

ACQUISITION EXCELLENCE

**SUCCESSFUL  
INTEGRATION  
OF  
COMMERCIAL  
SYSTEMS**



*A Study of  
Commercial Derivative Systems*

Stockman, Ross, Bongiovi & Sparks



# **SUCCESSFUL INTEGRATION OF COMMERCIAL SYSTEMS**



**A Study of  
Commercial Derivative Systems**

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# *Preface*

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## **Integrating Commercial Systems to meet DOD Missions**

The intent of this book is to provide a discussion of how commercial derivative aircraft (CDA) play a significant role in the past, present and future military force structures. At its simplest, a commercial derivative product is anything that was developed and produced for public use that might also have a military application. The basic theory is that the military might be able to save schedule and development cost by adapting this commercial product to meet a military requirement. This is an ancient concept that goes back to the early cavemen who would club their enemies with the same weapon they used to kill their food—dual use technology at its earliest! As military equipment and systems progressed and became more lethal, there still was normally little difference between the military and commercial version. It was only after the introduction of major military machines (combat ships, battering rams, catapults, etc.) that military engineering and development began to become a major business.

Thus, military history is full of weaponry that is either dual purpose or developed from a civilian product. On the surface, this sounds like a good, relatively easy, and inexpensive approach. Yet, recent DOD history is full of examples where the CDA approach ended up in cancelled programs, cost overruns and expensive life cycle costs. The simple reason for these negative outcomes, as we will present in this book, is that the DOD often fails to either learn the basic rules of CDA acquisition and sustainment strategy or else fails to implement them in practice.

For this book, we have limited our interest to aircraft procurement plus the sustainment and logistics benefits and mainly to those which have been previously developed for civilian use. Despite that limitation, most of our findings, lessons learned and conclusions apply just as effectively to other types of commercial derivative systems.

This book was begun in parallel with the development of the USAF Commercial Derivative Aircraft (CDA) Acquisition Guide that was delivered to the USAF in 2009. Major funding to finish this book was provided by PESystems of Dayton Ohio.

The guide provides a very succinct view of CDA acquisition and focuses on the differences compared to traditional, full-development DoD acquisition programs. One of the basic findings is that CDAs and traditional aircraft development/acquisition programs suffer many of the same problems and benefit from many of the same solutions. The guide provides straight forward advice on how to avoid the most common problems in developing and executing a CDA program throughout a lifecycle. This book supports the practitioner by providing an in-depth discussion of many of the key elements and problems of CDAs—something that the format of the guide did not allow.

To research this book, the authors spent a great deal of time reviewing the extensive acquisition documentation, studies, academic research, and evaluations from senior level review groups. We also interviewed many of the current and past experts in

this field to learn their thoughts and experiences in managing these programs. The result is a very interesting discussion of some recent CDA successes and failures along with an extensive list of lessons learned to pass on to current and future CDA program professionals.

## Lessons Learned

While there is a long list of detailed lessons learned in the latter chapters, the basic lessons are quite simple—much like the rules for taking care of the Mogwai.<sup>1</sup>

- Pick a civilian system that meets the military requirements.
- Understand that the civilian systems may have been built to operate in a totally different environment than that envisioned by the military operators.
- If there is a mismatch between the military requirements and the commercial capability, change the requirement.
- Understand at what point of the commercial product lifecycle the procurement will occur and what benefits or challenges will be encountered during product support
- Only minor changes should be allowed, since cost, risk and schedule delays increase exponentially with changes.
- As expected, all of the lessons learned for traditional DoD acquisition programs apply—funding stability, no requirements creep, and requiring high technology readiness levels.

As a program manager, you know you have achieved success on a CDA program when you reach the three-way intersection on the knowledge highway<sup>2</sup> where:

1. A match is made between the customer's requirements and the available technology
2. The product's design is determined to be capable of meeting performance requirements
3. The product is determined to be producible within cost, schedule, and quality targets

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<sup>1</sup> The Mogwai must be kept away from bright light, never made wet and never, ever be fed after midnight. . Confused? Find a copy of 1984s "Gremlins."

<sup>2</sup> "Best Commercial Practices Can Improve Program Outcomes," GAO Report GAO/T-NSAID-99-116, 17 March 1999.

## **The Architecture of this Book**

In this book, we have divided the chapters into five main sections:

### **THE BEGINNING OF COMMERCIAL DERIVATIVE SYSTEMS**

1. **In the Beginning:** This is an abbreviated discussion of the original United States CDA: The Wright Flyer.
2. **Recent Department of Defense Experience and Direction:** This chapter looks at the evolution of CDAs as DOD and the aerospace industry grew.

### **THE THEORY OF COMMERCIAL DERIVATIVES FOR MILITARY AIRCRAFT**

3. **Economics 101 for Commercial Derivatives:** This detailed discussion provides the framework for later chapters on how to successfully adopt commercial aircraft and major commercial technologies into military programs.
4. **Are Commercial Derivative Aircraft As Easy as They Look?** This chapter discusses the application of the theory and compares and contrasts commercial and military aircraft programs. This chapter focuses on three case studies of CDA programs to learn the pros and cons of actually executing a CDA program.
5. **FAA Certification—We Paid For It, Why Throw It Away?** This chapter discusses the certification issues of CDAs and why the military normally does let this lapse.
6. **Logistics and Support.** This chapter expands the discussion of logistics and support benefits from CDAs and why they are difficult to capture and retain.

### **WHAT'S SO HARD ABOUT BUYING SOMETHING OFF THE SHELF**

7. **Why Can't We Make Up Our Minds?** This chapter looks at how requirements guide the source selection and how recent history is challenging how we choose CDAs.
8. **Commercial Derivative Case Studies.** This looks at the challenges of setting up, acquiring and operating CDA programs.
9. **If It Already Works, Why Are We Testing It?** This chapter addresses the challenge of determining if the CDA meets military needs and how much new testing is actually required.

## **WHAT DO THE EXPERTS THINK?**

10. **Does Time Heal All Wounds?** For this book, we interviewed over 50 experts on CDA programs to include engineers, program managers, senior DOD officials and system operators. This chapter gathers their significant expertise and insight on the correct way to use CDAs.
11. **What Does Industry Think?** This is a compilation of industry comments based on our interviews with industry leadership.

## **DID WE PAY ATTENTION AND LEARN SOMETHING?**

12. **Lessons Learned:** This is a compilation of numerous sources on CDA lessons learned from the experts and the literature.
13. **What Does the Future Hold?** Like many studies of this type, we found a long list of lessons learned, met many really smart people and researched multiple CDAs that worked well in the commercial world—so how did things get messed up and where do we go from here?

## **The intended readership**

This book is written for present and future acquisition program managers and their functional staff for both aircraft producers and for government program offices. This book, along with the USAF Commercial Derivative Aircraft Acquisition Guide, provides a solid starting point for new programs attempting to acquire commercial aircraft to fill military roles. Many of the topics and lesson learned also apply to non-aircraft programs, so that anyone attempting to meet military requirements with an off-the-shelf system will benefit from its content.



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**Dayton Aerospace, Inc.**

All the interviewees who preferred to remain anonymous.

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Dr. Stockman received a BS in Mathematics and a BS in Business Administration in 1977 from Southeast Missouri University, a BS in Aeronautical Engineering in 1984 from AFIT, a MS in Engineering Management in 1986 from West Coast University, an MS in Operations Research in 1988 from AFIT, an MA in Economics in 1995 from George Mason University and a PhD in Economics in 1996 from George Mason University. A private pilot, Dr. Stockman built and flies an experimental Velocity aircraft.

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## Did We Pay Attention and Learn Something?

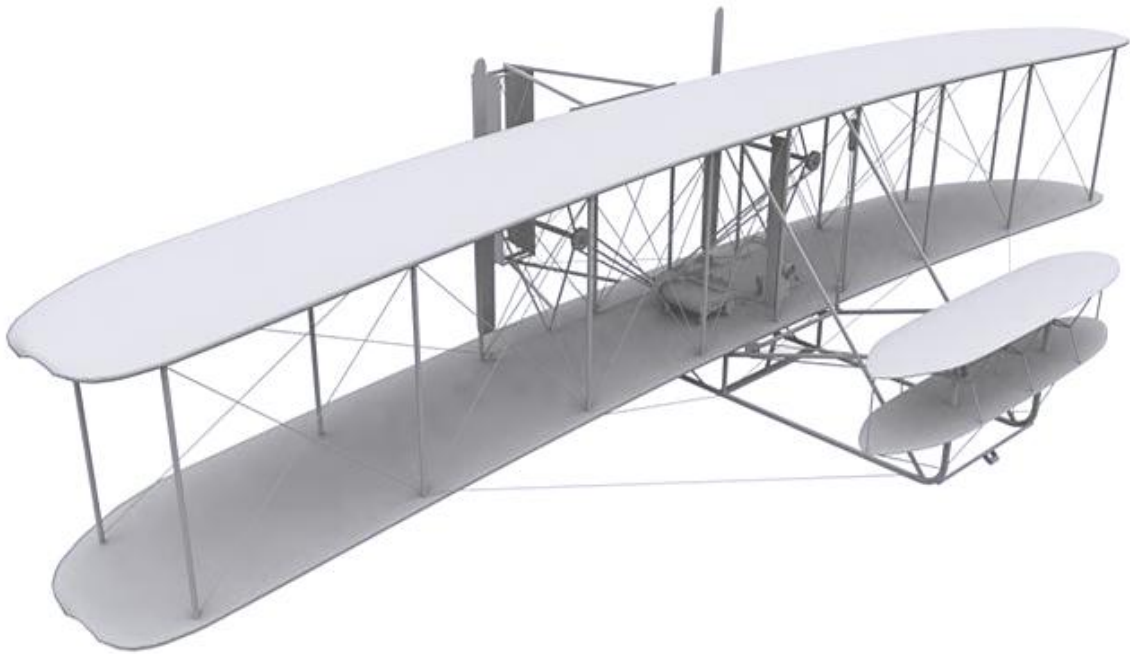
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# Part One

## The Beginning of Commercial Derivative Systems





# Chapter One

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## In The Beginning

*"Isn't it astonishing that all these secrets have been preserved for so many years just so we could discover them!" Orville Wright*

### The First Commercial Derivative Aircraft

It was a chilly day on December 17<sup>th</sup> 1903 with the wind gusting 20-25 miles per hour from the north. The Wright brothers were cold, tired and exhausted after several weeks on the beach of building and rebuilding their only aircraft. They had tried twice the day before to fly, but ended up damaging the fragile flyer. The brothers had invested every penny they had in this folly to fly, having recently sold their bicycle company which provided much of their income and research funding. Orville finally lay down on the plane's wing after making sure everything was ready, engines running strong, he signaled for the release of the ropes—12 seconds and 120 feet later he had made history. Less than a dozen people were there to witness the event. The first flight was reported to the news services at the time, but most did not pick up the story. Apparently someone forgot to schedule the ticker-tape parade.

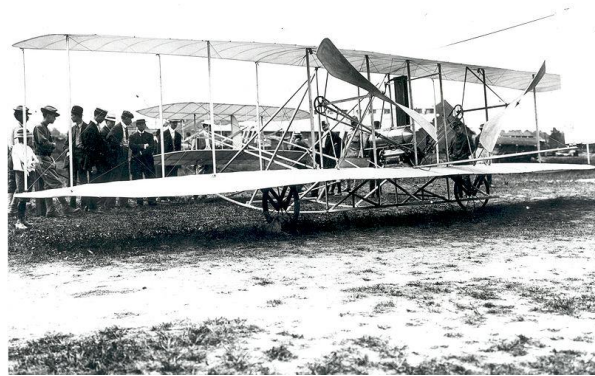
Despite the thrill of wind in your hair and bugs in your teeth, the Wrights were business men at their core and had given serious thought on how to capitalize on their invention. They realized that it was a rather pricey toy for the rich or could possibly be used by large companies or even governments. Observation balloons had been used since the Civil War, so the concept of having aerial capabilities was not totally new to either the general population or the governments. The Wrights attempted several times to contact the United States Federal government, but were politely told the government did not fund research projects by "private inventors." The Wrights in their letters explained they had already invented the airplane and just wanted to demonstrate it, but little came of these early efforts in the 1904-1906 timeframe.

This apparent firewall that the Wrights couldn't breach was likely a simple combination of three factors. First, there was no group in the War Department or other government agencies that "owned" this area of technology or capability. The closest would have been the aeronautical division of the Army signal corps (balloons) and they lacked what we would recognize today as a research capability. Second, there was an existing government effort funded by the Smithsonian and led by Dr. Langley to build an airplane. The agency along with Dr. Langley had significant political power compared to two unknown brothers in Dayton Ohio. It's doubtful that Dr. Langley was looking for

competition.<sup>3</sup> Finally, there was little knowledge about how far the Wrights had progressed and the advanced capabilities of their machine. Most of the aircraft up to this time (1907) could barely fly a few hundred feet straight ahead before crashing—not much of a useful military capability. The Wrights had spent several years in Dayton at Huffman Prairie after 1903 perfecting their design and exponentially improving its capabilities—all while being ignored by the press and potential competitors.

Five years after their first flight and with a newer, more capable Flyer, the Wright Brothers finally found an audience who appreciated and admired their work—the French along with other Europeans. From 1908-1909 the Wrights demonstrated their machine to European heads of state and hundreds of thousands of spectators. They had little trouble in garnering contracts to provide flight demonstrations, teach flying or sell aircraft to these countries and their wealthy citizens. To say the Wright brothers were heroes in Europe would have been an understatement. Despite their almost “rock star” status at the time in Europe, America continued to ignore them.

The Wrights finally got their opportunity due to a prior acquaintance with an elder French Balloonist and his son, US Army Lt. Lahm. The elder Lahm was a balloonist and an aviation enthusiast and had corresponded with the Wrights for several years. After the son (a West Point graduate) was assigned to the Aeronautical Division of the Army Signal Corps at Fort Myers, Va. the father arranged an introduction to the Wrights while they were doing demonstrations in France. Lt. Lahm saw them fly and became a major supporter of their work. Upon returning to the US, Lt. Lahm took it upon himself to contact the head of the Signal Corps, Brig. Gen. James Allen. After several attempts, the General agreed to meet with the Wrights, in this case Wilbur. Wilbur provided a rather simple presentation to the Board of Ordinance and Fortification based on their performance data—an aircraft that could carry two people at forty miles per hour, land and takeoff relatively quickly and could be transported by wagon over normal terrain.<sup>4</sup> This resulted in the Army releasing an RFP based on these performance parameters. The Government received 41 bids that ranged from \$100 to \$10 million, with one bid claiming their plane could fly at 500 miles per hour. The Army offered three contracts (see Figure 21) of which the Wrights were the only contractor who could meet the specifications. They offered their plane (Figure 1) for \$25,000 and the contract was signed in



**Figure 1. Wright Flyer**

---

<sup>3</sup> Langley was very aware of the Wright brothers and had received and answered several letters from them. It's not clear if he actually understood their first flight accomplishment.

<sup>4</sup> These initial specifications were based on the concept that the flying machine was to be used much like a balloon.

February 1908 with a requirement to deliver the plane within 200 days for flight test.

This became the first powered commercial derivative aircraft to be purchased by the military.<sup>5</sup> By today's standard it was a relative success. It was on time and on budget. It met all of its performance specifications and requirements. Relative however is the key word. They delivered the plane to Fort Myers in the late summer of 1908. The Army required flight trials which began in September. The initial flights went well, but on 17 September with a passenger onboard (Lt. Thomas Selfridge), the propeller and its drive chain failed causing a crash. Lt. Selfridge was killed and Orville Wright was seriously injured. After recuperating from the accident, Orville and Wilbur rebuilt the aircraft

and returned in the summer of 1909 to finish the acceptance tests. Tests included a two person cross country flight of 20 miles as well as speed runs to meet the 40 mph contract requirement. The plane actually flew at 42.5 mph and earned the Wrights a \$5000 bonus. The plane was formally accepted on August 2, 1909 and was designated Signal Corps Airplane No. 1.

Form No. 50. <b>Order No. 3619</b> Requisition No.	M. Show these numbers on bills and refer to them in correspondence. Forward bills to Disbursing Officer, Signal Corps, U. S. Army, Washington, D. C., rendering them the same day shipment is made.
--	--

**WAR DEPARTMENT,**  
**OFFICE OF THE CHIEF SIGNAL OFFICER**  
 WASHINGTON. February 10, 1908.

**Wright Brothers,**  
 Dayton, Ohio.  
 Gentlemen:

Under proposal No. 203, opened in this office on  
 February 1, 1908, (41)

*I am directed by the Chief Signal Officer of the Army to place order with you for the  
 articles listed below, subject to the instructions on the back hereof.*

Goods must be securely packed for shipment and delivered within 200 days from  
 receipt of order, ~~to Fort Myer, Va.~~ to Fort Myer, Va.  
 being forwarded

*If transportation charges are to be borne by the United States, Government bill of lading must  
 be received by you before shipment is made. If you ship without Government bill of lading, you  
 will be held for transportation charges. Advise if there is delay in furnishing bill of lading.*


*Inspection will be made at Fort Myer, Va.*

Mark packages: Order 3619.  
 Address and ship: Signal Officer,  
 Fort Myer,  
 Virginia.

**ITEM:**  
 One (1) heavier-than-air flying machine, in accordance  
 with Signal Corps Specification No. 486, dated December 22,  
 1907, at \$25,000.00-----\$25,000.00

**NOTE:**  
 Bond is required in the sum of ten percent of the considera-  
 tion, and upon receipt of same your certified check for \$2,500.00  
 will be returned to you.

App. Board of Ordnance & Fortifications  
 Encl. 4  
 Copies to AD-ED-B-TD-Con.  
 T. R. No.

Very respectfully,  
  
 Captain, Signal Corps, U. S. A.,  
 Disbursing Officer.

**Figure 2. Wright Military Flyer Contract**

<sup>5</sup> It was also the first performance based contract for a power aircraft. The contract offered a \$5000 bonus for exceeding the 40 MPH requirement; the Wright aircraft flew at 42 MPH.



## Chapter Two

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### Recent Department of Defense Experience and Direction

*“At that time [1909] the chief engineer was almost always the chief test pilot as well. That had the fortunate result of eliminating poor engineering early in aviation.”*

— Igor Sikorsky, reported in 'AOPA Pilot' magazine February 2003

#### The Airplanes

As the world watched the Wright brothers in 1908-09 with amazement, another group watched with a different purpose. Young military officers in the US and especially Europe looked at the airplane and began to debate, plan and strategize on how to use this new technology in warfare. The Wright's main dream was to just build an aircraft that would fly and hoped others would buy it for that purpose. With their strong religious background it is not likely they were creating it with warfare in mind. Yet, like most technology, commercial products often transition from weapons or transition to weapons.



**Figure 3 Early Curtiss Hydroplane**

As the Army was testing its single aircraft, others were indeed watching. The Navy paid attention and quickly bought their first aircraft in 1911. By this time they had a good theory of how to use it as a long range observation platform for ships, so they wanted an aircraft that operated off the water. They approached the Wright brothers about a Wright B Flyer and had them modify it with floats, which provided less than adequate performance. During this period, Glenn Curtis had developed his own design which worked well on water, so the Navy purchased it over the Wright aircraft (Figure 3). This began a long list of new commercial aircraft development that continued into WWII. On the next page is a partial listing<sup>6</sup> of the aircraft that the Army acquired starting with the Wright B Flyer through the end of the twentieth century.

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<sup>6</sup> This does not include training aircraft, which would provide several CDAs.

**Table 1. Listing of Early Commercial Derivative Aircraft**

Wright B Flyer	Aircraft Number One	Lockheed Lodestar Model 18	C-56, 57, 59, 60, 66
Fokker F-VIIA Trimotor	C-2	Fairchild Model 24	UC-61
Ford 4-AT-B Trimotor	C-3	Stout Skycar	C-65
Ford 5-AT Trimotor	C-4	Lockheed Martin Constellation	C-69
Fokker F-10A	C-5	Howard DGA	UC-70
Sikorsky 38A	C-6	Spartan Executive	UC-71
Fokker F10B	C-7	Waco Exec Cabins	UC-72
Fairchild Model 71	C-8	Boeing 274	C-73
Stout C-3 Trimotor	C-9	Boeing 307 Stratoliner	C-75
Curtis Robin	C-10	Cessna Model DC-6	C-77
Consolidated Model 17	Y1C-11	Cessna T-50	UC-78
Lockheed Vega	Y1C-12	Harlow PCJ-2	C-80
Fokker F-14	C-14	Stinson Reliant	UC-81
Fokker F-14 Ambulance	C-15	Piper Cub	C-83
Fokker F-XI	C-16	Lockheed Model 9	UC-85
Lockheed Vega DL-1b	Y1C-17	Fairchild F-24	UC-86
Boeing 221	C-18	Fairchild F-45	C-88
Northrop Alpha I	C-19	Hamilton H-47	C-89
Fokker F-32	C-20	Luscombe Model 8	C-90
Douglas Dolphin	C-21	Stinson Trimotor	C-91
Consolidated Model 17 Fleetster	Y1C-22	Akron Funk B-75	C-92
Lockheed Altair DL-2A	Y1C-23	Cessna 165	C-94
American Pilgrim	Y1C-24	Taylorcraft B-65	UC-95
Lockheed Altair 8B	Y1C-25	Fairchild Model 71	UC-96
Douglas Dolphin-mod	C-26	Boeing 377 Statocruiser	C-97
Bellanca Airbus	C-27	Boeing 314 Flying boats	C-98
Sikorsky S-39C	C-28	Northrop 2D Gamma	UC-100
Douglas Dolphin-mod	C-29	Lockheed Model 5C Vega	UC-101
Curtis T-32 Condor	YC-30	Rearwin Speedster	C-102
Douglas DC-2	C-32, C-33, C-34	Lockheed Model 118	C-104
Lockheed Electra 10E	XC-35	Stout Skycar II	C-107
Lockheed Electra 10A	C-36, C-37	Douglas DC-5	C-110
Douglas DC-2 mod	C-38, 39	Lockheed Super Electra	C-111
Lockheed Electra 12A	C-40	Douglas DC-6	C-118
Douglas DC-3	C-41, C-42	Lockheed 749 Constellation	C-121
Beechcraft Model 17	C-43	Cessna 195	LC-126
Taifun BF-108	C-44	DeHavilland Beaver	C-127
Beech 18S	C-45	Convair 240	C-131
Douglas DC-3	C-47, 48, 49, 50, 51, 52, 53, 68,84, 117, 129	Boeing 707	VC-137



Just a cursory look at the data and several things jump out at you:

- The Army/Air Force bought a large number of CDAs, more than most imagined and a significant percentage of the Army Air Corp fleet.
- While not totally complete, the list shows that most of the CDAs have been cargo and utility aircraft.
- There are few if any armed combat aircraft.

This list represents a major portion of all aircraft in the Army/USAF inventory for the period. The results should not be too surprising. During this early period of aviation there were many small companies building aircraft in search of a growing commercial market. The military did not have the large planning and requirements-generation bureaucracies that are so prevalent today, so they were more willing to try whichever aircraft reached the market. One of the early successes was the Douglas DC-3 airliner which became the C-47 transport (Figure 4). The Army and Navy were just learning how to use aircraft to supplement their traditional forces, so the military “environment” was similar if not the same as the commercial environment. Compared to the large traditional armies and navies with their equipment and logistical systems, there was little thought (or funding) to provide major air transport support or its required infrastructure.



**Figure 4. C-47**

While the US military did not have large aircraft fleets, they did have growing development and flight test operations prior to WWII—much of it occurring at Wright Field in Dayton Ohio. Much of this research and technology made its way directly into the commercial market. During this period, the military performed a significant number of test flights and experimentation with their aircraft to develop new operational capability. This included bigger engines, avionics that would allow IFR flying, autopilots, and larger aircraft. WWII provided an opportunity for the world to see the value of airpower and also accelerated the concept of unique military developed aircraft. This was partially driven by the cold war requirement to maintain a large standing military with significant numbers of weapons. This pseudo version of “economy of scale” helped offset the significant non-recurring development costs. It also helped create what President Eisenhower (Figure 5) termed the “military industrial complex’ or large military contractors who produce weapons full time.<sup>7</sup> This shift allowed the military to switch from commercial cargo and utility aircraft to military unique developments: C-130, C-124, C-119, C-141, C-133, C-5, and the C-17 among others.



