation with European firms such as EADS and Dassault, and will not enter the above-100 seat market. Embraer's interests in technology sharing and collaborative marketing, particularly with respect to its KC-390 tanker, confirm this direction.

That apparently leaves only Bombardier's CSeries as a viable, medium-term new entrant that can compete directly with the lower end (in passenger capacity) of the A320 and Boeing 737 families. Bombardier's ambitious manufacturing plan and somewhat adventurous worldwide supply chain, highlighted by production of the main fuselage in China, point to a high-risk project. In the case of the Boeing 787, outsourcing of the main composite fuselage barrel pushed the capability of the supplier too far. Boeing was able to recover, in part by purchasing Vought Aircraft in Charleston, SC, where the aerospace giant is now opening a nearby second assembly plant for the 787 (Sanders, 2009).

Bombardier is a diversified and smaller firm that may not necessarily have the ability to either manage the CSeries project or recover from a major supply chain problem in its manufacturing process. The decision to outsource the manufacturing of the fuselage barrel outside North America may be a major success in supply chain management, or it could virtually shut down the Montreal-based firm. The prospect of increased Chinese sales, in our view, is far too theoretical and distant to warrant such a risky decision, whatever the merits.

In conclusion, the only viable competitor to Airbus and Boeing (with Embraer having opted out) may find itself pulling back from a very expensive experiment. Has Bombardier really absorbed the significant and expensive lessons learned from the initial manufacturing concept for the Boeing 787?

### *Narrow-Body Airliners as a Contestable Market*

What is going on with the Boeing/Airbus duopoly in narrow-body airliners is largely explainable using a branch of microeconomics called *contestable market theory*. The

generally acknowledged seminal work in this area is Baumol's *Contestable Markets and the Theory of Industry Structure* (Baumol et al., 1982).

While the Baumol exposition (and others following) is quite sophisticated, the central idea is pretty simple. Markets which appear to have few (or one) firms competing may have potential entrants lurking about. The effect is to make the current (incumbent) firms behave more like competitive firms than appearances would indicate. (An internet site states this idea rather well: "a market in which there are only a few companies that, because of the threat of new entrants, behave in a competitive manner" ["Contestable Market Theory," 2012].)

Going a little bit deeper, a market is said to be "perfectly contestable" if the potential entrants could enter that market and exit without incurring any (recoverable) costs, or "costlessly reversible entry" (Bailey, 1982, p. xix). (It is worth noting that entry and exit are both important.) More generally, markets can have degrees of contestability—which increases as costs of entry and exit decrease.

In that context, the regional jet companies (such as Bombardier) have observed that the narrow-body airliner market now dominated by Airbus and Boeing is very profitable. As standard microeconomic theory predicts, they would like to enter, and compete with the two incumbents. Furthermore, having the option to do just that is sufficiently valuable that the potential entrants have developed variations of their regional jets that are much closer substitutes to the Boeing 737 and Airbus 320 families.

But, with the apparent exception of the Chinese Comac C919 (which is comparable in size to the A320), the potential entrants have trimmed their costs and hedged their bets by developing larger versions of their existing regional jets.

## Chapter IV: Concluding Remarks

This report has focused on the EADS–Boeing rivalry. The KC-X saga is significant for a number of reasons. One is that it is one of the major defense manifestations of a rather heated international rivalry—in the pursuit of both commercial and defense business. Another is the extensive interconnection between commercial and defense aerospace markets, particularly for military aircraft such as aerial tankers.

At the same time, the Boeing (737) and Airbus (A320) narrow-body airliner families are both (a) a key part of the overall Boeing–EADS competition, and (b) major profit centers for both firms. As one would expect, prospects of profits have attracted a number of firms who are actively pursuing market entry strategies. The approaches involved include "upsizing" regional jet designs (from, e.g., Bombardier of Canada) and new airframe designs (from, e.g., Comac of China) intended to compete directly with the incumbents (Airbus A320 and Boeing 737). In short, the narrow-body airliner market is becoming *contestable*.

Accordingly, both incumbents have developed counters to their potential competitors: the A320 neo (new engine option) and the B737MAX (also with a new engine). Both aircraft are already commercial successes (each with more than 1,000 orders or commitments). However, their ultimate degree of success in keeping potential new competitors out of this lucrative market remains to be seen.

In any case, Boeing and EADS will behave more like one would expect from competitors in standard microeconomic theory, and less like duopolists. Since more competition (in whatever form) generally means less profits, this could mean major changes in the profit structures of both Boeing and Airbus, with potentially significant effects on defense markets.

In any case, this situation has potential to affect the global aerospace market in major ways. If (despite the difficulties), one or more potential entrants becomes a major player, then the narrow-body airliner market will become more competitive—and less profitable. With lessened profits from the A320 and 737 product lines, wide-body developments (with their defense variants) could well change substantially.

### *Explanatory Paradigms*

We have also offered explanatory models for the developments we have discussed. The microeconomic theory of contestable markets turns out to be highly useful in explaining developments in the market for narrow-body airliners. For the third (and presumably successful) attempt to select a new aerial tanker (KC-X) for the U.S. Air Force, the picture is more varied. We used Allison's three models as candidates for explanation. Model I (unitary rational actor) is highly useful in explaining Boeing's rather low final bid, particularly as operationalized in the form of business case analysis.

There is more variety of useful perspectives regarding the Air Force's selection of the Boeing KC-46: changing circumstances, changing selection criteria, and politics. The "politics" hypothesis lays out pretty much as Allison's Model III (governmental politics). The "changing circumstances" hypothesis predicts a changed aerial tanker selection as a result of a changed airlift force structure (principally through increased numbers of C-17s available). Finally, the changing-selection-criteria hypothesis can be derived from any one of Allison's models. Model I (unitary rational actor) applies if the rules changes are related to changing circumstances (such as more C-17s). Model II (or a variant of bureaucratic process) is useful in explaining the Air Force acquisition establishment's effort to develop protest-resistant source selection processes. Finally, the "politics" hypothesis relates closely to Model III (governmental politics)—primarily the contending congressional factions.

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