**Figure 5. President Eisenhower’s Military Industrial Complex Speech**

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<sup>7</sup> At the end of President Eisenhower’s term he warned against the major changes he saw in rapidly expanding government and full time military contractors: “In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.” Eisenhower Presidential Library, 1960.

**Table 2 Boeing Family of Aircraft**

Boeing Airplane Families	2008 \$ in Millions
<b>737 Family</b>	
737-600	51.5 -- 58.5
737-700	58.5 -- 69.5
737-800	72.5 -- 81.0
737-900ER	76.0 -- 87.0
<b>747 Family</b>	
747-400/ -400ER	234.0 -- 266.5
747-400/ -400ER Freighter	238.0 -- 268.0
747-8	293.0 -- 308.0
747-8 Freighter	301.5 -- 304.5
<b>767 Family</b>	
767-200ER	127.5 -- 139.0
767-300ER	144.5 -- 161.5
767-300 Freighter	155.0 -- 166.0
767-400ER	158.0 -- 173.0
<b>777 Family</b>	
777-200ER	205.5 -- 231.0
777-200LR	237.5 -- 263.5
777-300ER	257.0 -- 286.5
777 Freighter	252.5 -- 260.5
<b>787 Family</b>	
787-3	150.0 -- 155.5
787-8	161.0 -- 171.5
787-9	194.0 -- 205.5

This switch from CDAs to military unique initially came at additional cost and schedule. Prior CDA's were bought from existing production lines with little or no new military development. The government was just another purchaser who paid some share of the original development program plus the current production costs. Table 2 on the left shows the current pricing range for Boeing commercial customers. This is a mix of production and prorated development costs. How does this compare to our USAF developed military aircraft, such as the C-17? In 2009, the GAO reported<sup>8</sup> the total program costs of the C-17 as \$66B for a planned buy of 205 aircraft.<sup>9</sup> This works out to an average cost of \$322M per plane. Had the USAF ordered B-747s at the time of the initial C-17 program start, they would have been much cheaper and delivered almost seven years earlier. The C-5 program cost over \$22B in current dollars for 131 aircraft with a new modernization program currently being executed to upgrade the remaining 111 C-5 engines and avionics—at a new cost approaching \$130M per aircraft.

With cheaper acquisition costs, one must then ask if the commercial aircraft can fulfill the mission requirements satisfied by the two USAF developed aircraft. There answer is no. No commercial aircraft can carry a main Army battle tank nor allow for roll-on cargo loading or land on unimproved fields. However, it is quite likely that several of the commercial aircraft on this list could satisfy a major

portion of the typical C-5 and C-17 missions and do so at a reduction in the cost per flying hour. The issue is: can the Air Force divide up its logistics missions to allow for a lower cost wide-body commercial freighter to be used.<sup>10</sup> Many of the studies in the past have looked at this, but most assume an all-or-nothing solution. It's interesting that the Air Force continues to use the Civil Reserve Air Fleet (CRAF) program (used during Desert Storm and other recent deployments) which uses these same commercial aircraft.

<sup>8</sup> "Timely and Accurate Estimates of Cost and Requirements are Needed to Define Optimal Future Strategic Airlift Mix," GAO Report November 2008, GA)-09-50.

<sup>9</sup> The USAF has since bought 6 more aircraft in the 2010 budget.

<sup>10</sup> One must also include the significant cost of the unique ground support and loading equipment that might be required for military cargo.

One reason might be that the USAF fleet is currently right sized for just those missions and cargo that CRAF can't handle—but this is unlikely.

One example of a current “commercial” aircraft is the Antonov AN-225 of which one is currently leased out worldwide to carry oversize cargo (Figure 6). The An-225 has been contracted by the Canadian and U.S. governments to transport military supplies to the Middle East in support of Coalition forces. This was a large military aircraft developed by the former Soviet Union, but available for production as a commercial aircraft.



**Figure 6. Antonov AN-225**

## **Current Policy**

In our quick snap shot of history shown in Table 1, the US military apparently had little difficulty in buying CDAs to meet its needs. Prior to this, there were few if any aircraft companies dedicated solely to the production of military aircraft—especially to meet cargo and utility mission requirements. The few that did build aircraft could not service the entire market so there appeared to be plenty of sales to go around. That began to change after WWII as the newly established military industrial complex stood ready to develop and produce custom built aircraft for all of the military needs. At the same time, military planners and operators developed requirements for new aircraft that no longer mirrored those of commercial aircraft. This movement hit its peak in the late 1950s and 1960s when almost all new aircraft were new developments. This included the traditional cargo, trainers and utility aircraft that the commercial industry had previously provided. This growth of the military industrial complex helped create dozens of military aircraft companies. This move toward unique military aircraft did not totally go unchallenged. One of the more interesting but unsuccessful ideas was to use a B-747 to become a giant airborne missile platform. As shown in Figure 7, the concept aircraft carried 48 cruise missiles. While this concept didn't make it very far, Boeing was successful several years later in winning the contract to develop the Airborne Laser aircraft using the B-747 airframe.



**Figure 7. Boeing B-747 Cruise Missile Platform**

The growth of the aircraft industry began to stall out in the 1970s as the US exited the Vietnam War era with its major build up of weapons. Military expenditures increased again with the peak of the Cold War and the Reagan build up in the mid-1980s. However, that buildup died quickly with the end of the cold war and a turning to other political priorities in the early 1990s.

During this period, the DOD encouraged the consolidation of the industry due to a long term forecast for fewer aircraft and minimal new aircraft development. The underlying theory was that this thinning of the industry would make it more efficient and thus lower costs to DOD.<sup>11</sup> One researcher<sup>12</sup> for the USAF described it as follows:

*“The recent consolidation of defense prime contractors represents the single starkest merger wave in US economic history. In retrospect the consolidation seems motivated largely by the urging of the Department of Defense (DOD) during the Clinton administration. During this period, the number of prime contractors dropped by more than 75 percent while revenues decreased no more than 15 percent in any given year—with no emergent trend in this decline—and the industry itself reported eight*

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<sup>11</sup> At an event dubbed Perry's Last Supper at the start of the Clinton administration, then Defense Secretary William Perry called in the leading defense industry CEOs and said that most of their companies would have to disappear. This helped spark a wave of consolidation, which was primarily horizontal companies buying up different capabilities.

<sup>12</sup> LTC Michael Hicks, PhD, “The Robust State of the US Aircraft Industrial Base,” Air & Space Power Journal, Winter 2006.

*consecutive years of growth as of 2005. The apparent hope from the early 1990s was that these mergers would cut acquisition costs through increased efficiency, although I have yet to uncover an argument for these mergers based on economic analysis. Importantly, the prime source of efficiency gains (and potential cost reductions) from these types of mergers would occur through achieving scale economies.*

*The DOD not only permitted but also promoted this merger wave despite clear and repeated violations of the Department of Justice's merger guidelines, established to protect competition (and, therefore, lower prices)—the goal of the DOD-supported consolidation. The seemingly incompatible goals of higher concentration and lower prices never materialized. Indeed, in 1998 the General Accounting Office (GAO) (now the Government Accountability Office) offered a highly cautionary analysis of the recent consolidation, in effect warning the DOD of the potential for market-power-related price increases in subsequent purchases.<sup>5</sup> These fears proved warranted, and recent analysis suggests that defense consolidation played at least a modest causal role in cost overruns of the 1990s.*

As shown in Figure 8 on the next page, the rapid consolidation left the DOD with few suppliers of military aircraft (and other military weapons) and created a monopoly supplier situation. During this period, DOD became interested in commercial derivatives since it appeared a good way to insert competition into the shrinking military industrial base. At its simplest, the DOD would be able to buy aircraft (assuming they met all military requirements) at commercial prices established in normal competitive markets. Further, it was widely believed that the commercial market was more efficient and that its best practices would work well on DOD programs.

The US Congress has often been a critic of the military industrial complex, at least since the Vietnam era, and has passed a series of legislative acts to encourage if not require the consideration of commercial items to meet DOD requirements. As shown in Table 3,<sup>13</sup> several major commissions, studies and legislative acts have pushed for commercial acquisition.

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<sup>13</sup> GAO Report "Efforts Needed to Address Air Force Commercial Acquisition Risk," GAO-06-995, September 2006.



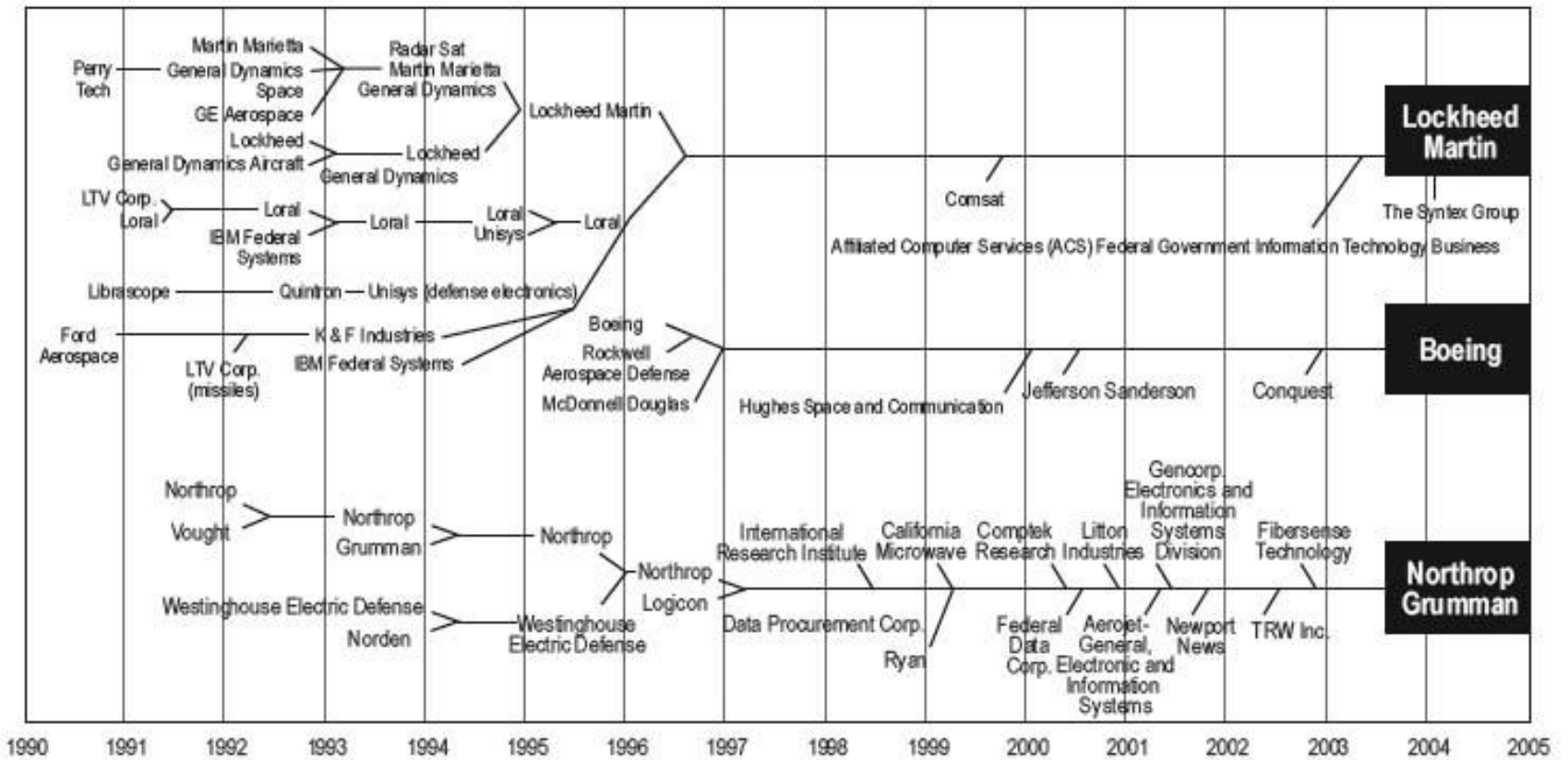


Figure 8. **Consolidation of Aircraft Manufacturers.** (From Security Data Corporation Merger Database, 2004.)

**Table 3: Overview of Commercial Acquisition Legislative History**

<b>1972</b>	Commission on Government Procurement: <b>Commission's recommendation:</b> Government should take greater advantage of the efficiencies of commercial marketplace.
<b>1984</b>	Competition in Contracting Act of 1984:  Required promotion of the use of commercial products whenever practicable.
<b>1986</b>	National Defense Authorization Act for Fiscal Year 1987:  <b>1986 act:</b> Required DOD to acquire non developmental items (commercial items) to the maximum extent practicable.  President's Blue Ribbon Commission on Defense Management (Packard Commission):  <b>Commission's recommendation:</b> DOD should expand the use of commercial products and commercial-style competition
<b>1993</b>	Advisory Panel on Streamlining and Codifying Acquisition Laws (Sec. 800 Panel)  <b>Panel's recommendation:</b> Called for the facilitation of government access to commercial technologies.
<b>1994</b>	Federal Acquisition Streamlining Act:  <b>1994 act:</b> Expanded the commercial item definition to include non developmental items, those not yet on the market, and "of a type" items and stand-alone services. Exempted commercial item procurements from requirement to submit certified cost or pricing data to the government under certain conditions. Provided preference for acquisition of commercial items and streamlined mechanisms for their procurement.
<b>1996</b>	Clinger-Cohen Act of 1996:  <b>1996 act:</b> Exempts commercial item acquisitions from requirement to submit certified cost or pricing data and comply with cost accounting standards.
<b>2003</b>	Services Acquisition Reform Act of 2003:  <b>2003 act:</b> Allowed different types of contracts to be treated as commercial acquisition under certain circumstances
<b>2006</b>	DOD Authorization Act:  <b>2006 act</b> requires that to use commercial acquisition procedures for major weapon systems, the Secretary of Defense must now (1) determine the procurement meets the definition of "commercial item," (2) determine that national security objectives necessitate the purchase of the system as a commercial item, and (3) give Congress at least 30 days notice before purchasing a major acquisition program using commercial acquisition.

The underlying theory for all of the early legislation was that DOD would select programs where the commercial sector offered a product developed and sold in a commercial environment (thus providing best value at minimum cost). The legislation also encouraged the use of commercial like contracts (FAR 12) with commercial terms and conditions. In the perfect theoretical world, this would have reduced risk, improved schedule and lowered acquisition costs—much like the military saw in the early 1930s and 1940s when they purchased commercial cargo and utility aircraft. As several GAO investigations later demonstrated, things didn't work out as planned. One reason for the



failure was that the traditional military contractors were able to hypothesize a faulty business case that their products qualified as commercial. One example was the Lockheed Martin C-130J (Figure 9). Lockheed had designed the original C-130 back in the 1950s and had built over 2300 since 1955. In the early 1990s, they were producing the successful C-130H variant and were planning the next upgraded version. The new aircraft was designed as a significant evolutionary change to the existing H model—almost a new aircraft. Lockheed prepared a business forecast and expected to sell hundreds (if not thousands) to the US and foreign markets as replacements for the existing C-130 fleet. The business case assumed large US military, NATO and commercial orders. LM would develop the aircraft on company money and prorate the development cost over the production run. They would then set a “commercial” price. The company expected the US in return to declare it a commercial program and allow them to use a FAR 12 contract which provided minimal cost and pricing data. The benefit to the US government (besides a technologically advanced transport) would be a lower price since they would only pay a small percentage of development cost. Unfortunately, the sales projection was wrong and the DOD ended up paying for much of the total development cost. As the costs rose and the schedule slipped, the DOD was not able to get detailed information on the program. Eventually the program was changed to a FAR 15 contract with detailed cost and pricing data required to set the negotiated prices.



**Figure 9. Lockheed Martin C-130J**

This and other examples during the period soured the DOD on commercial practices which indirectly impacted CDAs. Today the most recent relevant legislation (2006 Authorization Act) requires that to use commercial acquisition procedures for major weapon systems, the Secretary of Defense must now (1) determine the procurement meets the definition of “commercial item,” (2) determine that national security objectives necessitate the purchase of the system as a commercial item, and (3) give Congress at least 30 days notice before purchasing a major acquisition program using commercial acquisition.

With this act, the DOD hoped that they would have fewer problems in the future with CDA type acquisitions. As Chapter 7 and 8 in this book will discuss, this Act did little to save the DOD from future pain and suffering.

This raises the question of whether CDAs are still a good option. As we will say many times in this book, the answer is still yes—given that you follow the five basic rules.

1. You must fully understand the mission requirements before starting a search.
2. The “green” commercial aircraft must closely match the required military requirements—if not, adjust the requirements.
3. The commercial aircraft (system) needs to be developed, produced and competed in a real competitive market to keep the price low.
4. Commercial practices work best on military programs when the commercial market continues to discipline the manufacturer.
5. You must understand the point of entry for the CDA in the production line and commercial market trends that will influence the long term product support during the operational lifecycle.

## Part Two

# The Theory of Commercial Derivatives For Military Aircraft





## Chapter Three

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### Economics 101 for Commercial Derivatives

*“...most senior officers came to regard as among the most vital to our success in Africa and Europe during WWII were the bulldozer, the jeep, the 2 ½ ton truck and the C-47. Curiously, none of these were designed for combat”*

*-----General Dwight D. Eisenhower*

#### Are Commercial Derivatives a New Idea?

The use of commercial products or technology for military purposes goes back to the first caveman who used the same commercially available rock to kill his evening meal as he did to kill his neighbor. Unburdened by government regulations or a military industrial complex, this was the way militaries acquired equipment and weapons for many centuries. Most individuals (if not their communities) could not afford to invest valuable resources on items that didn't provide multiple uses.

As societies became more affluent, resources became available that allowed for specialized military weapons and equipment. Early examples go back thousands of years to the first naval vessels that served as cargo and military warships. But even then, these ships had to earn their investments by the cargos that they brought back to the owners or governments. Other early investments would also include walls, fortresses and other defensive structures that had to serve multiple purposes. The key element that determined the extent of the investment was the wealth of the society. As the Roman Empire crumbled and the middle ages began, history shows a significant reduction in military systems/investment with a return to lower cost/dual use systems and technologies. This is just basic economics at work. With a significantly reduced national economy, scarce resources are needed more for plowshares than they are for swords.

In recent times, we have witnessed a major increase in world economic levels and wealth, which has spurred a major investment in offensive and defensive systems. Famed economist Adam Smith<sup>14</sup> noted back in the late 1700s that nations had a rather simple decision to make about defense: either invest in defense and show your enemies

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<sup>14</sup> An Inquiry into the Nature and Causes of the Wealth of Nations, Adam Smith, 1776.

that any attack will be costly or minimize defensive investments and encourage your enemy to invest in military equipment to attack you. You also have to convince your enemies that you will use the military equipment to obliterate them.

In recent history, most nations ramped up for war by converting their civilian industries to war time producers of weapons. At the conclusion of the war, they would revert back—the old “swords into plowshares” philosophy. Many of these firms produced dual use technologies or at least had the capability to manufacture a variety of products for either war or peace. It also is often the case that after a war, there is a stockpile of weapons, so the victor doesn’t need to buy more.

At the end of WWII, there was an expected major build up of demand for commercial goods and thus the industries would quickly reconvert to producing consumer goods. However, in the United States and Europe, the demand for military weapons did not drop to zero. This was based on several factors. First, the United States knew during WWII that the Soviet Union would likely be a major threat after the war. Normally, after most European wars, the victors usually went home after imposing some penalty on the loser. In this case, the Soviets expanded their borders and occupied much of Eastern Europe. This required the US and its allies to counter this by occupying much of Western Europe. Shortly thereafter, China turned communist and allied with the Soviet Union against the US and its allies. The Korean War began in the early 1950s requiring another major military build-up. Finally, China, the Soviet Union and other countries continued to develop new weapon systems. All of this began an arms race that has lasted over seventy years.



**Figure 10. US Army C-47 (Douglas DC-3)**

Focusing on aircraft prior to the arms race, the US tended to buy two basic types—cargo/passenger/utility and bomber/fighters. There were few if any civilian designs that could be used for bomber/fighter roles, so these were almost all developed and produced by the military and their contractors. The cargo/passenger/utility category was just the opposite. The vast majority of military aircraft in this category originated as civilian designs, such as the C-47 shown in Figure 10, which commercially was a DC-3. There are many reasons that led to this acquisition practice:

- Most aircraft companies focused on commercial sales--where the majority of their revenue was derived; the military did not buy large numbers of these aircraft.
- The mission of the utility/passenger/cargo aircraft was the same for both military and civilian user. Both tended to use dirt/grass runways, flew simple cross-country missions and hauled passengers and cargo from airport A to airport B. Only later (post WWII) did the commercial designs require dedicated long, hard surface runways.
- Unlike the bombers and fighters<sup>15</sup>, the US military was not deeply involved in strategic thinking on how to use aircraft for logistics beyond the existing commercial practice. At this time, aircraft transportation was still quite expensive and there was minimal infrastructure.
- Finally, there was the common sense reason that there were many commercial designs to choose from with relatively good pricing.

One final thought on these pre-1950s aircraft—they did not have nor require expensive development programs. They were relatively simple aircraft with incremental technology improvements—all or most of which were driven by the civilian market but used by the military. WWII changed this approach. WWII in some ways was a giant development and testing opportunity for the military to discover how aircraft could be used to fight and support warfare. While logistics has been around since our rock throwing caveman, the integrated use of airpower had not. Now military thinkers had time and experience to optimize aircraft design and operations to meet new military objectives. This created the requirement for new aircraft that no longer shared the same mission and operational requirements as the civilian market—even for transport aircraft. Thus, the military decided it was worth the investment to design their own transport aircraft as well as their bomber/fighter aircraft. As an example, one of the first military unique transports was the Fairchild C-82 developed soon after WWII. It had clam shell doors for easy loading and unloading on unimproved fields and runway (Figure 11).

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<sup>15</sup> A good example would be Billy Mitchell and the bombing exercises that demonstrated the role of aerial bombardment and the need for specialized aircraft.





**Figure 11. Fairchild C-82**

The era of military unique aircraft that began in WWII has produced some of the US's mainstay transport aircraft: C-82, C-131, C-124, C-130, C-119, C-123, C-141, C-5, and the C-17 among others. There has also been a long stream of attack/fighter/bomber aircraft: A-10, F-100 series, F-5, F-4, F-111, F-16, F-15, F-18, F-22, F-117, F-35, B-47, B-52, B-1, and the B-2 among many others.

However, there has been continued interest in CDAs for training, VIP transport and certain utility missions. This has produced a long stream of commercial derivatives that occurred at the same time: JPATS T-6A/B, T-3 Firefly, KC-135, KC-10, ABL, E-10, JSTARS, and a whole fleet of VIP transport aircraft. Does this mean that the US is reverting back to CDAs or something different? We would argue that the US never left the CDA approach, but has become more adept about when to use it.

## **What's a Commercial Derivative?**

At its simplest, a commercial derivative (CD) is any military aircraft that is traceable to an existing commercial design that has either been built or is being planned. This book also considers major subsystems that are CD—such as engines or major avionics installations. In 2009, the Defense Science Board issued a report<sup>16</sup> that defined a continuum of CD items:

1. Buy it from a manufacturer and use it as is. In this purest form, the Air Force staff car looks just like your grandmother's Chrysler K-car. The aircraft could be easily returned to civilian use.

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<sup>16</sup> "Buying Commercial: Gaining the Cost/Schedule Benefits for Defense Systems," Report of the Defense Science Board Task Force on Integrating Commercial Systems into the DOD Effectively and Efficiently, February 2009.



2. Buy it from the manufacture and make minor modifications. This would be organizational paint or basic communication systems. The aircraft could be returned to civilian use with minor modifications.
3. Buy it from a manufacturer and make major modifications. This would be armament, guns, military avionics suites, major interior modification—but most modifications made on the green aircraft outside of the production line.
4. Manufacturer makes major modifications prior to delivering the green aircraft.
5. Have manufacturer gut the aircraft and replace with a majority of military systems.
6. Have manufacturer modify a prototype with military requirements and then produce the military version.
7. Have contractor assemble a group of independent military components to create a new weapon systems
8. A product that does not yet exist, but requires commercial development and utilizes commercial plants or processes.

At the other end of this spectrum is a product that is designed and built from scratch to meet military requirements. Most of the examples discussed in this book are levels 1-3 as described previously and probably match a typical description of a commercial off the shelf product (COTS). As a real world rule of thumb consider this: if a program manager is considering a level 4 or higher approach, they should also look at traditional military development which might be cheaper and quicker.

The basics of CDA potential savings rest on simple microeconomic principles that all impact cost and schedule:

**Non-recurring research and development costs:** Whether commercial or military, there is an investment in the basic technology and subsystems which must be recouped. In the case of the military, it is budgeted upfront and totally charged to the single program. In the case of commercial aircraft, the companies usually use a mixture of proven and production ready technologies that have been fully researched, but not flying. Their non-recurring technology costs are normally much smaller than DOD's. When combined, the commercial company spreads their non-recurring cost over a rather large fleet of aircraft that are sold to multiple customers. The military sells only to one.

Looking at this from the *DOD viewpoint*, a military development program requires extensive government oversight and is guided by DOD technical requirements. Both of these add significant cost and risk. For a CDA program—this development portion of the green aircraft program does not exist—this all happened prior to the DOD program so there may be no explicit development cost to be recognized.

**Production costs:** Depending on the aircraft, a production run involves the facility, the tooling, the workers and their training, and the establishment of the material supply chain plus other engineering, management and administrative support. Again, with a CDA program, there are multiple customers normally who split the non-recurring production costs and that buy some quantities of the aircraft. The aircraft costs follow a traditional learning curve which reduces the price with each unit sold (base year dollars). Since DOD usually buys aircraft in the middle or near the end of a production run, they get the lowest cost per aircraft. However, if this was a military only development program then

the DOD gets to pay the entire cost of the program and buys its aircraft at the beginning of the production run in terms of the price curve. As before, the pure DOD program also has extensive oversight while the production of the green aircraft will have little if any costs for oversight.

At this point, the CDA would have some version of a modification program for the green aircraft depending on how significant are the changes necessary to meet DoD customer requirements. There would be no modifications on the pure DOD aircraft since they would be part of the normal production program. The modifications would have all of the non-recurring and recurring cost issues of a typical military production program.

**Sustainment costs:** Sustainment is the cost of the flight line, intermediate and depot-like maintenance plus the cost of the supply chain system, any data required and sustaining engineering. For the CDA aircraft with minor changes, the cost can be similar to any of the commercial operators. As long as the modifications didn't significantly change the certification or systems, the DOD can leverage existing civilian maintenance practices and facilities. They can also participate in parts cooperatives, engine programs and avionics programs that leverage entire fleets of similar aircraft.<sup>17</sup> Since many of these aircraft are commercially supported from the start, they can leverage standard commercial arrangements.

Traditional DOD developed aircraft normally have to develop their own maintenance systems and supply chains. Even if the maintenance is CLS, this large non-recurring cost of setting up a sustainment system for a new aircraft type is mandatory. The DOD can also option to set up a full-up depot capability—which also has large capital costs and education and training costs for the depot workers.

The system is modeled as follows:

$$\begin{aligned}
 \text{Cost } CDA_{unit} = & \frac{\sum R\&D_{TRL=high}}{n_1 + n_2 \dots n_{mil}} + \frac{\sum Prod_{nr} + Prod_{high}}{n_1 + n_2 \dots n_{mil}} \\
 & + \frac{\sum (Mod_{nr} + Mod_{rec} + test\&cert)}{n_{mil}} \\
 & + \frac{\sum Sus_{nr} + \sum Sus_{rec}}{n_1 + n_2 \dots n_{mil}}
 \end{aligned}$$

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<sup>17</sup> The impact of FAA certification and airworthiness on logistics will be discussed in detail in Chapters 5 and 6.

$$\begin{aligned} \text{Cost Mil}_{Unit} = & \frac{\sum R\&D_{TRL=low}}{n_{mil}} + \frac{\sum Prod_{nr} + Prod_{low}}{n_{mil}} + \\ & + \frac{\sum Sus_{nr} + \sum Sus_{rec}}{n_{mil}} \end{aligned}$$

So what does the model imply? First, the typical commercial development for a green aircraft is less than that of a military aircraft. In competitive markets, competition does not allow for significant development expenditures. This assumes the military requirements are flexible enough such that the commercial design is satisfactory. Requirements that force changes to the green aircraft drive expensive modifications and budget risk. Here not only is the numerator less for the CDA, but the denominator is larger for the CDA—both of which confirm the theory that the development costs of a new military design will be more expensive at the unit cost level. Inherent with that major cost increase is the schedule required to accomplish the work.

$$\frac{\sum R\&D_{TRL=high}}{n_1 + n_2 \dots n_{mil}} \ll \frac{\sum R\&D_{TRL=low}}{n_{mil}}$$

Depending on when the DOD buys the CDA, much if not all of the original R&D may have been recouped. It is possible that the DOD could avoid this green aircraft R&D cost entirely

The second parts of the model are the non-recurring and recurring production costs. It is assumed that DOD is normally buying a green aircraft that is currently in production and is well down the typical production learning curve. The non-recurring portion is allocated over the entire production run with DOD paying only its share versus the entire cost for a traditional DOD acquisition program.

$$\frac{\sum Prod_{nr} + Prod_{high}}{n_1 + n_2 \dots n_{mil}} \ll \frac{\sum Prod_{nr} + Prod_{low}}{n_{mil}}$$

Using a very simple model and assuming that both a commercial program and military program would have the same production cost curve, the cost for a given lot of X aircraft is:

$$\text{Cost CDA}_{Unit} = A \left[ \sum_{i=1}^L i^b - \sum_{i=1}^{F-1} i^b \right]$$

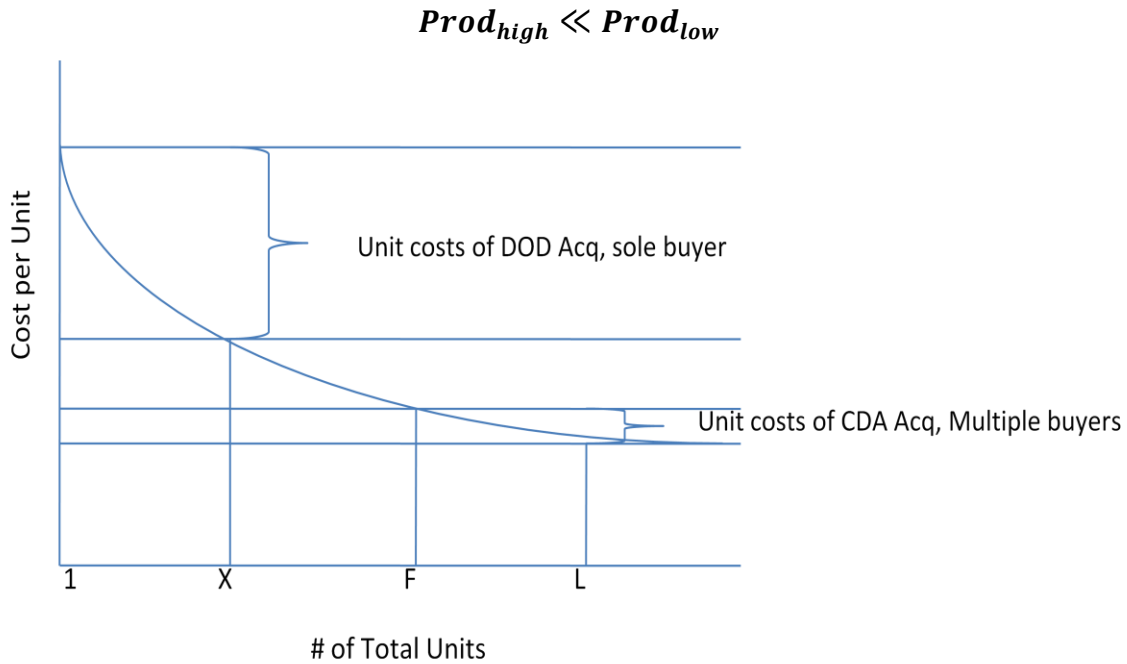
Where: F=First unit number in the lot

L=Last unit number in the lot

N=Cumulative number of X units

A=Cost of Unit 1

As shown in the Figure 12, basic learning curve theory predicts that the cost per unit of aircraft production decreases. In this model, if the DOD develops and solely produces the aircraft, then it pays for the first through X units at the highest prices on the price curve. Under a CDA approach for the same aircraft (this means the first unit cost “A” is the same for both), the CDA program would buy aircraft F through L (where L – F = X) at a much lower cost per unit. In this model it assumes both would have the same first unit cost (A), but this is probably optimistic since the DOD developed aircraft would probably cost significantly more due to its advanced technology and lower total production units.



**Figure 12. Learning Curve Effect**

The third piece in the life cycle cost model is the sustainment cost. The traditional DOD model can use either a commercial approach for aircraft support or invest in DOD depot capability and do the maintenance in-house as core workload. In the latter case, the program would pay for the non-recurring cost to set up the maintenance system (as well as the supply chain) and then allocate over a single group of X aircraft. The CDA model with commercial support assumes a larger number of customers with many total aircraft to spread the operations and support costs.

$$\frac{\sum Sus_{nr} + \sum Sus_{rec}}{n_1 + n_2 \dots n_{mil}} \ll \frac{\sum Sus_{nr} + \sum Sus_{rec}}{n_{mil}}$$

At this point in the discussion, we have assumed that the production aircraft are the same and both meet the DOD requirements. This is the extreme case described by the DSB as case 1. What happens to the model as we move to the other cases in the CDA continuum?

As we make modifications to the CDA aircraft, we must now consider the modification element of the model:

$$\frac{\sum (Mod_{nr} + Mod_{rec} + test\&cert)}{n_{mil}}$$

This part of the model assumes additional production facilities are needed that generate non-recurring costs along with the unit modification costs all of which are spread over only the CDA aircraft. This represents the military unique requirements that are not common with the commercial aircraft. This part of the model typically would show the highest cost and schedule growth since it may be a large development program in its own right with high technology subsystems, integration and requirements for extensive system testing. If we model a CDA program at the top level as:<sup>18</sup>

$$CDA = \alpha + \beta$$

$$\text{Where } \alpha = \frac{\sum R\&D_{TRL=high}}{n_1+n_2 \dots n_{mil}} + \frac{\sum Prod_{nr}+Prod_{high}}{n_1+n_2 \dots n_{mil}}$$

$$\text{And } \beta = \frac{\sum (Mod_{nr}+Mod_{rec}+test\&cert)}{n_{mil}}$$

Then we can use this to model the CDA continuum which ranges from a pure CDA (no modifications) to a totally new development.

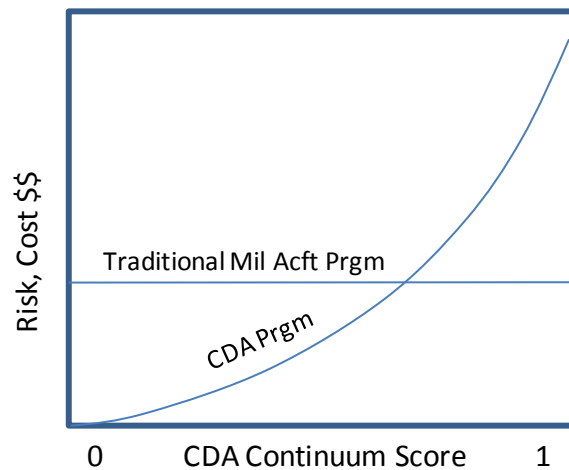
$$CDA \text{ continuum} = \frac{\beta}{\alpha + \beta}$$

Here a pure CDA (totally commercial) is zero and pure military development is one. As shown below, as the number of modifications increase ( $\beta$ ), the cost and the risk of the delivered product is driven higher and higher. From a practical viewpoint, if the DOD

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<sup>18</sup> Note, for simplicity the model had left out sustainment, since that occurs for both.

allows the additional requirements to increase the volume of modifications, there is a breakeven point where they should, instead, build a traditional military only aircraft.



**Figure 13. CDA Continuum**

In the real world,  $\beta$  takes the form of requirements creep or uncertainty, post deployment modifications, or a failure to estimate the size or cost of the modification.

For this model, the modification piece includes test and certification. This can be a major undertaking if the modification makes a significant change to the airframe, the engines or the basic avionics for the aircraft. One of the theoretical savings is that the green aircraft is already FAA certified or the equivalent. The more the CDA continuum score moves away from zero, the more testing is required and the more the FAA will want to test the new aircraft for safety of flight considerations and compliance with the existing certificate for that aircraft.<sup>19</sup> This is a major advantage of CDAs since they do not have to comply with the same stringent certification rules as newly developed aircraft.<sup>20</sup>

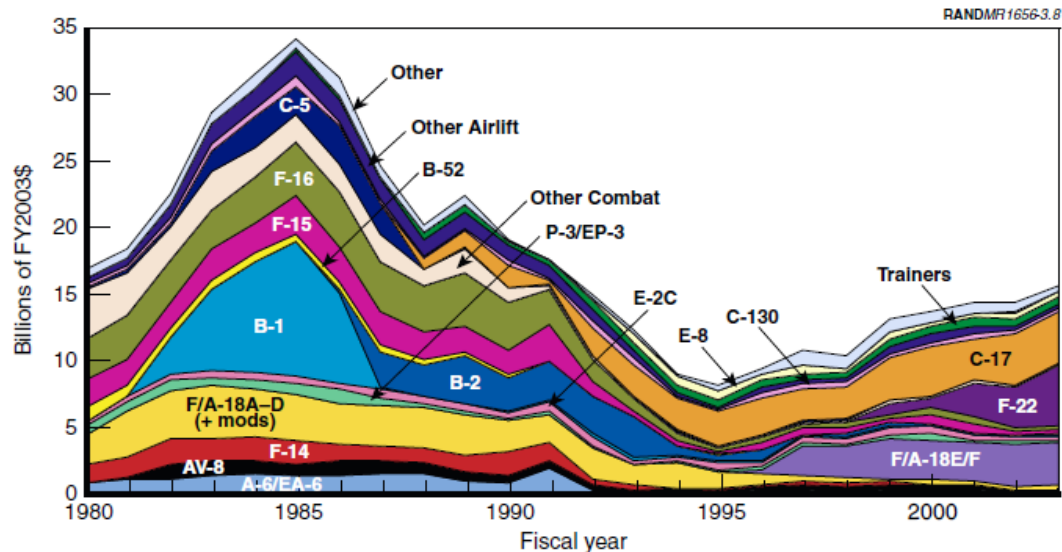
## Competition

One question worth asking is how does DOD encourage and capture innovation so that it procures the best technologies in its future aircraft. By definition, if DOD buys pure CDAs, then we are only able to procure the current state of the art (which still may be superior to legacy systems). If DOD does traditional acquisition approaches, they have to gamble on low technology readiness levels (TRL), make major investments in

<sup>19</sup> Air Force Policy directives required that CDAs comply with civil airworthiness standards set by the FAA. The DOD agency maintains currency of the FAA type certificate which requires FAA approval of all in service modifications.

<sup>20</sup> "Derivative Strategy Shows Its Limits," Pierre Condom, Interavia Business and Technology, March 1997.

new technologies or settle for mid level TRLs to reduce risk and cost. This becomes even more critical as the aerospace industry shrinks to fewer and fewer firms.



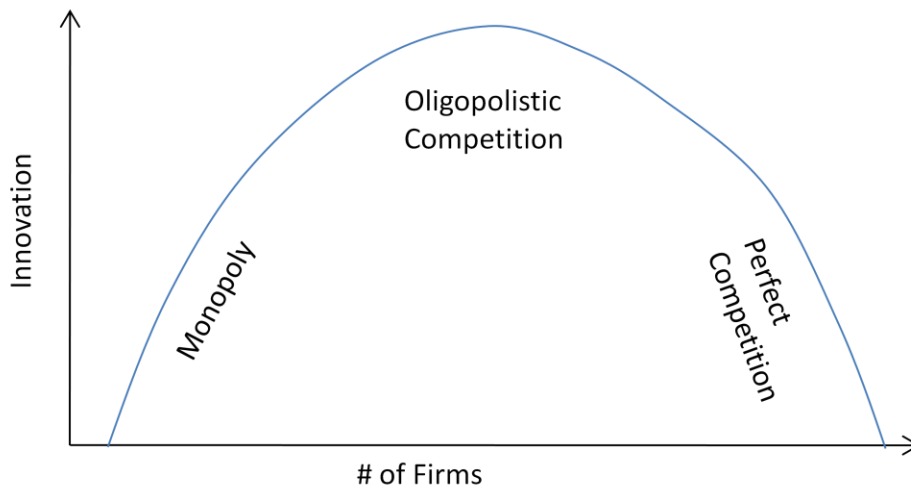
**Figure 14. RAND Aircraft Industry Results**

RAND did a study on competition and innovation as it relates to the current industry state. As shown by the RAND analysis in Figure 14, the number of aircraft in development or production has steadily decreased since the 1980s along with the budget. At the same time, the number of major airframe contractors has dropped to three.

The Rand analysis (among others) has shown that competition is the most important driver of innovation in the aerospace industry. Innovation cannot be specified in an RFP and ordered like a pizza. Rather it is the result of industry visionaries who understand DOD needs and have a business sense about the potential future benefit stream to their firm. Most important, the firms must see it as a technology or capability whose property rights they can defend to procure a profit stream. While common sense to economists, many in government fail to appreciate that the aerospace firms are in business to make a long term profit for their owners and this drives their desire and ability to invest in new technologies that they can capture and defend.

The key question that RAND addresses is how we maximize innovation through competition. Basic economic theory shows that when one firm has a monopoly, it will maximize profit, minimize investment, and only provide enough innovation to thwart competition. If there are many competitors, this reduces profits to a minimum and firms will have no capital to invest in new technologies. This area of competition is misunderstood since the firms remain in business, but find that there is no benefit to investing in new technologies as it raises their costs which can't be recouped in a low

price market.<sup>21</sup> Government buyers fail to realize that while they get the benefit of great pricing, they are denying the warfighter the benefit of future technologies.



**Figure 15. Innovation as a Function of Market Size**

The research indicates that the maximum innovation occurs in the oligopolistic competition region which means a few firms compete for the market (Figure 15). In this case, the firms can charge a higher price which funds their research and development. Further research<sup>22</sup> indicates that the most significant innovation occurs outside the current industry by firms that are willing to take large risks to break into the competition. That is a critical point—innovation tends to occur in small businesses that are currently not DOD incumbents or primes. At the same time, the large firms desire to erect barriers to entry to maintain their oligopolies. The challenge to DOD program managers is how to find and include these small innovative businesses.

Now what does this have to do with commercial derivative aircraft? If one looks at the long history of CDAs—especially in the 1930s and 40s -- the military competed for a wide variety of aircraft and bought quite a few from new-start companies. Many of these innovative firms became the aerospace giants of today. The lesson learned is that the DOD should encourage competition from all sources and not just the established companies. This might mean the DOD will need to provide adequate notice of upcoming competitions, fund prototypes and provide commercial contracts and payment terms. A prime example of this was the July 2009 Request for Information (RFI) issued by the Aeronautical Systems Center (ASC) Capabilities Integration Directorate (XR). They were conducting market research assessment of fixed-wing platforms available for

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<sup>21</sup> The Rand Study also mentions the spillover effect during periods of excess competition. This describes the effect of employees moving from firm to firm and taking information with them—which tends to level the playing field between competitors.

<sup>22</sup> “The Cutting Edge: A Half Century of US Fighter Aircraft R&D,” Mark Lorell and Hugh Levaux, RAND MR-939-AF, 1998.



conducting strike, armed reconnaissance and advanced aircraft training in support of Irregular Warfare (IW) operations. The RFI implied a quick acquisition cycle with first aircraft deliveries in two years. While the RFI attracted existing airframes—Raytheon JPATS and the Embraer Super Tucano (Figure 16)—it also attracted attention from new start firms with fresh designs and capabilities



**Figure 16. Embraer Super Tucano**

## **Traditional Military Development is Expensive**

Common sense dictates that if an existing commercial system meets the military requirements it will be cheaper and faster to obtain. However, there is another cost driver that commercial systems and commercial practices prevent when going the CDA route.<sup>23</sup> FAR 15 acquisition rules are onerous and often are applied in a heavy handed way that implies contractors can't be trusted. For development programs, the government approach assumes that a major government presence along with extensive data reporting will reduce cost and schedule risk on a program. There is little if any evidence to support that this approach reduces risk. Rather, a multitude of studies support the opposite and show how expensive this oversight approach can be. A study by the Center for Strategic and International Studies performed multiple case studies to determine what the added personnel and administrative costs were for these excessive government procurement regulations. They considered one large firm that had total yearly sales of \$14B of which defense contracts represented \$4B. The company used 8500 people to administer the commercial contracts but needed over 18,200 to do the military contracts. This meant they had to expend six times as many personnel dollars on the military effort as the commercial ones. If they had been able to use the same commercial approach on the military contracts, they would have saved \$750M out of the \$4B military price.

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<sup>23</sup> "Marrying Commercial and Military Technologies: A New Strategy for Maintaining Technological Supremacy," Colonel Jeanne C. Sutton, USAF, DAU Acquisition Review Quarterly, Summer 1994.

In another case, the study looked at IBM and determined on military avionics efforts, they spend 26 percent of the contract value on government requirements that add no value to the military. The Office of Technology Assessment estimated that the cost of FAR 15 oversight adds from 10 to 50 percent additional cost. Finally, the Defense Science Board did a similar study<sup>24</sup> and found that systems built with commercial components or totally commercial are cheaper by a factor of two to eight. The overwhelming result for DOD CDA program managers is that commercial acquisition can save large amounts of money. Contractual remedies are available through FAR 12 that reduce government risk without burdening the contractors with non-valued added reporting and oversight requirements.

### **Use of COTS as a Major Subsystem**

The Navy's E-2C program (Figure 17) was in need of a major mission computer upgrade in the early 1990s—just as the Cold War was ending and the first Gulf War began.<sup>25</sup> Due to funds limitations and rapid technology advances in the commercial market, the Navy elected to go with a state of the art, open architecture commercial



**Figure 17. Navy E-2C**

solution. With few changes the new computer was half the weight, a third the size and offered an order of magnitude improvement in computing power. The second major upgrade occurred in 2000 when the Navy again inserted the latest technology as well as introduced new software—all based on using commercial equipment. The new system

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<sup>24</sup> "Report on the Use of Commercial Components in Military Equipment," Defense Science Board Summer Task Force Study, Washington DC, 1986.

<sup>25</sup> "Commercial Off the Shelf: Doing It Right," Jacques S. Gansler and William Lucyshyn, Center for Public Policy and Private Enterprise, University of Maryland, Sept 2008.

had an MTBF of over 10,000 hours and made implementation of future technology changes easier. The last upgrade occurred in 2006 and used a state of the art commercial single board computer that increased speed and further reduced maintenance.

The increase in performance with each new COTS upgrade was impressive, but more important was the reduction in nonrecurring cost and schedule. As shown in Figure 18 below, the three upgrades went from a \$200M development and test program lasting seven years to less than 24 months and only \$9M. Even at three years for the first COTS upgrade, this was significantly quicker and cheaper than previous bottoms-up developments. The lesson learned is that significant time and budget can be saved by using green aircraft and/or proven commercial systems and subsystems.

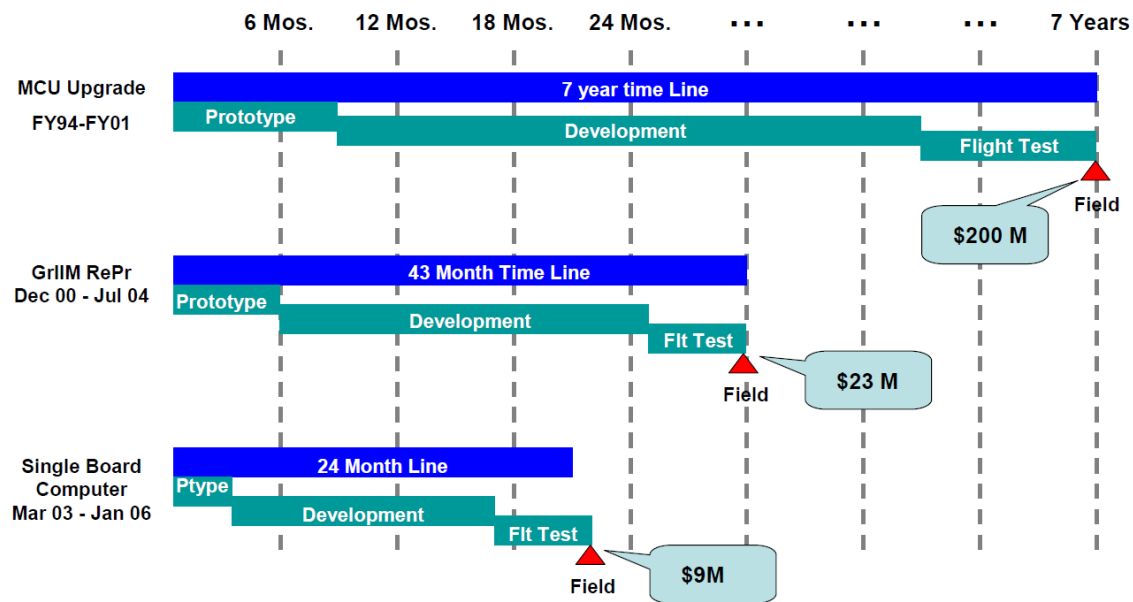


Figure 18. E-2C COTS Insertion Times



## Chapter Four

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### Are Commercial Derivative Aircraft as Easy as They Look?

*“No one will dispute the fact that, in the absolute sense, a plane which must meet both the civil and military requirements cannot be the perfect machine for either purpose”---Giulio Douhet, Command of the Air*

Are CDAs as easy as they look? The simple answer is yes—if indeed you comply with all the assumptions discussed in the last chapter. The basic approach is simple:

1. Determine the system requirements to include KPPs, schedule and cost—but allow flexibility to allow the consideration of CDAs.
2. Do thorough market, engineering and performance research of candidate CDAs as compared to a new development.
3. To the degree possible, relax the requirements and then evaluate all remaining candidates, choosing the best fit based on a rigorous risk assessment.
4. Make the contract and program as commercially competitive as possible.
5. The best candidate should provide maximum performance with minimum modification.
6. Consider and use product support that best emulates what is available in the commercial market.

The US military has a long history of over 150+ CDAs since the 1930s with few significant problems. Failures or major program slips have occurred when DOD attempted to redesign or make major modifications without understanding the full program effects.

A brief look at all the previous aircraft shows a simple result. If you buy the green aircraft and do little if any modifications—they work. The simple matter is that most of the CDAs do not have catastrophic outcomes if there is a small mismatch between the stated requirements and the commercial design.

### System Requirements

A common issue with CDA is requirements mismatch that is either known upfront or discovered later which then results in a poorly planned modification. Commercial airplanes are optimized to meet their commercial mission. This is usually accomplished by flying cargo or personnel point to point in a benign fashion. Fuel consumption is normally the top priority so the planes are designed to operate in the most optimal environment which usually is a very narrow operating range. This means operating at

maximum altitudes with few changes in the daily flight profiles. The planes are lightweight and efficient with only those redundant systems needed for safety.

Today in many applications, there is a major gap between DOD and commercial operational use of aircraft.<sup>26</sup> Modern military aircraft are designed to operate in a wide variety of environments that burn more fuel, require landings on unimproved fields and provide minimal ground support.<sup>27</sup> DoD systems, even cargo aircraft, must interface with other aircraft and systems—so the modifications could be significant. All of these requirements shift the beta in our model and drive multiple modifications. Worse, if the “new” requirements-shift happens after aircraft selection it might require significant modifications that are unfeasible compared to a new design. Thus, the more the requirements vary, the less advisable it is to do a CDA program. Having stated that, it is important to get the user’s input to do the trade-off between cost, schedule and performance.

A recent study by the Defense Science Board<sup>28</sup> determined that the decisions to pursue CDA solutions are much more complex than previously thought and that the in-place processes don’t adequately support the program managers. The study indicated that most program managers lack the processes, resources or authority to trade off performance requirements against cost and schedule considerations. Further they lack the resources to have rigorous systems engineering and cost studies done to evaluate those trade-offs among CDAs and new development aircraft.

In many of the programs, the DOD has wisely elected to have prototype fly-offs. This is a great idea if the offerors can fly their final configuration against the system requirements. Unfortunately, most acquisition strategies only consider the commercial variant as-is, since the offerors may not have the resources to do the major modification just for a proposal effort. If the requirements are such that most offerors have to make significant modifications, then this is a warning that the requirements are not flexible enough.

The problem arises when requirement planners fail to adequately study the cost, performance and market availability to come up with commercial solutions. In chapter 8, there is a detailed discussion of the USAF T-3A Trainer fiasco which is a prime example of this failure. In that case, the USAF looked at the market, found an existing aircraft with initial performance and cost that was considered satisfactory. In reality, they failed to do their full market research, failed to realize early that it was lacking in performance, and then failed to understand the total implications of redesigning the aircraft. In the end, the aircraft did not meet performance needs, was very costly to fix,

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<sup>26</sup> “Commercial Item Acquisition: Considerations and Lessons Learned,” C. Albert and E. Morris, Software Engineering Institute, Carnegie Mellon University, 26 June 2000.

<sup>27</sup> “Complicating Issues in Adopting Commercial Contracting Practices in Defense Acquisition,” Michael Heberling and Mary E. Kinsella.

<sup>28</sup> “Buying Commercial: Gaining the Cost/Schedule Benefits for Defense Systems,” Report of the Defense Science Board Task Force on Integrating Commercial Systems into the DOD Effectively and Efficiently, February 2009.

and there were other feasible commercial options that were cheaper (and had been from the start).

## **Market, Engineering and Performance Research**

The DOD does not have sufficient resources today to perform detailed research on potential CDAs. It is very expensive and time consuming to perform detailed engineering analysis, simulation and tests of proposed modifications to commercial aircraft. The services CDA offices are minimally manned with some support from IPTs. The quick answer is to minimize modifications and or to push this requirement back on the contractors who propose them.

## **Commercial Environment**

There are fundamental differences between the normal DOD FAR 15 environment and most commercial firms that inhibit participation and create mistrust. The strict DOD contracting environment and its many rules about data submission, price negotiations, oversight, and payment schedules paint a clear picture of mistrust. It is also very expensive. Several studies have shown that FAR 15 full oversight can easily add 20 percent or more to the cost of a contract. If the contractor is truly a commercial vendor with little or no DOD experience, the added burden of compliance will be excessive. What types of things do the commercial vendors find frustrating?

1. “Color of Money” –If one takes a dollar out of their wallet it clearly states that it is “legal tender for all debts public and private.” This is how commercial firms operate, but not the federal government. The DOD segregates its budget into different categories that can’t easily be interchanged. While this purports to allow for the micromanagement of funds, it also stifles efficient program execution.<sup>29</sup> There is no auditable trail in the DoD to prove that this form of budget execution or tracking is more efficient than commercial practices.
2. In the commercial world, contractors who meet all obligations while under-running the contract are rewarded. Not so in the DOD where failure to execute all budget often leads to future reductions in budget.
3. Commercial vendors are infuriated at the lengths the DOD goes to insure “fairness,” “political correctness,” and to attain social engineering goals. This leads to directed awards to small business based on their characteristics rather than their ability to do the job. It also encourages protests that slow down

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<sup>29</sup> The DOD track record for self audits and reporting is dismal. DOD failed to comply with the Federal law requiring auditable financial statements in 2007, 2008, 2009, and 2010. January 2010, Congressman Forbes.

contracting process. While most firms do engage in some sort of socio-economic support, it doesn't approach the scale of the DOD efforts.

4. The DOD (and government in general) fails to understand the role of profit in a capitalistic society. There are many rules to limit profit on DOD contracts based on a government assessment of what is fair and reasonable. These rules fail to consider the market environment or the company investments. In the end they tend to drive firms out of the industry. In most cases there is a simple solution to the profit issue—it's called meaningful competition.
5. Closely tied to the profit issue, is the cost data oversight issue. Because of the DOD desire for unique systems and often a lack of competition, the DOD requires significant cost support data. This normally falls under the Truth in Negotiations Act (TINA) and Cost Accounting Standards (CAS). The government believes that if they can view and analyze the details of the vendors operations, they can then determine if the DOD is getting a fairly priced contract. The first problem is that fair is defined by which side of the business deal that you reside on. The second is that most vendors see this data as proprietary and that no one—including the DOD—has a need to know. On top of this, it is very expensive to provide the data in a format that the government will understand and very expensive for the government to gather and evaluate the data. From the vendor viewpoint, the cost of the cure far exceeds any excess profits that might have occurred. Many companies do not want to invest in a CAS compliant accounting system just to satisfy a single customer or a one-time customer.

## Logistics Issues

The DOD tends to buy aircraft and then keep them a very long time if they meet expectations. During wartime, attrition from battle damage and accidents can rapidly deplete the inventory. Normal peacetime operations (even with some contingency operations) means our CDA type aircraft normally fly less than 1000 hrs per year, some significantly less. A case in point is the KC-135 tanker (Figure 19) which has been in the fleet over 50 years:<sup>30</sup>

- While the KC-135 fleet averages over 40 years in age, the aircraft have relatively low levels of flying hours. The Air Force projects that E and R models have lifetime flying hours limits of 36,000 and 39,000 hours, respectively. According to the Air Force, only a few KC-135s would reach these limits before 2040, but at that time some of the aircraft would be about 80 years old.

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<sup>30</sup> "Information on Air Force Aerial Refueling Tankers," GAO Report GAO-03-938T, 24 June 2003.



- Flying hours for the KC-135s averaged about 300 hours per year between 1995 and September 2001. Since then, utilization is averaging about 435 hours per year.

While this is a long period, the total hours are very low compared to commercial airlines that fly 3-5 times this number of hours per year. Further, most airlines are very sensitive to operating costs, so they constantly run a business case analysis on when to upgrade to the latest aircraft—with the result being a much more rapid turnover of the commercial fleet. The big sustainment advantage of the CDA is its access to a world wide support network of parts and maintenance services. The downside is that this network changes to match the commercial market. As the commercial operators either scrap or sell their worn out fleets, the military variants are left as orphans.



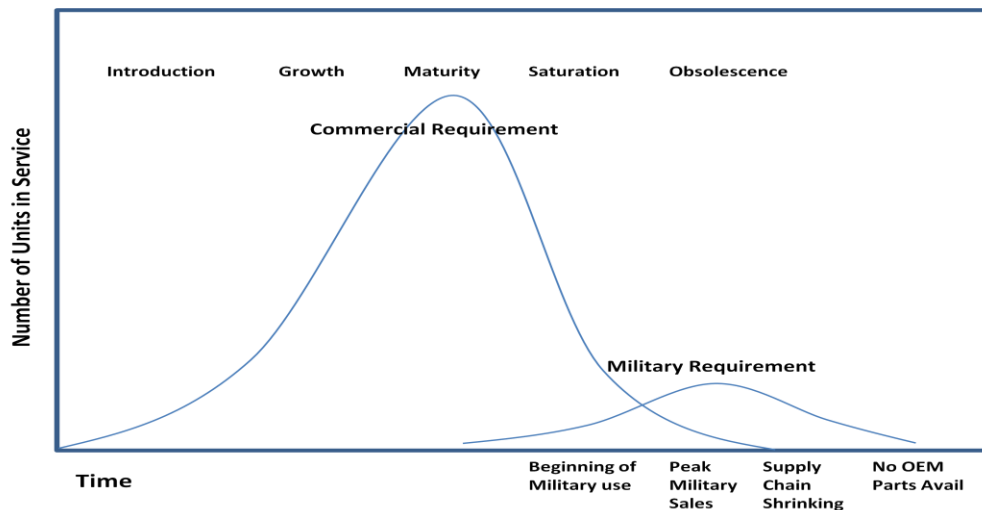
**Figure 19. KC-135R Tanker**

This rapid turnover and new aircraft design means the industry may not maintain production lines forever or produce spare parts. This creates a different logistics support business case for the USAF which often supports in-house depot support vice commercial logistic support. While there are still ample KC-135 parts, most of the commercial operators upgraded their B-707 fleets to new aircraft decades ago. As demonstrated in the figure 20 below,<sup>31</sup> the DOD normally buys a CDA on the backend of a production run in order to get the lowest unit cost. The commercial fleets often downsize the fleet (buy the next generation aircraft) which drives the suppliers out of the market. Finding

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<sup>31</sup> "The Problem with Aviation COTS," Lionel D. Alford, Jr., IEEE AES Systems Magazine, February 2001

the ideal time to procure and eventually support commercial airframes is explained in detail in Chapter 6.



**Figure 20. CDA Procurement Timeline**

If the DOD purchases CDAs with minimal modifications it is possible to upgrade with the industry at some point in the future. However as the modifications become larger (greater beta) then it becomes more difficult to justify a major modification program. The key point is that the logistics part of the life cycle cost estimate is more important than the initial acquisition cost.

## Data Rights

CDA programs face many of the same issues that DOD and contractors face on traditional acquisition programs. One major difference is that CDA programs start with green aircraft that already have well established data rights policies with their commercial customers. Most commercial customers do little upgrades or modifications themselves. Aircraft manufacturers are continually providing upgrades or variants to attract sales of a product line. When they do need modifications they normally would go to an established “mod house” that would then negotiate the technical data rights with the OEM.<sup>32</sup>

DOD considers itself to be in a different situation—one in which they want to reserve the right to modify the aircraft themselves, choose who they want to do the modification, continue competition at the component level, and tend to believe that their purchase price should include a full data package. Further, the DOD believes once they receive the data it is theirs to use with no restrictions and that they can provide it to

<sup>32</sup> “Adopting Commercial Practices in the Department of Defense: Barriers and Benefits,” Lean Aircraft Initiative Policy Group, 16 Sept 1996.

whomever they desire. This DOD position frustrates most commercial manufacturers and does an effective job of keeping many world class manufacturers from dealing with DOD.

In addition to the reasons stated above, the DOD also wants detailed design and test data to support the DOD directed modifications. Most CDA strategies require offerors to work out arrangements with subcontractors for modification work if the OEM is not doing the modifications. In the commercial world, when one buys an aircraft it comes with the operations and maintenance manuals as prescribed by the FAA and little else. The DOD wants much more since they want to retain the option of competing future aircraft modifications and parts buys. The study<sup>33</sup> also found evidence that small business refuse to compete due to the possibility that their data will be shared with competitors. (*A lengthy discussion of technical data rights is contained in Chapter 6.*)

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<sup>33</sup> “Adopting Commercial Practices in the Department of Defense: Barriers and Benefits,” Lean Aircraft Initiative Policy Group, 16 Sept 1996.



## Chapter Five

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### FAA Certification—We Paid for It, Why throw it away?

*Alleged FAA Slogan: "We're not happy, till you're not happy"*  
**Popular aviation T-shirt**

#### "Wright" Certification

It was an even chillier day on December 18<sup>th</sup> 1903 with the wind still gusting 20-25 miles per hour from the north. The Wright brothers were cold, tired and exhausted after several weeks on the beach of building and rebuilding their fragile aircraft and now finally succeeding in their first flight. However, they felt an empty feeling, like something was missing. Could it have been that their plane was not FAA certified or that neither had a pilot's license?—highly unlikely. It would be twenty-three years before the passage of the Air Commerce act of 1926 which required licensing of pilots and airworthiness certification for new aircraft. After Wilbur's death in 1912, Orville would fly for the last time as pilot in command in 1918 in their 1911 Wright Model B Flyer—all without government licenses or certifications.

The early era of flight was quite dangerous with frequent crashes and death—both in the air and on the ground.<sup>34</sup> The Wrights (Orville) had the unfortunate distinction of having the first fatal air crash while demonstrating their Wright B Flyer to the military at Ft. Myers. Many others crashed while trying out new designs or while learning to fly. By today's standards, these were very dangerous times for new aviators. The Wrights had demonstrated that almost anyone could build a flying aircraft with off-the-shelf hardware and these new innovators quickly copied and improved on each other's designs. A typical example was Clyde Cessna from Kansas. He was a farmer who had dropped out of school by sixth grade. He had a talent for engines and for repairing and building farm equipment. He also was stubborn and proceeded to build/repair a dozen versions of his first airplane. It was alleged that he crashed 12 times before successfully attaining normal flight in his aircraft.<sup>35</sup> Even before they flew, the Wright's understood the inherent danger and required method to conquer flight: "If you are looking for perfect safety, you will do well to sit on a fence and watch the birds; but if you really wish to learn, you must mount a machine and become acquainted with its tricks by actual trial."<sup>36</sup>

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<sup>34</sup> The Wright Brothers were very aware of the danger and only flew once together (May 1910) out of concern that they would both die in the same crash and their work would be cut short.

<sup>35</sup> "America Has Grounded the Wright Brothers," Capitalism Magazine, Heike Berthold, 17 Dec 2003.

<sup>36</sup> Wilbur Wright quote from a presentation on 18 September 1901 to the Western Society of Engineers.

In the years prior to WWI, airplanes were still rare vehicles that were more of a spectacle for the public to watch, especially in the United States. The only places to see airplanes were at the growing number of air shows in the bigger cities—as had become popular in Europe. This quickly spread to the United States and the two largest sponsors were Glenn Curtiss and his team along with the Wright Brother’s team of aircraft and pilots. For most of the attendees, this was the first time they had ever seen a real aircraft fly—especially in a controlled manner. Much like watching NASCAR today, these events were quite exciting and often resulted in deadly crashes directly in front of the audience. The aircraft fatality data shows the trend: 1908—1 fatality, 1909—4 fatalities, 1910—28 fatalities and 1911—61 fatalities. During this period, both the Wright and Curtis teams lost their most experienced pilots in crashes. To look at this in perspective, in 2009, there were 10,349,200 departing flights that flew 18,001,000 flight hours with only 2 fatal accidents.<sup>37</sup>

While some new planes appeared in the skies over America during the 1910-1915 period, the Wrights aggressive attempts to enforce patents and restrict competition deterred any major growth in the fledgling US aviation infrastructure or new aircraft production. Meanwhile, in Europe, the aviation industry was taking off. It included government intervention with registration, certification and investments in infrastructure. The Europeans were preparing for WWI and saw the value of aviation. Here in America, there was great debate but little financial investment made to determine what aviation infrastructure was required or what its long term future uses might be.

## **The New Industry Takes Off**

The WWI experience changed America’s idea of aviation. First, the market became flooded with aircraft, pilots and ideas for the use of aviation both in the military and civilian markets. The airplane had proven itself in the war doing observation, air to air combat and bombardment—so now it was seen as a potential transportation vehicle for personnel and goods. Second, issues with the Wright’s patents had long been settled and a healthy competitive environment was growing.

Several major issues faced the growing military and civilian fleets. First, fight training was haphazard at best. Anyone who could afford an airplane could fly it—with or without competent instruction. Military flight training was not much better. Initial candidates received their training from the Wright brothers’ company. Later, as units received aircraft, they trained themselves. It was many years before a unified training command with learned and proven processes would be initiated. After WWI the number of new and used aircraft expanded rapidly and there was no certification or inspection process in place. Each operator was responsible for their own maintenance and repairs.

As air commerce developed, airplane operations revealed the need for aviation unique infrastructure. These aircraft were now flying across the country and aerial

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<sup>37</sup> FAA Accident Statistics, <http://www.nts.gov/aviation/Table2.htm>

navigation was becoming an issue along with the need for better airports (other than pastures on the edge of town). There was a need for rules and regulations to cover the operation, maintenance and air traffic control of these new aircraft. Finally, there was great discussion about where this oversight function should reside—state or federal, civilian or military, new or old departments. The military was moving ahead with aircraft and system development and was beginning to realize the need for major infrastructure investments.

## **Billy Mitchell and Calvin Coolidge take on Aviation**

The FAA that we have today is a direct result of Calvin Coolidge and General Billy Mitchell. Surprised? The Civil Aeronautics Act of 1926 was a direct result of Coolidge's efforts to support and advance the aviation industry in America. While never flying in a plane himself, he understood the role that aviation could play both for commerce and military operations. During the period of 1924-26 major debates were occurring about the future and safety of aviation and especially who should control, fund and guide it. One outspoken advocate was General Billy Mitchell who was a major critic of the Coolidge administration and what he saw as a lack of action to support this fledgling industry. Mitchell made several public speeches<sup>38</sup> claiming "criminal neglect of aviation by the Coolidge administration" and blaming recent aircraft losses "on its short-sighted policies." These statements and others contributed to Mitchell's eventual courts martial.

Under pressure from Mitchell and others, Coolidge eventually chartered a commission headed up by Wall Street banker Dwight Morrow to investigate the status of aviation in the United States and report back with recommendations. One of the first to testify before the committee was General Mitchell. He presented arguments for major US investment in infrastructure and made the case for federal control of the airways. Mitchell also wanted the War Department to be in charge of all aviation policies and operations. Morrow gathered together a group of experts and reported back after only three months of research and deliberation. The resulting Air Commerce Act of 1926 gave the government the responsibility for developing and supporting air commerce. The Act allowed the federal government to establish airways and air navigation aids, establish pilot training and licensing requirements, and set requirements for new aircraft certification and their maintenance. One major thing it did not do was to put the military in charge of all aviation activities. It addressed the issue by changing the Army Air Service to the Army Air Corps and created an Assistant Secretary for Aviation in the War Department and in the Navy Department.

It took many years and many different named organizations before the current oversight infrastructure was created. The Federal Aviation Act of 1958 created the agency under the name Federal Aviation Agency. The current version of the FAA came

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<sup>38</sup> Calvin Coolidge Memorial Foundation Archives.

into existence in 1967 when it became a part of the Department of Transportation. Its major roles include:

- Regulating civil aviation to promote safety
- Developing and operating a system of air traffic control and navigation for both civil and military aircraft
- Researching and developing the National Airspace System and civil aeronautics
- Developing and carrying out programs to control aircraft noise and other environmental effects of civil aviation
- Regulating U.S. commercial space transportation

The FAA's role in aviation is to ensure the adherence of safety standards by overseeing the maintenance, operation, and manufacturing of all aircraft. The FAA issues and enforces regulations and minimum standards covering manufacturing, operating, and maintaining aircraft. The FAA also certifies airmen and airports that serve air carriers. In addition, the FAA operates a network of airport towers, air route traffic control centers, and flight service stations ... in the process, assigning the use of airspace and controlling air traffic.

## **Military Aircraft in FAA Airspace**

As mentioned above “The FAA's role in aviation is to ensure the adherence of safety standards by overseeing the maintenance, operation, and manufacturing of all aircraft.” Well, not really “all” aircraft. The FAA has no formal jurisdiction or oversight responsibilities for military or public use aircraft operated and maintained by the USAF (or other DoD agencies for that matter). Under USC Title 10 and a lengthy list of DoD and service specific regulations and policies, the Department of Defense is responsible for the certification and airworthiness of its own aircraft. To put this in perspective, what does the FAA normally provide or oversee for a typical commercial aircraft?

- FAA Type Certificates, Amended Type Certificates, or Supplemental Type Certificates are FAA determinations that the design of an aircraft, engine, or propeller meets all civil aviation regulatory requirements for safe operations within a defined flight envelope, design limits, and maintenance approach.
- FAA Production Certification indicates an applicant successfully demonstrated to the FAA the ability to consistently manufacture specific Type Certificated designs and has effective quality and manufacturing inspection systems for these products.
- An FAA “Production Approval Holder” will have documented and auditable processes for manufacturing management, configuration management, quality assurance, and supplier management systems.



- Airworthiness Certification when an aircraft, engine, or propeller was manufactured in conformance to the Type Certificated design; was operated and maintained in accordance with FAA approved limits; alterations were accomplished in accordance with FAA approved practices; all Airworthiness Directives were complied with; and supporting documentation meets FAA standards. This is required for individual aircraft and all must be registered with the FAA and display the assigned N-number.

These four processes and certifications are intended to provide the public with a safe airplane that has been designed, manufactured, tested, and maintained to FAA standards. In addition, these commercial aircraft are operated in compliance with FAA operational guidelines and regulations that cover normal day-to-day commercial (and general aviation) operations.

The military has maintained and defended their need to be outside of this civilian type control going all the way back to Billy Mitchell. The military operates aircraft that are often significantly different in performance and missions than any normal civilian aircraft or operation. The military is concerned about safety, but performance and mission success is primary. Just like the FAA, the military has a well defined process for developing, producing, testing and operating new aircraft that are designed solely for military use (such as the F-35 or C-17). The manufacturers have multiple design and production readiness reviews along with extensive flight test and operational readiness reviews.

As discussed above, the USAF (and other services) has an extensive regulatory process that new aircraft programs must follow—but how does this apply when the USAF buys a new commercial aircraft to be used as a tanker? Is it treated like any other commercial aircraft or like a pure DOD developed aircraft or some hybrid? From the DOD viewpoint, a commercial aircraft is defined as when the DOD buys or leases an unmodified commercial aircraft and operates it in essentially the same manner as the civilian operators. The aircraft is normally maintained and operated in accordance with FAA requirements and uses FAA approved repair stations, personnel and procedures. If the military service operates and maintains the aircraft under full FAA certification, airworthiness and civil registration throughout its life, that service is considered an owner-operator under FAA guidelines like any other civilian carrier. There are very few examples of this in the USAF. Examples would be USAF Aero club aircraft or leased VIP aircraft. In addition to the advantages discussed earlier, these aircraft would be easily sold or placed back into commercial fleets.

In this book, we are primarily focused on commercial derivative aircraft that are purchased and or operated by DOD personnel. These differ from pure commercial aircraft in that they have been modified from the existing commercial configuration. This may be as simple as new avionics or communications gear to major structural changes to accommodate weapons or defensive systems. It is possible that they could maintain their FAA type certificate and their airworthiness certificate by negotiating with the FAA. As with commercial aircraft used by the DoD, these aircraft must be operated

and maintained in accordance with FAA requirements and using FAA approved repair stations.

When the DoD acquires a commercial derivative aircraft, compliance with Federal Aviation Regulations and FAA oversight cannot be assumed. Military aircraft and equipment, whether or not based on FAA certified designs, are considered “Public Aircraft” by statute and are exempt from Federal Aviation Regulations and FAA oversight. FAA’s involvement with Public Aircraft is at FAA’s discretion. To address this, the Military Departments, US Coast Guard, and FAA established a Memorandum of Agreement (MOA) (FAA Order 8110.101) to provide reimbursable FAA support for commercial derivative aircraft. The extent of FAA support depends upon whether the military’s design, manufacturing, operational usage, and maintenance requirements are comparable to that of the civil sector or whether the military requirements differ significantly from civil applications. The basic idea is that the FAA will only become involved if there is a similar civilian fleet of the aircraft or civilian aircraft using the major systems. Thus, while the C-130J was initially defined as commercial, it really wasn’t, so today the FAA would not entertain a request to support FAA certification.

Since even commercial aircraft become public use aircraft when procured and operated by DOD, the FAA oversight umbrella disappears without additional action by the DOD. Aircraft operated and maintained outside of FAA oversight will not retain their FAA Type Certificate, even if the aircraft delivered to the DoD is a Type Certificated aircraft. Outside of FAA oversight implies that the military operator does not comply fully with all FAA rules concerning operation, maintenance, repair, documentation and reporting.

## **Mil Cert Process (62-6)**

The USAF has implemented a new airworthiness process as defined in Air Force Instruction 62-601 (11 June 2010). The new instruction states:

“The Air Force (AF) is responsible for assuring the airworthiness of the aircraft which it operates. This Directive establishes policies for formal airworthiness assessments to ensure that AF organizationally operated aircraft are airworthy over their entire life cycle and maintain high levels of safety. This policy Directive applies to all aircraft operated by organizational components of the AF, manned or unmanned, including aircraft organizationally operated by the Air Force Reserve Command (AFRC) and Air National Guard (ANG). It does not apply to non-AF aircraft operated by AF aircrew in accordance with AFI 11-401, *Aviation Management*.”

This new policy drives the issuance of military type certificates that will mirror the FAA type certification process. This is the Air Forces preferred method and is appropriate when the intended usage is similar to that of the commercial world. The goal is that within two years (approximately 2012-13 timeframe) all USAF aircraft will have a military type certificate. For CDAs, this means that all will initially have a FAA type certificate and a military type certificate issued by the US Air Force.

Under this new instruction, a CDA is defined as:

“Any fixed or rotary-wing aircraft procured as a commercial FAA type certificated off-the-shelf non-development item, and whose serial number is listed on an FAA Type Certificate Data Sheet.”

One key item in the definition is the requirement for the serial number of the individual aircraft to be listed on the FAA type certificate. This would appear to be a simple assumption that all CDAs would initially comply, since they come off of a commercial production line. The reality is different. For instance, the early C-27Js purchased by the US Army (and later the USAF) were delivered and flown (as experimental test flight aircraft) prior to issuance of the type certificate. They did not conform to the configuration of the eventual type certificate so were not included. If an aircraft is modified on the production line and the type certificate is not modified (supplemental type certificate), then those aircraft will not be included when the FAA issues a type certificate.

One might ask why should the DOD care? The reason is that military type certificates for CDAs heavily leverage the FAA type certificate—basically the civilian certification transfers to the military certification. This can’t happen if the aircraft fail to receive their FAA Type Certificate. In the worst case, they would be treated like any other new military development and have to go through a full testing regime.

How does the normal process work? Within the USAF, the Commander, Air Force Material Command (AFMC) designates a Technical Airworthiness Authority (TAA) to establish, approve and maintain airworthiness for each USAF fleet type. Airworthiness is defined as verifying and documenting the capability of an air system configuration to safely attain, sustain, and terminate flight in accordance with approved usage and limits. The TAA will issue a **Military Type Certificate (MTC)** which provides evidence that the aircraft system type design is in full compliance with its approved certification basis. The MTC is the equivalent of the FAA type certificate. With the approval of the TAA, program manager for the aircraft will issue a **Military Certificate of Airworthiness (MCA)** to each individual aircraft that provides evidence of compliance with its approved MTC and its condition relative to safe operation.

## **Why Buy CDA’s and maintain FAA certification (either type and or airworthiness)**

There are other certifications for modifications, but the major point is that these all initially leverage off of the aircraft’s initial commercially based FAA type certification. Where the story starts to get interesting involves how and why the DOD might want to retain FAA type certification and the FAA airworthiness certification for individual aircraft. Throughout this book, we have referred to various benefits of CDAs. The following summarize the key findings:

1. A CDA aircraft allows the DOD to avoid paying the full cost of the development and test costs for a new aircraft. These are spread over the entire fleet and the DOD only pays its proportional share in the unit acquisition cost. This effort provides the data and flight test for the FAA certification which directly supports the military type certification.
2. It is least expensive and most appropriate to maintain ongoing FAA certification for those aircraft whose missions and flight profiles are primarily commercial. This means the military aircraft fly the same or similar profiles to their commercial cousins. Thus, it makes sense to maintain FAA type certification for military Learjets or Gulfstream passenger jets which operate just like commercial operators (i.e., point to point navigation and normal takeoff/landing profiles). On the other hand, the C-27J was delivered with an FAA type certification but will never operate in flight profiles used by commercial operators.
3. It makes sense to acquire commercial aircraft with existing FAA certification to allow for quick and relatively low cost military certification. This initial cost savings has almost no impact on the decision whether to maintain the FAA certification after the military certification is in hand.
4. When the DOD acquires a CDA aircraft, it rarely acquires the full proprietary design data and OEM flight test data that supported the initial FAA certification. This results in the DOD either maintaining the FAA certification with a continuing OEM relationship or having to reverse engineer much of the data internally. This is done at great cost and safety risk. The reality is that a CDA (and especially a foreign CDA) limits the DOD's ability to provide full operational support, maintenance and modification compared to a military designed and built aircraft (assuming the DOD buys all necessary data).
5. Whether the DOD buys a CDA or a traditional DOD developed aircraft, both require lifetime engineering support for operations, support, maintenance and modifications. The CDA aircraft, if widely sold to other customers, may provide economy of scale savings as these costs are spread over multiple operators with the same needs. This connection to the commercial fleet ensures that commercial modifications, maintenance issues, safety issues and other relative information are quickly shared with the military operators. A lone DOD aircraft program must normally shoulder the lifetime expense of maintaining a standing army of support engineers to handle these same issues.
6. One of the most important life cycle cost savings is the ability to share maintenance costs with a commercial fleet. This includes using commercial Type 145 certified repair stations as well as supply systems for spare parts. The challenge for DOD is they must maintain full FAA certification and airworthiness for their aircraft, maintainers and repair stations. They also must maintain full documentation per FAA standards.

If the DOD follows the full FAA regiment of certification, maintenance, supply chain management and documentation, then there are potential savings. However, DOD typically does not take the actions necessary to leverage these commercial benefits.

So what are findings relative to FAA and Military Aircraft?

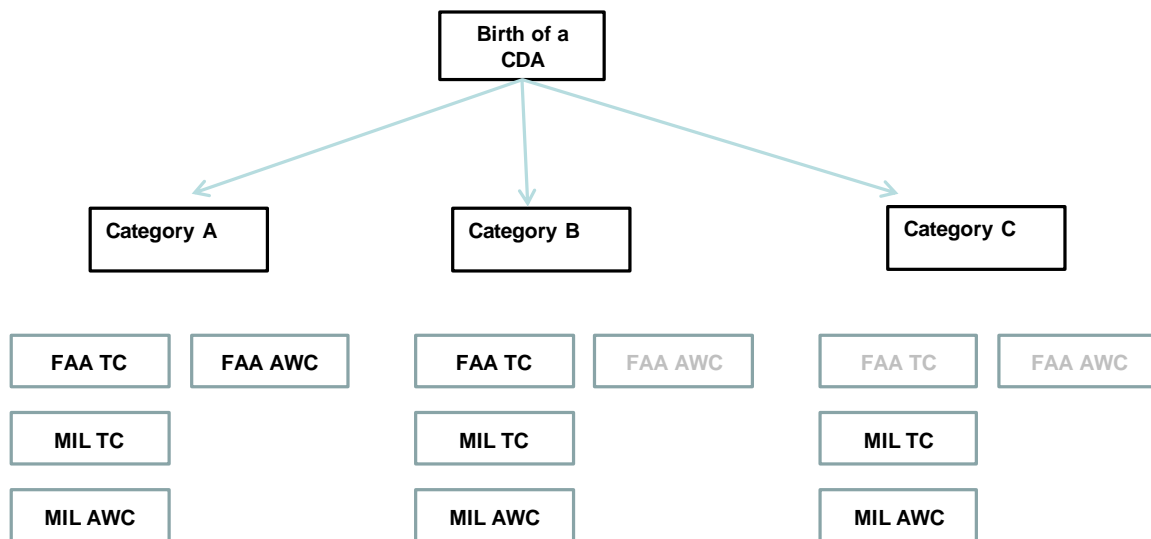
- No FAA issued Type Certificate or Airworthiness Certificate is required for aircraft owned and operated under military registration. This has always been the case for DOD developed aircraft (i.e., B-2) but means that CDA's will always fall under military airworthiness authority unless they are civil registered and maintained under FAA certification.
- FAA airworthiness certification is required for the manufacturer to operate aircraft prior to military ownership and registration.
- DOD has the option to own and operate aircraft under FAA registration if they are registered, operated and maintained under civil regulations.
- DOD can theoretically maintain dual registration—but this has not been done in practice on any large scale to date.
- Almost all USAF commercial derivative aircraft are military registered and not FAA registered.

The USAF does not follow an FAA approved maintenance program or use an FAA approved repair facility—though the actual military maintenance program and repair facilities may be equivalent or even superior. Most, if not all, spares will come from the OEM and its FAA approved providers. From the OEM viewpoint, they will provide all parts and requested service the same as any other commercial customer with one major exception. Once the parts leave the FAA approved factory or supply system, they leave the FAA system.<sup>39</sup> Even though the military certified system may be equivalent, the FAA will not allow a parts pooling arrangement between these redefined military parts and the rest of the commercial parts pool.

As illustrated in Figure 21, USAF aircraft can be place in three unofficial categories of certification as shown below. In the first, Category A, aircraft are produced by the OEM and delivered to the USAF with an FAA type certificate and FAA airworthiness certificate for that particular aircraft. Each aircraft is registered with the FAA and provided an N number. Each aircraft is listed on the FAA type certificate as being compliant. These aircraft will also receive a military type certificate and a military airworthiness certificate (per AFI 62-601). They are maintained to FAA standards and operated in a similar fashion to their civilian counterparts in order to maintain their FAA certifications. The maintenance will also satisfy the requirements for their military certifications.

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<sup>39</sup> United States Navy Aviation Critical Safety Item Management Handbook, 2 September 2010.



**Figure 21. DoD Aircraft Certification Categories**

These aircraft may be given military markings or paint, but are normally not modified with military equipment. With few exceptions, they are maintained under Commercial Logistics Support (CLS) contracts and participate fully in parts and subsystem supply chain pools. These Category-A type aircraft can benefit from all the savings discussed above.

Despite all of the potential savings, there are very few USAF (or DOD) aircraft in this category. Most are aircraft flown by USAF aero clubs, flight screening programs at USAFA or leased VIP transport aircraft. These fleets all fly missions identical to their civilian counterparts. You might think that the VIP fleet operated by the 89<sup>th</sup> VIP Air Wing at Andrews AFB would be category A, but you would be mistaken. While they received world class maintenance and use OEM parts, etc, they are not on the civil registry and do not qualify for FAA airworthiness certification.

This brings us to the second class of USAF aircraft, category B. Like Category A aircraft, Category B aircraft are produced by the OEM and delivered to the USAF with an FAA type certificate. These aircraft are not civil-registered and do not receive an N-number. These aircraft will also receive a military type certificate and a military airworthiness certificate (per AFI 62-601). They are maintained in a fashion that allows them to keep their FAA type certificate and all future modifications are done per FAA certification standards. They do not however have an FAA airworthiness certificate nor are they maintained in full compliance with FAA standards.<sup>40</sup> This lack of FAA

<sup>40</sup> The key difference here may be as simple as not providing required FAA documentation, since the FAA does not track non-registered DOD aircraft after production.

airworthiness prevents them from participating fully in parts pooling with other commercial fleets. The government can still buy new parts from the commercial sources, but normally cannot return the serviceable cores or swap parts with commercial operators. They still have to comply with all military type and airworthiness standards. The key here is that these aircraft can't share in the economy of scale savings available to commercial fleet operator of the same make and model in the supply chain. A possible example of this might be the recent C-27J which required FAA type certification as part of the acquisition strategy.

The last type of USAF aircraft are the category C's. They are delivered with FAA type certificates and then receive their military type and airworthiness certifications. The major difference is the USAF drops all efforts to maintain the FAA type certification. All modifications and maintenance are done to USAF standards, not FAA standards.<sup>41</sup> This category of certification represents the bulk of USAF (and DOD) aircraft.

The key differences between category B and C aircraft revolve around modifications and meetings FAA type certification and supplemental type certification requirements. While the FAA Supplemental Type Certificate (STC) is primarily the responsibility of the requester (USAF), it normally requires coordination and data from the OEMs. It also may require additional engineering support as well as administrative record burdens compared to military supplemental type certification. The cost delta between the two is relatively small and primarily engineering-labor driven. This triggers a simple question—why maintain FAA type certification (Category B) if there are no apparent benefits?

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<sup>41</sup> By no means does this imply that USAF maintenance and standards are less than FAA, rather they are equal if not greater.





## Chapter Six

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### CDA Logistics and Support

*“If the Wright Brothers were alive today Wilbur would have to fire Orville to reduce costs”*     *Herb Kelleher, CEO Southwest Airlines*  
1994

#### Early Commercial Logistics and Support

It was an even chillier day on December 18<sup>th</sup> 1903 with the wind gusting 20-25 miles per hour from the north. The Wright Brothers had actually flown for the first time the day before, but now were faced with repairing and doing maintenance on their damaged airplane. That same feeling from the day before returned—but what was missing? Was it detailed FAA guidelines prescribing maintenance requirements or a licensed aircraft and powerplant (A&P) mechanic or even a licensed repair facility—not available for at least another 23 years.

As a matter of practicality, early military maintenance was the same as commercial maintenance practices—non-existent. There were some limited rules, regulations or requirements prior to the Coolidge Act in 1926, but nothing compared to what eventually was developed. The WWI military aircraft that flooded the commercial market had little if any consistent maintenance—much less government regulatory guidance. The fledgling military fleet was totally dependent on limited support from the OEMs and organic maintenance—often from the same folks who repaired their trucks and equipment fleets. As a result, the MTBF was quite low in these early days of flight.

After the Coolidge act of 1926, the commercial OEMs and early fleet managers began to develop maintenance and logistics systems for their aircraft. The majority of these were small companies with relatively small aircraft fleets. Each aircraft was a unique design and there few supply houses for aircraft parts. These early manufacturers were competing for market share in a really small market. When WWII began in Europe, it brought a major shock to the industry. Suddenly, the government was buying thousands of aircraft, building airbases around the world and requiring extensive supply chains to keep the aircraft in operations. This required an amazing ramp-up of capability that had never been seen in this young industry. With few exceptions, the development and implementation of these logistic systems came from the industry providers and were taught to the military crews.

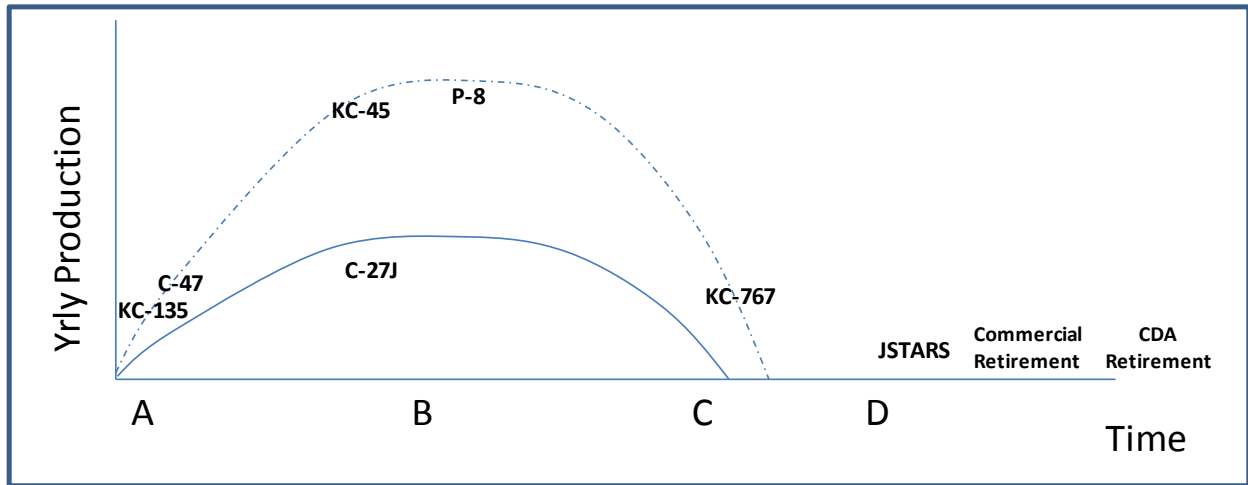
The post-WWII airlines were largely based on ex-military equipment and their government trained pilots and maintainers. The commercial airlines quickly procured most of the military fleets and personnel in a race to put together the first profitable

airlines. In the meantime, the militaries dumped their aircraft and personnel back to the commercial markets—but not to the low levels prior to WWII. Instead, a relatively large standing-army of aircraft and operators became the status quo which continues today. It is probably safe to say that those early airline operations and military squadrons used very similar processes immediately after WWII. Prior to WWII and during its execution, maintenance was what we see today at the organizational level. Most repairs were done locally and there were not major depots. The main reason for lack of military depots was that the aircraft were expendable and relatively replaceable. If the local maintainers couldn't fix it, it was cannibalized for parts—the birth of the hangar queens. More important, these early aircraft were not designed or planned to be used over a long period—they were essentially disposable. This is clearly seen in the fighter aircraft developed and deployed after WWII. Most were only in the inventory for a decade or less due to the rapid replacement by new and better designed aircraft.

The cargo and utility aircraft used prior to WWII were primarily CDA's. After the war, this changed to unique military aircraft: C-124, C-123, C-130, C-119, C-131 and C-141 among others. These aircraft had no commercial equivalent and required the military to develop its own maintenance infrastructure to include organic depots. These new aircraft were now designed to last many years—though most would not have had predicted life spans of 40+ years back in the 1950s. At the same time, the commercial industry was developing new aircraft for the growing airline industry and a new logistics infrastructure. A prime example was the Boeing 707 which was introduced in the late 1950s and quickly became the aircraft of choice worldwide. Boeing and its suppliers had to set up a major logistics infrastructure to allow for regular and emergency maintenance.

Today, the commercial fleets operate a large number of aircraft that are common with most of the world's military forces. Most are used for cargo, utility or training missions with only minor modification for operational avionics.

## Sustainment Life Cycle



**Figure 22. CDA Production Profiles**

Figure 22 above illustrates the typical production profile of a CDA candidate as compared to its total life cycle. Of interest is how the timing of the decision to purchase the CDA is affected by the stage of its commercial production. The stage of a production program affects the OEM's price, sustaining engineering (SE) support, data costs and spares availability.

The first thing to consider is the size and length of the production run. This contributes to the total size of the commercial market (number of aircraft) and the time period that the factory is producing new aircraft and spare parts. A large and lengthy production provides the most benefit to the commercial market and thus to the military CDA program. When the military buys a plane in the production life cycle can make a difference. Early buys (A on the above chart) indicates the military is likely the first major customer and will receive the early aircraft. These are most likely to have design, schedule, production and operational issues compared to mid-production aircraft.<sup>42</sup> The good news is that the OEM will be in production for a larger percentage of the CDA's life cycle. This reduces risk for SE and spare parts support. Several examples are shown in Table 4. The venerable C-47 (DC-3) was designed and flown prior to WWII as the mainstay of the airline industry. Due to the war over 16,000 were built over a very short period—less than ten years. After the war there was a glut on the market, so aircraft and parts were relatively cheap for all users. Douglas Aircraft stayed in business and was available to support these aircraft. The next aircraft, the KC-135 was co-developed at the same time as its civilian counterpart the B-707. The aircraft was in production 36 years and ample support was available to the USAF.

<sup>42</sup> Prime examples are the first buyers of the B-787 and A380 aircraft which both have suffered schedule and quality issues.

**Table 4. CDAs with Significant Production Runs**

<b>Military Designation</b>	<b>Commercial Designation</b>	<b>Company</b>	<b>Total Built</b>	<b>First Yr Production</b>	<b>Last Yr Production</b>
<b>C-47</b>	<b>DC-3</b>	<b>Douglas Aircraft</b>	<b>16,076</b>	<b>1936</b>	<b>1945</b>
<b>KC-135</b>	<b>B-707</b>	<b>Boeing</b>	<b>1010</b>	<b>1958</b>	<b>1994</b>
<b>P-8</b>	<b>B-737</b>	<b>Boeing</b>	<b>6605+</b>	<b>1968</b>	<b>Present</b>
<b>KC-767</b>	<b>B-767</b>	<b>Boeing</b>	<b>994+</b>	<b>1982</b>	<b>Present</b>
<b>KC-45A</b>	<b>A-330</b>	<b>Airbus</b>	<b>750+</b>	<b>1993</b>	<b>Present</b>

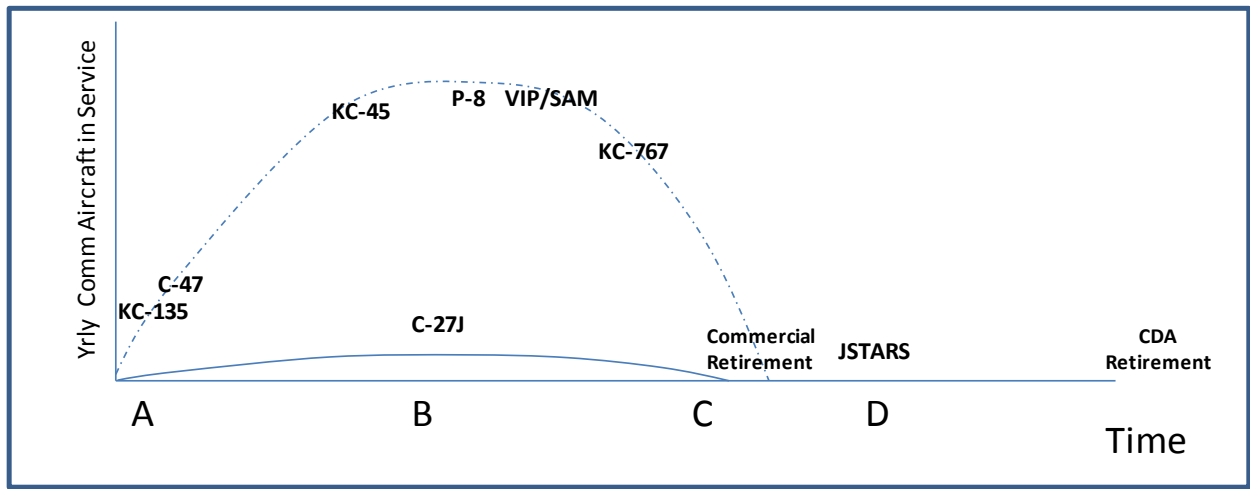
Aircraft delivered mid-life (B on the chart) are normally past the early production issues with a good proportion of the OEM's production and SE support remaining. This is probably the "sweet spot" where one would want to purchase their CDA. Three diverse examples of mid production CDA's are shown. The Navy P-8 is a recent CDA that has just started flight test and low rate production. It is based on the very successful B-737 that has already been in production 42 years with over 6600 aircraft produced to date. This aircraft is very successful and sales are expected for at least another decade with no Boeing successor on the drawing board. The Airbus 330 competed for the USAF tanker buy. It is a new aircraft just now reaching full production. If it had won, it would have increased sales significantly for Airbus. Finally, we have shown the C-27J at that point based on the current known sales and production schedules. In this case, it's in the middle of the production lifecycle, but the total sales are relatively small. This means that long term, there may be a higher risk for SE support and spares.

Point C on Figure 22 represents CDA buys at the end of the production life cycle. Often, this is due to the OEM's dropping their prices to bring in business at the margin rather than shutting down production. The B-767 is a wide body airliner chosen to fill the USAF tanker role. It has been in production since 1982 (28 years), but is likely to be shut down after the tanker Procurement. In this case, the USAF buy is at the end of the production run, but that production buy could exceed 500+ aircraft which would end up being over one third of the total production. This should provide a lower price for the government but also raises risk since the production line is shutting down after this order.

Finally there is scenario D where the government buys CDAs after the OEM has ceased production. This was the case of the USAF JSTARS aircraft. The USAF had intended to buy new aircraft from Boeing but failed to close the deal prior to a Boeing

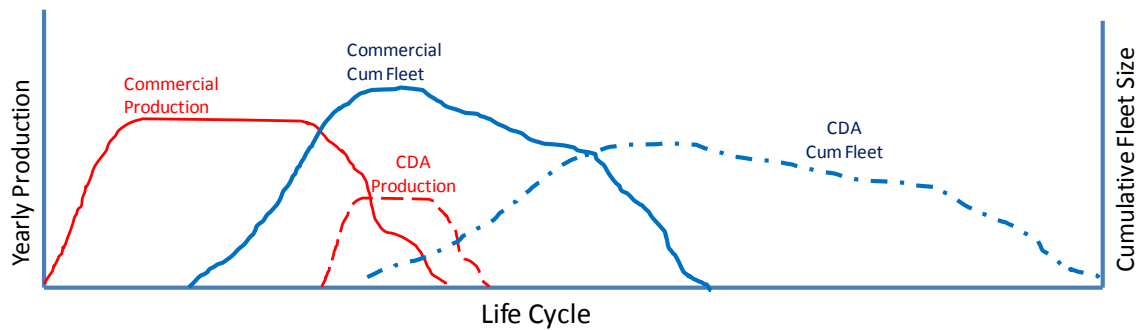
business decision to cease production. The result was the USAF buy of used cargo aircraft that had major corrosion issues.

Another way to consider CDA's is to evaluate where they fit into the total life cycle of the underlying commercial fleet. As shown below in Figure 23, DoD has acquired aircraft that were the first of the production line and flown them well beyond that of the commercial fleet. The KC-135 is a great example. On the other extreme, we have purchased CDAs at the end of the commercial life cycle—the JSTARS is a good example.



**Figure 23. CDA Fleet Life Cycles**

Why is this important when considering the purchase of a CDA? A major underlying benefit is that an active commercial fleet requires a full parts and systems engineering support infrastructure. The government greatly benefits from this established source of parts and technical support that is either totally or partially paid for by the commercial fleets. Once the commercial fleets retire or drop to a low level, then the government finds itself in the position of having the majority if not the entire surviving fleet of that aircraft. There is also a benefit of being the last to operate a fleet—a large pool of used aircraft, used parts and possibly new parts never needed by the commercial fleet.



**Figure 24. CDA Combined Production and Fleet Life Cycles**

By combining these ideas in Figure 24, we begin to see the challenge of bringing on a CDA while attempting to leverage the underlying commercial fleet. As shown above, when DOD is the last customer to buy, they totally fund the end of the production. This provides the best unit cost in terms of learning curve effects, but shoulders the DOD with the full support infrastructure. It also means the producer may quickly shut down the operation (and support) after the last aircraft is delivered. This is the likely situation the USAF finds itself in with the new Boeing Tanker buy of the B-767. The overlap of the commercial and military fleets provides the opportunity to leverage support and supply chain infrastructures (which should produce lower costs). Most DOD aircraft are operated long after the commercial market is retired. This is preferred time for the DOD to re-assess core-decisions, organic depot support, and transition to government supply chains.

One of the big challenges for USAF program managers and Air Staff planners is often the lack of knowledge or research on the commercial market and how it can support DOD logistics requirements. The program manager (PM) and program support manager (PSM) must know the product and product support life cycles of the commercial platforms being considered. The military invests billions in studying our enemies and allies, but not near so much in market research for the next great aircraft acquisition. The PMs and PSM must understand the market trends and how CDAs can support the warfighters. Usually, there is little time or resources spent to do proper business case analyses that look at all aspects of CDA life cycle benefits. Since DOD spends billions each year on CDA acquisitions, there should be consideration given to establishing a CDA center of excellence. This would provide needed market research that would allow PMs to stay ahead of market trends.

Even if research and data is available, DOD policies and changes make it difficult to implement commercial product support practices. Most beneficial CDA commercial practices require long term program stability to achieve significant cost savings. This is rarely possible with DOD short term focus on budgets and immediate savings. Policy changes are often politically motivated to drive business from one sector to another. Statutory requirements such as Core and 50-50 move work to the DOD depots despite

commercial options that may provide better performance at lower costs. Recent emphasis on FAR 15 contracts vice FAR 12 commercial approaches tend to raise costs and lower performance with no benefits to the warfighters. At a minimum, the DOD should consider competing logistics support on all CDA systems to give PMs the best options for support.

## **Attributes of CDA Co-Production and Fleet Management**

Understanding and leveraging the product support attributes at any point in the life cycle is a benefit to any CDA product support approach. Commercial aviation products are continuously evolving, taking advantage of technology and market trends to satisfy a variety of users. In contrast, many times military aviation products are only satisfying one user. Watching for the characteristics that can best benefit a CDA's product support approach provides insight for planning and management.

***Sustaining Engineering Maturity:*** High operational tempo in the commercial market leads to early problem resolution within the first years of product support. Commercial airlines usually purchase aircraft with performance requirements that necessitate quick and efficient problem resolution. Once mature, this engineering knowledge leads to identification of product improvements either for supply support or future variants. This approach is very comparable to military engine procurements using Component Improvement Programs (CIP). The advantage in the commercial market is that continuous process sustaining engineering is applied to benefit the product line. The April 1, 2011, 737 fuselage fatigue failure with Southwest Airlines flight 872 illustrates the benefit of a robust sustaining engineering which will benefit all users. Late in the life cycle, sustaining engineering support will be minimized as retirements occur. Second market opportunities can rejuvenate a manufacturer's interest in sustaining engineering supporting continued use of the product line. The recent Tanker decision to use the B-767 airframe will reinvigorate their sustaining engineering as the USAF becomes the long term operator for the fleet. The downside is that the USAF will likely be the only operator of the fleet in the latter years.

***Reliability, Maintainability and Availability (RMA) Knowledge:*** The benefits for sustaining engineering from the RMA knowledge gained early in commercial programs comes from millions of operating hours that provide a wealth of actionable knowledge to improve the product, increase maintenance planning efficiency, and perfect the supply chain. Commercial airline demands assist this process for resolution and efficiency. Comparably, military programs can take decades to accumulate equivalent knowledge. Late in the life cycle, RMA knowledge helps identify aging aircraft trends which decrease reliability and inhibit availability. Commercial airlines leverage this knowledge to bolster a continued life cycle or to make a decision to retire the aircraft type.

***Supply Support–Supply Chain Management Establishment:*** Efficiency and effectiveness early in the establishment of a supply chain needs time to grow. Thousands of relationships, procedures and an inventory factors need to be established to achieve expected efficiency and effectiveness. Normally five years after product introduction the supply chain will reach maturity, usually commensurate with reaching a million flight hours. As the life cycle continues, added efficiency and effectiveness usually result when new vendors and competitors enter the market. By mid life cycle, efficiency should peak. Potential benefits for CDA procurements at mid life cycle include parts pooling, repair processes, and eventually excess parts due to retirement. Supply support will always benefit from increased quantity, high utilization, and a stable maintenance concept.

***Product Improvement and Upgrade Possibilities:*** Closely tied to sustaining engineering maturity and RMA knowledge is the commercial market opportunity to improve products and services and offer variants. Many times product improvement is an evolution to satisfy emerging commercial market trends or technology changes. As the life cycle continues there are opportunities to capitalize on technology refresh programs to avoid obsolescence. The recent history of commercial aviation shows 3 to 6 improvements or variants to a single product line. Popular aircraft, such as Boeing 737, actually transformed into an entirely new aircraft in the 1990's during mid production with five additional variants. The 737 has seen a production run of over 6600 aircraft to date with a large backlog of future production. Product improvements do have an effect on supply support, resetting RMA knowledge and reestablishing sustaining engineering. Late in the product life cycle, product improvement is less likely unless sponsored by a specific user.

***Maintenance Planning Efficiency:*** Most commercial manufacturers utilize Maintenance Steering Group-III (MSG-III) procedures to establish maintenance planning. Early in a product support life cycle, inspections and retrofit procedures are immature and risk adverse. Maintenance training and tech manuals will improve quickly in the commercial market. Opportunities to seize MSG-III process benefits are realized early in commercial aircraft products as maintenance planning becomes more flexible and efficient when RMA knowledge is understood and applied. All users benefit from this process, as would a CDA.

## **Synergy with Commercial Providers**

We have discussed many of the potential benefits of choosing a CDA vice a military unique developed aircraft:

- Minimal or no developmental risk—spreads risk from a sole military user to the commercial market base
- Leverages the industry R&D investment which is primarily paid for by the commercial fleet



- Commercial industry creates multiple tiers of vendors to support the prime
- Quickly provides an FAA certified aircraft to the DOD without the lengthy wait for a traditional military development program
- Minimal test and certification programs as long as the military CDA is not heavily modified
- Ability to leverage the FAA or EASA certification to avoid a full up military test and evaluation program
- Adherence to published industry standards
- Option to maintain FAA airworthiness and oversight
- Demonstrated performance by prior customers
- Ability to leverage early fleet delivery
- Lower acquisition cost potential due to shared fixed costs and production curve
- Relatively quick delivery of operational aircraft from program inception to initial operational capability
- Commercial logistics and sustainment infrastructure to support operations
- Shared operational and maintenance data with other fleet users
- Shared parts pooling
- Potential worldwide maintenance sites

With these and other possible benefits, it would seem plausible that most DOD CDAs would take advantage of the many commercial opportunities to reduce life cycle costs. If you think that is true, then you would be wrong. Most DOD aircraft drop the FAA type certification and airworthiness which limits their ability to fully integrate with commercial logistics and support opportunities.

## **Impact of Airworthiness Certification Decisions on Logistics and Sustainment**

As discussed in the chapter on airworthiness, the DOD rarely maintains FAA airworthiness for its aircraft. There are a few examples such as training aircraft at aero clubs or USAFA or some leased VIP aircraft that were N-registered. However, USAF normal policy is to drop FAA airworthiness and type certification and go with military airworthiness and type certification.

This loss of FAA airworthiness and certification and the applicable standards for the aircraft and its DOD supply chain and maintenance and repair facilities creates an orphan fleet.

### **Development**

- Minimal impact to normal savings, but does open door to more intrusive design changes (outside of original FAA type certificate)—all at a significant additional cost

## Production

- Minimal impact as long as the green aircraft are similar or the same as the commercial variants prior to additional modifications.

## Sustainment

- New maintenance procedures that may differ from commercial standards
- Requirements for supply chain support, local and depot repairs
- Possible disconnect from commercial experience and maintenance notices
- Not able to participant in full parts pooling with two way exchange of parts
- Still able to procure commercial parts and services as long as they meet military airworthiness requirements
- Not able to fully participate in cross servicing with EASA/FAA fleets

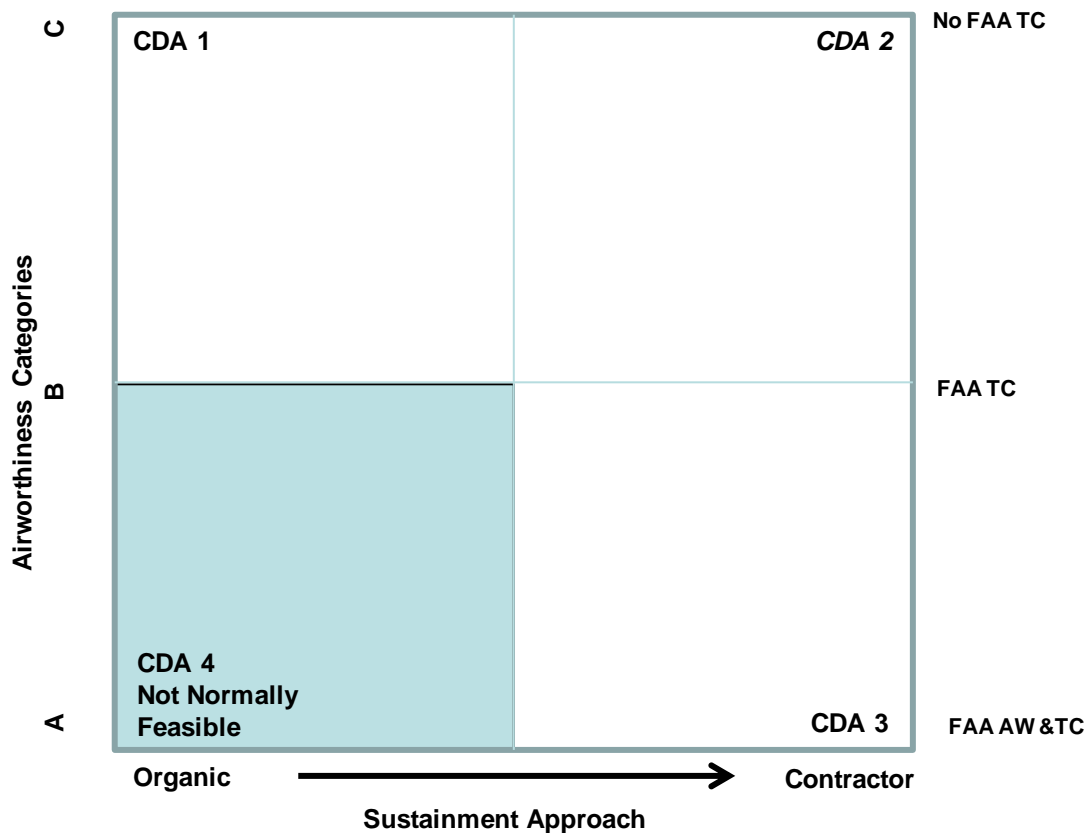
The biggest issue with dropping the FAA airworthiness is basically divorcing from the commercial fleet if there is one. Maintenance practices, supply chain practices, and parts are no longer acceptable to the commercial fleet.

When does it make sense to drop the FAA airworthiness (and type certificate)? If the Service is the only operator of the aircraft or the super majority owner, then in reality it is the “fleet”. This was the case for the C-130J and is almost the case for the C-27J.<sup>43</sup> As the sole buyer of the aircraft, the Service is free and required to set up its own logistics and sustainment system.

So how does the choice of airworthiness affect the sustainment options? As shown in Figure 25, one can take the three categories of airworthiness and map them against sustainment strategies. The four quadrants are labeled as CDA 1-4. CDA 1 implies organic sustainment with only military airworthiness—this is common to most of the USAF fleet of aircraft. CDA 2 is CLS but again only military airworthiness. This is also quite feasible and matches the other half of the USAF fleet. CDA 3 has full FAA airworthiness and is sustained by a CLS contract—same as the commercial aircraft, but very rare in the USAF. The last, CDA 4, would be a FAA airworthy aircraft but maintained at the depots—not normally possible with the existing USAF depots.

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<sup>43</sup> At the time of the USAF purchase, the US would own 39 of the total 89 aircraft fleet with no other country having more than 12 aircraft.



**Figure 25. CDA Airworthiness Options**

## Parts Pooling and Cross Service Agreements

Two significant benefits available to commercial fleets are parts pooling and what the military terms “cross service agreements.” Parts pooling is where a pool of parts is established for the benefits of a group of users. All aircraft fleets have a requirement for spare parts to cover operational usage, and predicted failures as well as safety stock for unexpected repairs. Most commercial aircraft are sold to a large number of companies or agencies who each have a total requirement for parts. If they all have the same airworthiness requirements for parts (FAA/EASA) then they can share parts. Depending on the parts pool arrangement, individual operators can reduce their spares requirements (based on the quick access to the parts pool) and save a great deal of their sustainment budgets. The key point here for the military is the requirement for

participants to share the same airworthiness criteria, otherwise they may not be able to share parts.

There are a variety of models used in the military and commercial markets. The simplest is the free market commercial model. In this case, multiple customers with the same aircraft would buy and sell parts in the commercial market. Multiple suppliers would enter the market to provide the inventory and provide repairs. The users may also repair parts in certified repair stations and provide them back to the pool. All parts/aircraft are maintained to FAA/EASA standards. Most military CDAs don't fully participate in this approach since they don't maintain FAA airworthiness.

In the final parts pooling scenarios, the USAF aircraft does not have FAA airworthiness nor are the USAF repairs done in a FAA part 145 repair facilities. This means the USAF may purchase parts from the pool (and share in the quantity discount), but may not input parts back into the pool for others to buy. In a free market model, this is not an issue since anyone may purchase parts if they are available.

Many parts pools are not open to the public and are normally created for smaller fleets with a more limited number of users. In this type of parts pooling, the users invest in a pool of parts (along with the infrastructure to maintain and stock them) and each has access to the pool based on their paid membership. In this case, the airworthiness can be either FAA/EASA or a level of airworthiness agreed to by all participants (military). The pool can either be run by a contractor (usually the OEM) or one or more of the participating governments. The USAF participates in two versions of this: the C-17 Virtual Fleet or a traditional Cooperative Logistics Supply Support Agreement (CLSSA). In both cases, the aircraft are part of a Foreign Military Sale (FMS) agreement. In both, all countries agree to a common set of airworthiness standards, but are able to operate on a much smaller spare parts pool than if they carried individual inventories of spares.

So what does the USAF normally do? As mentioned, two things constrain the savings. First, if the FAA airworthiness is dropped, then the aircraft can only do a one way parts buy. Second, if the maintenance is done by organic facilities, then those parts may not go back into a commercial pool. The USAF typically does a CLS approach or establishes an organic maintenance and supply system.

## **The Effects of DoD Policies**

When Delta airlines decides to buy a new aircraft for its fleet, it does an integrated assessment to include logistics and sustainment. In the DOD, the services have the same requirement and they fulfill it using a Business Case Analysis (BCA) process. A BCA is a decision support document that identifies alternatives and presents business, economic, risk, and technical arguments for selecting an option to achieve organizational or functional missions and goals. The BCA analysis should also account for legislative criteria such as limitations on contractor performance of organic depot maintenance workload. Performance metrics must address the BCA objectives and the primary weapon system support areas under evaluation. At a minimum, the BCAs must

address life cycle cost and key performance parameters such as system availability. The DOD is always interested in the best value solution which maximizes performance at the least cost—not necessarily just the lowest cost solution.

As we have discussed in this book, there are many potential benefits to buying a CDA that extend into the logistics and sustainment area. However, often DOD policies and decisions prevent the program manager from capitalizing on those potential CDA benefits. At its essence, CDA benefits flow from the ability to embrace commercial maintenance and supply chain infrastructure. Most analysis and DOD studies indicate that new aircraft programs should always include commercial practices in business case analyses. Just like constraints in optimization problems that often limit and deny optimal solutions, so do constraints against commercial solutions in logistics support.

In sustainment of military systems, there is a great deal of regulation and legislative interest. The legislative interest is a strict function of jobs for the local communities either directly at the maintenance facilities or indirectly with the lower tier suppliers of parts and services. There are also legitimate national security needs that require that we maintain some level of organic capability that is termed “core.” The Defense Acquisition University website defines core as:

*In accordance with (IAW) Title 10 United States Code (U.S.C.) Section 2464, a core requirement is a depot maintenance and repair support capability that is established and performed by Government personnel with Government-owned and Government operated equipment and facilities to sustain a ready and controlled source of technical competence and resources necessary to ensure effective and timely response to a mobilization, national defense contingency situations, and other emergency requirements.*

There are no standard (predetermined) core depot requirements for acquisition programs—this is done on a program by program basis. DOD guidance requires that the core logistics capabilities be identified no later than Milestone B, or by Milestone C if there is no Milestone B. The acquisition strategy must address and identify those requirements for the program and state how the program would go about establishing the required core capabilities. There should be a plan to establish core capabilities within 4 years of initial operational capability at military depots; (DoD Directive 4151.18); however, the DoDI 5000.02 is silent on the required timeframe for establishing the required core capability.

What does this have to with CDA’s? It means that the government gets to decide if they want to leverage commercial capabilities or provide all logistics and support organically. Who decides this? It’s the governments call and does not require a BCA or any other independent or neutral evaluation. It is based on the assumption that the government needs to be able to repair its equipment (and even manufacture some parts) since it can’t depend on the commercial market. The decision is often made based on capacity availability—such as when an older system is retiring and the depots are losing

work. It may also occur when a new technology is becoming commonplace and the depots have no existing capability in that area.

While this precaution may have seemed prudent back in the 1930s, it is questionable if the underlying justification is still true today. What are some of the justifications given for maintaining depot capacity (largely based on core determinations)?

- No commercial sources for the repairs—very unlikely when considering CDAs
- No commercial source that can respond rapidly—very unlikely for CDAs repair facilities that provide round the clock repairs to highly competitive commercial fleets
- Organic sources are lowest cost—not necessarily true if competition is used and if the comparison is for the same level of performance
- Commercial sources will not be available during a crisis—not clear what that crisis would be that wouldn't also impact the depots
- Depots provide long term repair capacity for legacy systems, long after the commercial market has moved on

What this means for a new CDA program manager is a list of regulations<sup>44</sup> the PM must successfully “fly” the program through:

1. The PM has to get the program reviewed to see if it's “core” or not. There is not a detailed set of criteria for this determination, so it is subjective at best.
2. If core, there is no guaranteed funding to stand-up the required depot capacity. If not funded, the program manager is left with an unsustainable program.
3. The USAF must determine how this program will affect its 50/50 calculations
4. If it's declared non-core, then the PM must compete the work to the lowest-cost source. This could be public or private.

The Congress has been supportive of commercial practices off and on for the last decades. In general, they point out government waste and inefficiencies while pointing to industry examples of new technologies, processes and infrastructure investment. CDAs offer a great way of obtaining military equipment while exploiting the best processes and capabilities of the commercial market. In a major 2008 Defense Science Board (DSB) Study<sup>45</sup>, the final report concluded:

*“The DOD logistics systems are clearly behind commercial industry benchmarks, are costly, and do not optimally support combat operations. The logistics system is not only the most expensive of DOD's acquisition processes, but it is also the most critical for sustained war fighting. It is currently far from world class, as response time is measured*

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<sup>44</sup> “Contractor Logistics Support in the US Air Force,” RAND Project Air Force, 2009

<sup>45</sup> “Creating an Effective National Security Industrial Base for the 21<sup>st</sup> Century,” Report of the Defense Science Board Task Force on Defense Industrial Structure for Transformation, July 2008.

*in weeks vs. hours. In spite of high logistics costs, there is little total-asset-visibility since DOD has yet to adequately exploit the revolution in information technology and communication.”*

As shown previously in Figure 23, it makes sense to leverage commercial logistics and sustainment sources while the commercial fleet is operational. Once production ceases and or the commercial fleet retires, then and only then should the government worry about “Core” or consider major investments in depot infrastructure.

## **Technical Data Rights**

On August 2, 1909, the Wright Brothers delivered the first airplane to the US military for a total price of \$25,000 plus a bonus because it exceeded the contract requirements of being able to sustain 40 mph. The contract only required delivery of the airplane and future flight training. The Army did not own the data rights or the right to copy the design and build additional aircraft on their own. The Wrights had spent over five years at this point acquiring a patent on their design for aircraft control and were very astute when it came to the subject of intellectual property and technical data rights.

Over the years since the Army first bought this aircraft, the industry approach to technical data rights has come full circle. The business model of aircraft manufacturers has swung back and forth between capturing all possible revenue from birth to death of their aircraft life cycles. In the period prior to the 1960-70s, most manufacturers produced aircraft that could easily be maintained by third party repair facilities. While the OEMs have always provided spare parts, they have not always provided full service maintenance for their fleet of sold aircraft. As the industry consolidated and sales have dropped, these firms have looked for new business areas to improve sales—one of which is sustainment and support. This has grown into an industry wide practice of providing contractor logistics support (CLS) and OEM parts supply.

At the same time, this growth of contractor sustainment has challenged the traditional military maintenance and depot structure. After the WWII experience, all the services had developed world class maintenance and depot support infrastructures. With new technologies and rapidly advancing aircraft designs, the contractors were able to gain a foothold in the sustainment industry for military support. This has continued through today as the military depots struggle to gain funding for infrastructure improvements and to train and hire workers with these new skills.

The OEMs best defense in this economic war for sustainment market share has been technical data rights. While one might have been able to “reverse engineer” the early Wright Brothers aircraft to make fixes, it is impossible on today’s advanced technology fighters, bombers and cargo aircraft. As far back as the 1970s, DOD would have bought a CDA and would have likely received sufficient technical data to do normal organizational and depot level maintenance. This was expected since most of this maintenance work was performed by military technicians. Some on-site parts manufacturing was done, but most likely only on traditional back shop parts that were not technically advanced (such as sheet metal or aluminum airframe work). With new

aircraft like the F-117, B-2 or even the C-17, the military depots lacked the trained employees or high-tech equipment for in-depth maintenance and repair.

What does this mean for today's CDAs? It has caused a major issue in today's budget constrained DOD environment. One of the possible benefits of acquiring CDA's is the potential for sharing sustainment investment costs across a large commercial fleet and thus reducing the USAF life cycle cost. This would normally mean a CLS contract with the OEM. However, core and 50-50 requirements force the USAF to instead use traditional organic maintenance that might be more expensive and provide less capability. These organic decisions can be problematic. The first issue deals with organic capability and training. Most new aircraft require new infrastructure and training programs that are quite expensive and not in the normal acquisition budget. The recent C-27J CDA was initially planned to have CLS (when it was an Army program), but this changed to organic support by the USAF. No budget was allocated for the depot standup costs which could easily exceed \$700M over and above the cost of organic maintenance. For a program like the new Tanker, the depots and their supporters will see this as a major target for future business. Despite the fact that there is an existing worldwide commercial sustainment infrastructure, the tanker (actually each critical component within the system) will likely be declared "core" and require billions in depot infrastructure and training.

The second issue then is technical data. These OEMs do not and will not usually sell their full technical data rights. They do not want the government or anyone else to have the ability to reproduce their aircraft or parts in an attempt to establish a second source for parts or aircraft. They might (for a price) provide technical data to allow for normal organizational and depot maintenance—which does not allow them to reproduce any of the OEM or sub-OEM parts. The OEMs realize that the sustainment tail on these programs can produce more revenue than the initial procurement costs. Aggressively defending technical data rights effectively deters entry to their market by outside manufacturers or the government. When the OEMs do consider selling those rights, it normally is at a price that is more profitable than if they had produced the parts or performed the maintenance themselves.

Is this issue any different for CDAs than for DOD developed aircraft? Yes, it probably is. The reason is that for traditional military development and production, the number of aircraft is relatively low and usually high performance and high tech. This tends to force the DOD to retain OEM support for the life of the aircraft. A CDA on the other hand has normally been sold to a large commercial base prior to the DOD entering the market (think Tanker). The OEM is not going to "give-away" the full data rights to a minority customer who is probably demanding a below market price for the acquisition program. Despite government assurance of security, there is always the danger that the data will be compromised and shared, and worse, the government will use it to take business away from the OEM. Finally, the commercial pricing model for the OEM is likely based on the assumption of recovering its non-recurring costs over a lifetime of aircraft and sustainment sales. Government buyers must understand that aircraft offered on the commercial market are often priced based on expectations of



future spare parts and maintenance revenues.<sup>46</sup> If the DOD wants to just buy the aircraft and tech data, they will need to pay their proportional share of the development costs and profit.

Since most military CDAs do not maintain FAA airworthiness, the DOD is free to reverse engineer the parts and attempt to build them in-house and use them on their aircraft (provided they meet all USAF airworthiness requirements). Due to the high cost of the development effort, the need for new high tech production equipment and skilled engineers and technicians, this is usually cost prohibitive. This tends to only work for low technology parts that are within the depots' established capabilities.

If the government decides to buy the full technical data package, what should they pay? There are several pricing strategies that have been tried or at least offered:

1. Free—An option the government might prefer, but highly unlikely. Probably only feasible if the company sees no future revenue stream from owning the data long after production is over and the commercial fleet has retired.
2. 1-4% of total price—The OEM likely is at the end of the production run and sees limited or no opportunity for significant sustainment support sales.
3. Present value of the estimated profit stream of the life cycle sustainment sales—basically, the OEMs are saying they are indifferent between taking the profit upfront in the data sale or actually running the sustainment business. This might also include future aircraft sales.
4. Present value of the total life cycle production and sustainment sales—the OEMs want the total revenue which they realize will stop the sale.

The OEMs understand that technical data rights and depot standup costs are a major barrier to entry for the USAF depots. These are all key elements that should be considered when the DOD makes major decisions on life cycle support strategies.

The best time to address data rights is in the competitive environment, but often product support considerations are not that clear. Determining where the CDA fits in the commercial product support life cycle as described earlier and considering the scope of the planned modifications are strategies to define assumptions and set objectives for the planned service life of the CDA with and possibly without a commercial product support capability to fall back on. This information provides the source data for determining what data rights are needed and when. Understanding these needs sets the stage for consideration of alternative approaches to access the required data. Commercial aircraft manufacturers claim that the Government wastes “mega-bucks” buying data to be ready to do organic support without articulating the need or likelihood.

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<sup>46</sup> One prime example deals with aircraft tires, wheels and brakes. Many OEMs recruit suppliers of these items and require them to provide these items for free on the delivered aircraft since it reduces the initial acquisition price. The expectation is that the airline will then buy many tire, wheel and brake sets over the life of the aircraft from the subcontractor who will then recoup this initial cost.

One approach to address data rights up front is to include as part of the contract a “data assertion list”. For a data assertion list, the OEM and/or modification contractor defines the data available on the program and the Government asserts which data it needs to access (data rights). To make this work, it is important that the Government understand its data needs as discussed above or this can become a fishing expedition. Data assertion lists are typically living documents and may be revised as CDA product support conditions change due to changes in the commercial market.

## **DOD CDA Sustainment Cases**

The United States has been buying CDAs since the Wright Flyer and in most cases, providing organic sustainment. Only in recent years has DoD made the move toward commercial sustainment options to reduce O&S costs and improve performance. Below, we describe several of the current CDAs and discuss how their O&S plans are performing.

### **Army UH-72A Lakota**

The Army Light Utility Helicopter (LUH) program is a descendent of the 1980s LHX program which attempted to develop two new helicopters: a light utility and an armed-reconnaissance helicopter. After almost \$7B in development, the LHX program was ended with no new capability in sight. With essentially only procurement dollars in hand, the Army and Navy wanted a commercial-off-the-shelf solution to replace their



**Figure 26. Army UH-72A Lakota**

aging UH-1 “Huey” and OH-58 “Kiowa” helicopters—both of which were CDAs. In 2006 they awarded a contract to EADS North America and American Eurocopter for 345 aircraft over an expected ten-year program. The new UH-72A Lakota is a derivative of the commercial Eurocopter EC-145.

As of this writing (2011), the program is on schedule and on cost. EADS/American Eurocopter funded a new production facility in Columbus MS with a capacity to build over 55 helicopters per year. The Army has made significant manpower reduction in their maintenance career fields so they wanted Contractor Logistics Support (CLS) as a major part of this program. The UH-72A is maintained by civilian mechanics under a subcontract to EADS North America. EADS NA has also

teamed with Sikorsky to provide Contractor Logistics Support (CLS) for the UH-72, through its Helicopter Support, Inc. (HSI)/Sikorsky Support Services, Inc. (SSSI) subsidiaries. It's a performance based contract that requires the contractor to maintain a minimum operational availability rate of 80 percent. The current attained rate for operational availability and parts fill rates has exceeded 90 percent.

The Army program manager is currently quite enthusiastic about the program and the commercial aspects of both the production and sustainment.<sup>47</sup> The program is procured under commercial FAR 12 rules which has allowed for quicker contract negotiations and changes compared to a traditional FAR 15 approach. One example of this was the ability to set up and negotiate commercial training for the pilots which allowed them to avoid the congestion and administrative costs of setting up a program at Fort Rucker, Alabama, the traditional Army helicopter training location.

## **P-8A Poseidon**

Since the early 1960s, the Navy has performed most of its maritime patrol mission with the Lockheed P-3 Orion. The P-3 was CDA based on the L-188 Electra commercial airliner from the 1950s. The Navy attempted to replace it in the late 1980s with an updated version, the P-7 LRAACA. This program was touted by Lockheed and the Navy as an upgrade to the P-3—new engines, avionics, mission equipment—and was sold as a low risk, minimal development effort. Unfortunately, Lockheed and the Navy decided to replace almost 80% of the aircraft and move production to a new site—making it essentially a new development program. This led to major cost and schedule overruns that caused the program's cancellation after only a year.



**Figure 27. Navy P-8A Poseidon**

To no one's surprise, the Navy realized in 2000 that the P-3s were near the end of their service life with rapidly increasing maintenance and operational costs. A competition was held<sup>48</sup> and Boeing won with a heavily modified B-737-800. As a CDA, it was able to leverage the prior production and sustainment system of over 6000

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<sup>47</sup> "Commercial of the Shelf (COTS): A Success Story," *Aviation Today*, Col L. Neil Thurgood and John Burke, 1 July 2010.

<sup>48</sup> The other competitors were a Lockheed Martin updated version of the P-3 similar to the previous P-7 and BAE offered a new version of the Nimrod

commercial aircraft in the international fleet.<sup>49</sup> However, it must be stated that the aircraft is being heavily modified which resulted in a development program of over \$6.5B in \$BY04. The P-8A is being built on the existing B-737 production line with major modifications being done in line. This is a major change from how traditional CDAs are normally modified—where a green aircraft moves to a program unique modification center.

This aircraft has not completed full testing so it has not achieved IOC as of this writing. Current plans for maintenance by the Navy are CLS with Boeing and its partners for the life of the aircraft. Boeing will maintain the airframe and engines to commercial standards to leverage the established airline operating model for CLS.<sup>50</sup> The contractor will run the supply chain and leverage off the existing parts system that they use for the 4100+ commercial customers. From the Boeing support view, the commercial approach provides maximum support for minimum government investment:

- Extensive experience with this airframe and the existing 737-800/900 airframes operating in the airline market
- Established value stream with Boeing and its commercial partners
- Established worldwide maintenance operations, infrastructure and supply chain
- Proven commercial maintenance procedures that are certified airworthy
- Spare parts commonality with 737-800 and P-8A
- Established repair processes, manuals and technical data exchanges
- Established training systems and programs for maintainers
- Established procedure for “dual use” common airframe parts so that P-8A parts may be exchanged within the civil aviation community (allows full parts pooling)

Since the P-8A is one of the newest and larger purchases of a CDA, several studies have been done to determine the best approach for this type of CDA. One of the better studies came out of the Naval Postgraduate School in 2008.<sup>51</sup> This study did a basic business case analysis that considered three options:

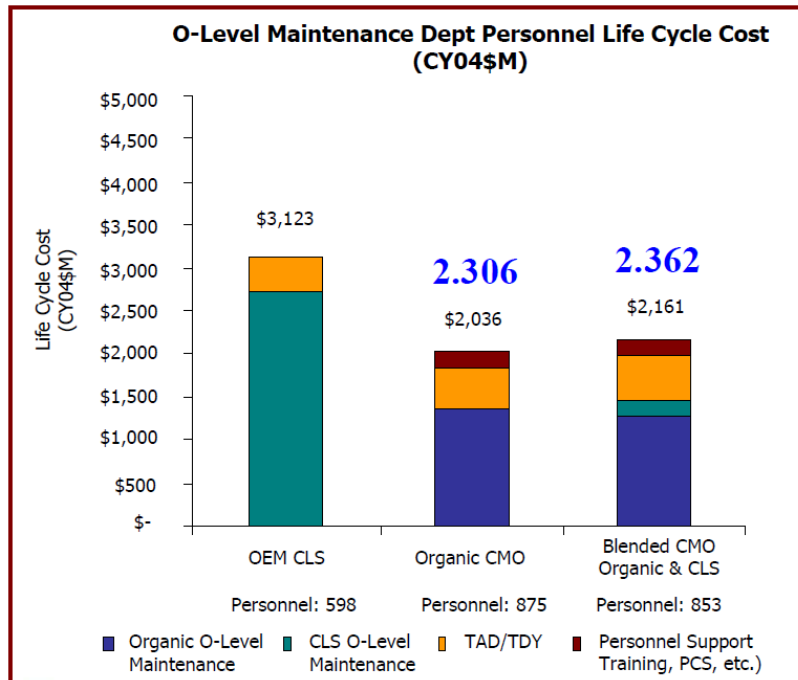
1. OEM CLS (current program plan)
2. Organic Consolidated Maintenance Organization (CMO)
3. Blended Organic CMO and OEM CLS

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<sup>49</sup> The Boeing 737 is the most produced commercial airline in history with over 6100 delivered by 2011 and almost 3000 on backorder. Not since WWII has a large aircraft been produced in these numbers.

<sup>50</sup> “Product Support for a Commercial Derivative,” Ray Figueras, Product Support Engineer, Boeing Corporation, 2007.

<sup>51</sup> “Analysis of Contractor Logistics Support for the P-8 Poseidon Aircraft,” Tallant, Hedrick and Martin, Naval Post Graduate School, Monterey CA, June 2008

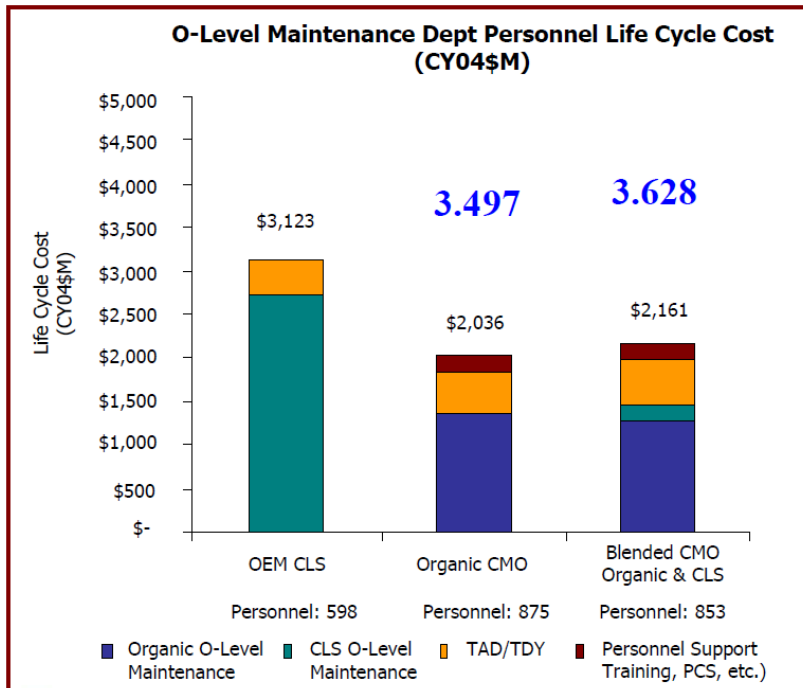


**Figure 28. NPS P-8A Thesis Results**

The initial results in Figure 28 show the direct life cycle costs for the organizational level maintenance using only the maintenance manpower requirements. Costs for any future depot maintenance or second part supply chain were not considered. The data showed that the proposed Boeing CLS support was significantly higher than the organic or blended option based on NAVAIR data and methodology. These however, are just the direct personnel costs. They do not include the costs of the shore duty personnel required to support operational (i.e., training pipeline and shore rotation billets). The OEM does not have this requirement. When this cost is added, then the OEM CLS option is cheaper by 11-14% as shown in Figure 29.

This result was shared with maintenance experts, P-3 operators, and officers familiar with CLS contracts in the field for comment. While the discussion was more focused on CLS versus organic support, it is relevant to CDAs since CLS is a major desired attribute of using CDAs.

The field maintenance commanders were unanimous in their praise of the CLS results. Comments ranged from “have never seen things run so smooth” to “the aircraft were always in top shape and very rarely saw a repeat discrepancy.” They felt the aircraft were always at the peak of safety and airworthiness, and availability was never an issue. They described the contractor personnel as loyal, hardworking and demonstrating daily a sense of duty and loyalty to their country. They stated the contractors provided continuity and experience not available within the military and civilian employee pools.



**Figure 29. NPS P-8A Thesis Results**

The same commanders also had concerns about contractors and their ability to deploy to the battlefield. They worried that contractors couldn't just pack up and leave on a moment's notice. There were issues with visa, passports, immunizations, transportation and deployment of their tools and equipment. A few were even concerned that a few contractors may refuse to go or just quit. Others were concerned that without a very detailed and specific contract, it might be difficult to pay or track the cost of the deployment, much less provide contractual guidelines for execution. Last, but not least, how do you budget for an emergency deployment that might quadruple your CLS costs? The study authors felt that these issues could be overcome, but that it was critical that the contract consider all of these issues.

Since the deployment to combat zones was the biggest issue, the study predicted that the best value decision would be the blended OEM-Organic option. It would minimize the deployment problems but provide a sufficient core of contractor personnel to guide their maintenance and provide a direct connection to commercial practices. While these are all legitimate concerns, it must be noted that in the current Afghanistan and Iraqi conflicts, well over a million contractors have deployed successfully and few of these issues have been significant.

## C-27J

The C-27J program was the result of the Army's Future Cargo Aircraft program in 2004 which eventually became the Joint Cargo Aircraft. Previously, the Army had used the C-23 Sherpa, the C-12 Huron and the C-26 Metroliner to provide "organic" intratheater airlift (all CDA's). After a great deal of debate between the USAF and Army, the Army Chief of Staff decided that the aircraft and its funding should go to the USAF based on a better fit with USAF roles and responsibilities. As part of the transfer, the total aircraft buy was reduced from 78 to 38. The aircraft will be located at nine Air National Guard bases.



**Figure 30. C-27J**

The winning C-27J Team was led by L-3 Communications Integrated Systems (L-3 IS), Finmeccanica's Alenia North America, and Global Military Aircraft Systems (GMAS). They bid a modified version of an existing design that traces its roots back to the C-27A and G-222. The C-27J is in service with the Air Forces of Greece, Italy, Lithuania and Bulgaria. At the time, the C-27J was the best selling twin-turboprop military tactical airlifter in the world, ordered by six air forces: Italian (12 aircraft), Greek (12, plus 3 options), Lithuanian (3), Bulgarian (5) and by the U.S. Army and U.S. Air Force (78), for an expected total of 110 aircraft. At the time, the C-27J had also been selected by the Romanian Air Force for 7 aircraft, with a contract under negotiation. The loss of forty aircraft by the US Army was a major impact on their sales strategy.

The Army sustainment plan was to maximize the use of CLS and minimize the organic footprint for the Army. This is similar to their UH-72A sustainment plan which was working well. The Army program office began a major business case analysis (BCA) to compare sustainment strategies. The Army program office competitively awarded a two-year, multi-million dollar contract with a well-respected analysis company to perform the BCA to consider a wide variety of sustainment scenarios. The study considered as many as six alternatives in the key areas of depot level maintenance,



organizational maintenance, supply support, aircrew training, and maintenance training. The BCA determined that the best solution that provided the highest aircraft availability was a CLS approach where supply, organizational and depot maintenance are all under a single manager. The BCA noted that the C-27J was not a traditional CDA since there were currently no commercial sales and little chance of any in the near future.<sup>52</sup>

The BCA was finished in the same time period that the program management was transferred to the USAF. At that point, the program was sustained using the existing L-3 interim contractor support (ICS). Shortly thereafter, the USAF came out with a program strategy in its Cost Analysis Requirements Description (CARD)<sup>53</sup> that directed organic support in the USAF depots, GLSC supply chain and ANG organizational maintenance. This was supported by a memo from SAF/AQ<sup>54</sup> that directed the same sustainment approach. During the same period, the USAF declared the C-27J “core” and supported it with a DSOR and SSOR paper. The USAF did not redo or update the BCA with additional data that might have changed the BCA analysis or outcome. This left the USAF in the position of having a BCA that recommends contractor logistics support for best performance and lowest cost and a program direction to do just the opposite. The C-27J was considered “core” and directed to utilize the USAF depot system. At the time of this writing, the USAF is preparing estimates to determine what the cost of “standing up” the depots will be for the USAF. Estimates range from \$100M to almost \$800M—if indeed the high estimate is correct that brings into question whether it was a good business decision to abandon CLS in favor of the depots. If the high range of the estimates is correct, the USAF should redo their BCA to determine the best life cycle sustainment concept.

## **C-27J and the FAA**

The original Army plans were to maintain FAA type certification and leverage commercial practices as much as possible. This was a major part of the Army acquisition strategy to reduce life cycle costs and utilize industry best practices where ever possible. When the USAF took control of the program, they quickly made the decision to drop the FAA certification and rely only on the military type and airworthiness certification. Was this a huge mistake by the USAF? Not necessarily. The Army had already looked at the issue in their BCA and provided the following insight for CDA programs:

1. The C-27J is a tactical airlifter with an expected operational profile outside of anything a commercial operator might perform. The aircraft maximizes performance, but at higher than normal commercial cost per hour operation rates. It is unlikely that a commercial operator would use this type of aircraft new. It is

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<sup>52</sup> Belzon JCA BCA, Spring 2010.

<sup>53</sup> Cost Analysis Requirements Description for the C-27J, 15 March 2010, Version 1.0, AFPEO for Aircraft, 516<sup>th</sup> ASC Wing, Mobility Systems.

<sup>54</sup> C-27J Training and Sustainment Strategy, SAF/AQ Memo, 28 September 2010



also unlikely that commercial fleets would want to parts-pool with an aircraft that operates in such an intense environment and operates its aircraft systems at max capacity on a regular basis.

2. A major benefit of acquiring a CDA is to leverage the flight test program and FAA/EASA certification. The current C-27Js and the rest of production will all benefit from this regardless of dropping FAA type certification after delivery.
3. Most operators of CDAs also leverage CLS contracts to sustain their fleets without incurring a major infrastructure investment. Not only do they not need the large infrastructure investments, but they don't need expensive technical data. The USAF has contracted for organizational and depot level maintenance data, but not full data rights. This becomes an issue if the USAF wants to recomplete maintenance, second source spare parts or build their own. The lack of data rights established a permanent link to the CDA OEMs. This may not be an issue early in a program while there are relatively large commercial and military fleets—but what happens when the USAF flies the aircraft 40 years and finds itself with an orphan fleet. In this case, maintaining FAA certification and especially FAA airworthiness might be an issue if the USAF manufactures its own parts or performs major repairs.
4. Large commercial fleets allow the OEMs to maintain adequate engineering staffs to support the owners and to develop upgrades—all compliant within airworthiness and certification requirements. The USAF decision to go organic (and drop FAA certification) means they will lose their direct connection to the OEM expertise that normally comes with a commercial sustainment arrangement.
5. Normally a large commercial fleet with equivalent certification and airworthiness allows for parts pooling and large commercial supply of parts. In this case, the fleet is not large nor is it commercial. Additionally, the USAF is dropping FAA (or EASA) certification, so it's not clear what if any parts pooling is possible. With such a small fleet, it is likely that the OEMs will remain the sole source for most parts.
6. A large commercial fleet usually generates multiple FAA/EASA certified providers of depot maintenance at competitive prices (to include the OEMs). The small size of the C-27J fleet will not generate this type of depot activity, so the lack of FAA certification will likely have little impact in this area.
7. The USAF C-27Js will be flown in a manner outside of normal commercial operations plus be potentially exposed to combat fire and damage. These are areas outside of normal FAA rules and regulations. In this case, the decision to adopt military certification and airworthiness is a better decision.

## USAF Tankers

No CDA program in recent USAF history has generated as much controversy, discussion and political interest as the Aerial Tanker replacement program. The original KC-135/B-707 program was a very successful program. The commercial variant set the standard for airline transportation and firmly established Boeing as a major aerospace manufacturer. The KC-135 has successfully flown thousands of hours and several decades past its originally planned life cycle. The old Strategic Air Command was thinking ahead of its time when in 1967, just three years after the KC-135 production line shut down, it issued a ROC for the KCX. It took almost thirteen years before the next tanker would fly—the KC-10, another CDA. It was a successful program that delivered 60 wide body tankers to the USAF to provide not only tanker services, but significant cargo capability.

The KC-10 primarily utilizes CLS for sustainment, but does not maintain FAA airworthiness. The aircraft does share parts with the commercial pool of other MD-10 and DC-10 airframes (386 produced). As of January 2011, only 97 DC-10 produced remain, mainly as cargo aircraft with Federal Express (74) in the MD-10 configuration. This has provided the USAF with a much larger pool of commercial parts and maintenance options than they would have compared to a military only aircraft.

The new tanker competition was awarded to the Boeing 767 team. Since its first flight in 1981, Boeing has delivered over 1000 B-767s including a tanker version for Japan and Italy. Prior to the tanker win, the production run was coming to an end with only a few remaining aircraft to be built. This sale to the government will reinvigorate the program and its engineering support for many years past what was originally planned by Boeing.

For both of these aircraft, there is a large commercial fleet operating around the world with well established commercial sustainment infrastructures. Next to the current Joint Strike Fighter acquisition, this will probably be the largest aircraft buy that the USAF makes. Theory is on the side of maintaining FAA certification for the basic green aircraft in order to take advantage of the commercial sustainment opportunities. With this new sale, many current customers may extend the use of their aircraft to leverage the benefits that come from the large USAF purchase and expected long term sustainment effort. This may even encourage new commercial buyers.

Despite the opportunity to save several billion dollars by maintaining FAA airworthiness and leverage full commercial logistics and sustainment options, it is unlikely this will happen. Rather, the USAF, under Congressional pressure from the depot coalition, will attempt to force the tanker into the depot system. First, many of these aircraft will likely be assigned to the Air National Guard or Air Force Reserve, who will have numerous flight line maintenance personnel available after the KC-135s are retired. This will result in organizational maintenance being done by a mixture of military and government civilians. Second, the depots will be losing business as the KC-135s retire and they will be looking hard for replacement aircraft projects. The USAF will “determine” that the aircraft depot maintenance is “core” which forces the USAF to invest in new infrastructure, processes and training—duplicating what the commercial

market already provides. Finally the DOD will demand that the GLSC set up the supply chain system in an expensive move to duplicate the commercial market. As part of the acquisition plan, the USAF will drop the FAA certification which will effectively cut off access to commercial parts pooling and maintenance opportunities. The USAF will be required to conduct a business case analysis to compare commercial logistic support options against traditional depot support. The recent experience with the C-17 and C-27J predicts that the USAF will conform to Congressional preferences and decide the depots can do it cheaper and better, while down-playing a history of CLS that produces higher weapon system availability and performance at reasonable cost.



## Part Three

# What's So Hard about Buying Something off the Shelf?





## Chapter Seven

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### Why Can't We Make Up Our Minds

*If we did not have such a thing as an airplane today, we would probably create something the size of NASA to make one.*

**--H. Ross Perot**

#### Protests

So far we have discussed changing requirements and the sage advice that CDAs should remain as close to the green aircraft as possible even if that means adjusting the requirements a bit. Unfortunately, many of the problems happen before the DOD ever makes the source selection decision for the aircraft and starts to change things. The actual source selections have recently become as controversial as any other element of CDA theory. The Air Force faced three protests on its only three major aircraft source selection during the 2006-2008 period involving the KC-X tanker, the CSAR-X helicopter and the JCA cargo aircraft, all CDA platforms. Early-on, it had to defend itself in a lengthy protest over the JPATS source selection and prior to that, the T-3A source selection decision. Only recently (February 2011), was the USAF able to finally finish the new KC-X tanker source selection II without a protest.

It is not fair to the Air Force or DOD to assume that something systemic is wrong with the acquisition process just because of a protest. Contractors protest awards for a large number of reasons other than the government made a mistake. Some of the most common are:<sup>55</sup>

1. Save face with their corporate headquarters: The bosses expect a win and they expect their team to fight till the end—which is the protest. This proves that the team did everything possible.
2. Maintain the corporate image and position in the market: This is much like yelling at the referee in hopes that it will impact future decisions. If the protest sticks it can delay award which is an advantage to the incumbent even if they lose. It also may allow the protestor to gain information from the government on the winning offeror.

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<sup>5555</sup> “Why DOD Contractors File Protests. . . and Why Some Don’t,” Steve Roerman, Program Manager, March-April, 1998.

3. Protest since there is nothing else in sight: As in the KC-X or CSAR-X, these were the only major acquisitions in sight, so a loss might mean exiting the market to the losing firms.
4. Poor communication between the government and offerors: Sometimes the contractors don't understand the RFP requirements and evaluation criteria, so protest based on what they believe the RFP implied. This is only made worse if the government fails to properly communicate during the pre and post source selection periods.

In normal, clean-sheet development acquisitions, the government issues a statement of objectives for the new weapon system and sometimes an estimated budget. The requirements for the new aircraft usually push the state of the art to some degree and each offeror works hard to meet the requirements or thresholds. Thus, if the USAF needs a fighter that will do Mach 2.5, supercruise, 3000 nm combat radius and a payload of 4000 lbs, they will likely get proposals that approach the requirements and offer little more. The competition will then take the form of all contractors attempting to meet the performance requirements (probably within a few percent of each other) based on paper designs or minimal capability prototypes. The major challenge for the source selection team is to assess the risk and probability of each offeror finally delivering on their proposal on time with the promised performance and on cost.

Why is a CDA competition different? It starts the same with a list of requirements and a statement of objectives. The first problem starts with the requirements. As this book has preached, flexibility is not only the key to airpower; it's the key to successful CDA acquisition. It is also a huge problem. The DOD must do thorough market research to see what existing systems are operating that can meet the program's needs, what variants are in the future and how to include as many different systems as possible to create competition. The DOD market research identifies a reasonable number of aircraft and then adjusts requirements if needed to include as many as possible in the competition. This must be done prior to proposal submissions and after extensive discussion with the user community to make sure that the pool of candidates is truly viable for the mission. At this stage, the DOD may face its first round of protests since it likely defined requirements that eliminates someone who wanted to bid.

Why not just let everyone bid? The problem is that without requirements (and thus constraints that eliminate some offerors) it makes for a difficult if not impossible evaluation process. The evaluation teams would still have to do "rack and stacks" against performance, cost and other evaluation criteria, but with more offerors, most of whom likely have little if any chance of winning. Why don't the offerors understand this simple concept? They do, but that's not their real problem. Their real problem is that at any given time, they only have a finite or maybe singular product in production that they can propose, or perhaps one on the drawing board. Assuming this is a low risk CDA program (basically with few modifications), then they really have no option to change their aircraft in the short run—thus they have to try and change the DOD requirements so that it includes their aircraft. This game of trying to adjust the rules is played hard up until the source selection decision. This practice is called "shaping the requirement"



and is a common practice. Many government personnel in the acquisition community are unprepared for this onslaught of contractor “help.” On top of help from the contractors, the government also gets “help” from the higher headquarters and Congress after the requirements have supposedly been locked down. When there are multiple potential suppliers, this is not that critical, but when there are only two—this becomes a major issue for the contractors and the government. With only two competitors, any changes to requirements or RFP processes often end up benefiting or appearing to benefit one bidder over the other due to the limited trade space.

The government has another major area where they often err and it’s usually a self-inflicted wound. Over the years, the contracting community has debated how much and what type of data to request in Section L of the RFP. This information can range from detailed design specifications, to studies and simulations, to full-up flight tests. There are groups that believe you should ask for minimal data for CDA evaluation since all candidates have already flown and been FAA certified. The opposite extreme wants full performance, design, cost and in-depth flight testing to be accomplished and submitted. The problem arises with Section M of a CDA RFP which must tell how the government will use the Section L requested data in its evaluation. For the simple data call, the evaluation might be a simple rack-and-stack or simulation/performance model—all which is shared with the offerors. In this case, the winner is obvious and the source selection decision easy to explain. On the other extreme, if one has thousands of pages of data, it may not be clear how the DOD will evaluate and or use the data. The larger the differences among competitors’ aircraft, the more the RFP tends to request large amounts of data. This has been the trend in recent source selections. In the cases of the CSAR-X and KC-X, the Section L alone exceeded 50 pages and asked for boxes of data.

The government sets themselves up for a fall by asking for data that they have no definite idea how to evaluate. The basic theory is that all data in Section L must map to an evaluation in Section M. The source selection team needs an evaluation plan/model that they can share with the offerors. Otherwise, the offerors will easily be able to find data that they submitted that is better than the winner’s submission, but was not used or acknowledged by the source selection team.

Some contracting officers feel that sharing the evaluation plan or models allow the offerors to “game” their bids. The source selection must be transparent and the evaluation methods must be limited to those areas that are of vital importance to a decision. Further, when the source selection team does generate an evaluation methodology, they must execute as written in the RFP. An important part of this is to share the evaluation in the debriefings and detail it in the final decision report. Most protests are lost because the government failed to conduct the evaluation according to their own RFP. The GAO rarely finds against the government if they do their evaluations according to the RFP Section M criteria. The GAO rarely questions the government’s technical judgment—but they will overrule them for failing to follow Section M evaluation criteria.

Why are CDA evaluations any different than normal development/acquisitions? The challenge is that most CDAs are built to different market requirements and thus end up with a very different capabilities and performance metrics. Imagine if the USAF required a new tanker with significant cargo capability along with other secondary mission capability. If the requirements are broad enough to encourage competition, you might have KC-5s, KC-17s, KC-747s along with the KC-767 and KC-330 challengers. They all can be turned into tankers for a price. The CDA problem is that since they were built to meet differing requirements, they all offer some unique benefits—which may not be one of the basic USAF requirements. For instance, the C-17 derivative can use unimproved fields and the others can't. However, to keep them all in the competition, one has to lower the minimum key performance parameters. This creates a situation where they all can claim best value based on meeting the minimums plus their special capabilities—like landing in dirt. The source selection team can get into trouble by fumbling how they handle these non-mandatory benefits of the differing aircraft.

The next sections are going to look at the recent CDA source selections and discuss the protests. The purpose is not to chastise the government or the contractor for protesting. Rather, it is determine if there was anything unique about CDA competitions that must be planned and handled differently.

## **CSAR-X**

The current rescue helicopter, the HH-60, entered service with the USAF in 1982. It was expected to have a service life of about 19,000 hrs which would run out prior to 2020. The helicopter performed quite well in its role, but changing requirements, threats and new unconventional warfare threatened the aircraft's continued service. In January 1999, the Joint Requirements Oversight Council (JROC) determined that the HH-60G was deficient in areas such as survivability, range/ combat radius, payload capacity/ cabin volume, battle-space/ situational awareness, mission reaction (deployment) time, adverse weather operations and service life limit. The recent experience in Afghanistan has led the Air Force to require a rescue platform that can operate for extended periods at high altitude in very remote locations. The current HH-60 is at the limits of its capabilities in this type of mission (actually deficient in some elements). The Air Force chose to select a new aircraft based on existing designs that could be fielded by 2012.



**Figure 31. HH-60**

The Marines and Navy had recently finished several competitions for vertical lift airframes (the new Presidential Helicopter fleet and the V-22), so there was a relatively large group of possible “off-the-shelf” competitors. The USAF also wanted the new vehicle as soon as possible, so the decision to acquire an existing airframe made great sense over a long and expensive new development program. The USAF (along with the other services) is strongly committed to rescuing isolated servicemen, and acquiring and operating the best equipment to accomplish this role was major priority for DOD (the #2 acquisition priority for the USAF next to the tanker). As shown in Figure 32, there were three helicopters competing: CH-47, HH-71 and HH-92—all existing airframes.



**Figure 32. Boeing CH-47 Chinook, Lockheed Martin/Augusta Westland VH-71, and Sikorsky HH-92 Superhawk**

The USAF began detailed planning for the source selection in 2005 and eventually released a draft RFP with a very large Section L—roughly 50 pages or more asking for extensive cost, operations, logistics and maintenance data. Section M was relatively short and provided little insight on how the USAF planned on using all of this data in their evaluation. In hindsight, this lengthy Section L was their undoing. Had the source selection team developed a detailed evaluation plan mapping all Section L data requests to specific Section M evaluation models/evaluations, the USAF would not have lost the upcoming protests. The GAO and past court decisions have been very clear that

they will not uphold a protest if the government follows their evaluation rules and clearly explain their process to the bidders in the RFP.

While this is an issue for all source selections, it is also an important issue for commercial and military derivative aircraft. As mentioned earlier, the USAF was faced with three different helicopters and at one point also had to consider the V-22. Each of these systems had their own unique operating capabilities, maintenance concepts/issues, and life cycle costs. The USAF wanted to encourage competition and provide each with an opportunity to meet a common set of broad requirements. This creates a source selection dilemma since you then have to determine how to do an apples-to-oranges evaluation and comparison among different, existing aircraft. Had this been a traditional new development, the requirements might have been more narrowly focused. The other problem with evaluating existing airframes is they can provide actual data for all of the evaluation metrics. By asking and receiving this data, the source selection team is expected to not only use the data, but to figure out how to fairly compare and evaluate the data.

In November 2006, USAF Chief of Staff, General Michael Moseley announced the plans to acquire 141 CSAR-X helicopters with IOC expected by 2012 and that the Boeing CH-47 was the winner. The Chinook had a long, proven record with the Army, but came across as a surprise to many outside observers. The Air Force Chief of Staff, General Moseley commented <sup>56</sup> “It was a surprise to me . . . I am going to be OK with this . . . The US military has a lot of people out there operating this airplane in some fairly bad places and it is working like a champ.” When questioned about the comment,<sup>57</sup> he said “I didn’t say I was upset about it. All I said is, it wouldn’t have been the one that I picked, but I will make it work.” Many observers were surprised since the USAF had been discussing the need for “medium lift” helicopters to fill the mission, while the Chinook was a heavy lift helicopter and the most expensive of the three alternatives.

Within weeks of the announcement, the two losing contractors filed protests against the decision. They claimed the USAF failed to follow its RFP criteria and failed to properly evaluate the proposals. Per the law, the USAF issued a stop work order pending resolution of the protests. On February 26, 2007 the GAO issued its decision and agreed with the protestors. While the protestors claimed a long list of issues in their filing, the GAO decision focused primarily on one issue. The USAF had requested specific data on unit mission personnel and indirect support costs, which all had provided. While the RFP stated the these evaluated costs were to be calculated by the government, the GAO<sup>58</sup> found that “the USAF’s method for calculating these O&S costs did not reasonably account for each offeror’s unique technical approach.” The decision took the USAF to task for specifically asking for the information (which indicated significant differences in O&S cost per system) and then ignoring portions of the data.

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<sup>56</sup> Comments made at the 2007 Air Force Association Symposium in Orlando, FL.

<sup>57</sup> “The Struggle over CSAR-X” AIR FORCE Magazine, September 2007.

<sup>58</sup> GAO Decision B-299145, B-299145.2, B-299145.3, Matter of Sikorsky Aircraft Company; Lockheed Martin Systems Integration-Owego. February 26, 2007

Furthermore, the decision notes that the USAF had flip-flopped on their stated strategy and actually used similar data in another part of the evaluation.

The USAF reissued the RFP with appropriate changes to address the GAO decision. In the new amendment, the offerors were asked to resubmit limited, specific portions of the proposal that dealt with the O&S issue. The amendment eliminated consideration of unique aspects of each offeror's airframe. It also did not allow them to resubmit the rest of the proposal to accommodate any desired changes due to this new restriction. The two losing offerors again filed protests claiming the new amendment did not fix the problem and did not allow for a fair evaluation of their proposals.

On August 30, 2007, the GAO issued its third protest decision<sup>59</sup> on the CSAR-X and found on the side of the protestors.<sup>60</sup> They agreed with the protestors that the changes in the evaluation were material and that the USAF should have let them revise their entire proposal:

*"In these circumstances, we conclude that the USAF, having materially altered the methodology for evaluating O&S costs, was therefore required to permit offerors to revise both their cost/price and non-cost/price aspects of their proposals in response to the new evaluation scheme."*

The USAF took the advice and began to rewrite the RFP with the apparent intent of allowing the offerors to make major changes to their proposal if desired. A new draft was released in October 2007 and the field would be limited to the existing three offerors. Over the next year, the USAF issued two more amended RFPs along with promises to issue a final RFP and begin the final evaluation. In the meantime, the KC-X protests occurred and confidence in the USAF's ability to run a protest-free evaluation dropped. Finally, in June 2009, the Air Force issued the following announcement:

*"The Air Force is terminating for convenience the System Development and Demonstration Contract for the HH-47 Combat Search and Rescue Recovery Vehicle Program with the Boeing Co., of Ridley Park, Pennsylvania for \$712,156,535. This contract termination is a result of the CSAR-X program cancellation directed by the Under Secretary of Defense for Acquisition, Technology, and Logistics (FA8629-07-C-2350)."*

In the end, the USAF (along with DOD) failed to acquire a badly needed CSAR-X asset to replace the aging HH-60 fleet. Worse, the USAF lost its budget and potentially its control of this vital mission area. The lesson learned here (and on the following KC-X) is to balance the desire to ask for unlimited actual data on existing airframes and then fail to use it in the evaluation. Once the USAF opened Pandora's Box by asking for excessive operational data, they were obligated to use it. In the end,

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<sup>59</sup> Lockheed Martin Sys. Integration-Owego--Request for Reconsideration, B-299145.4, Mar. 29, 2007, 2007 CPD ¶ 78, in which GAO found that additional protest grounds regarding areas other than the operations and support evaluation were without merit.)

<sup>60</sup> GAO Decision B-299145.5, B-299145.6, Matter of Sikorsky Aircraft Company; Lockheed Martin Systems Integration-Owego. August 30, 2007

the only defense would have been to have an extremely detailed and complicated evaluation tool that utilized all of this data—not likely to occur and equally not likely to be successful. In the end, a much simpler and limited data call tied to a well defined evaluation plan would have eliminated this problem.

## KC-X

As mentioned in the KC-10 discussion, the USAF has been trying to buy a replacement for the KC-135 for almost fifty years. The most recent tanker competition began out of a cloud of mistrust, misinformation and alleged criminal actions.<sup>61</sup> The original KC-X program took almost a decade before it finally picked an aircraft that met a set of requirements that had become a moving target. As far back as the 1980s it was claimed that the KC-135s were going to wear out quickly and need to be supplemented, if not replaced. Thirty years later the debate continued. The KC-135 E&R models were nowhere near their projected lifetime flying hour limits of 36,000 and 39,000 hrs respectively. As of 2009, the average fleet hours were between 12,000 and 14,000 hrs. Even with the ongoing conflicts in the Middle East, the oldest E models wouldn't hit the limits until 2040. No doubt there are aging aircraft issues and corrosion that gets worse every PDM cycle, but none of the aircraft were “falling out of the sky.” The Air Force over a ten year period initiated many studies that prioritized their procurement; and the tanker would rise and fall on this priority list raising questions about the criticality of the timeline and the Air Force's real needs.

The first major attempt to obtain new tankers was the KC-767 lease program. At its simplest, the Air Force lacked significant new acquisition budget to buy new aircraft—but hoped to use the existing operations budget to lease them. The idea was a carefully crafted lease which would allow the USAF to work with a lesser to buy the aircraft and keep the lease payments and operating costs within the planned operations budget. A study posited that the operations “savings” would ultimately pay for the aircraft. There was a great deal of discussion, debate and apparently not a lot of analysis (especially legal) as this program began. Several variants of this idea were pushed, but none survived. Opponents (led by Senator John McCain) attacked the idea and its supporters which eventually killed the idea after a few years. By this time, the lease

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<sup>61</sup>“ On April 20, 2004, Darleen A. Druyan, the former lead Air Force negotiator on the tanker lease proposal, pleaded guilty to one charge of criminal conspiracy. Ms. Druyan admitted to secretly negotiating an executive job with the Boeing company while still overseeing the \$23 billion leasing arrangement between the Air Force and Boeing.( R. Merle, “Ex-Pentagon Official Admits Job Deal,” *Washington Post*, April 21, 2004.) Lease supporters argued that Ms. Druyan was a single “bad apple” and that her actions did not negate the merits of leasing Boeing 767s for use as tankers. In February 2005, however, the DOD IG reportedly concluded that Air Force Secretary James Roche misused his office when he lobbied the Office of Management and Budget (OMB) to support the lease concept. (R. Jeffrey Smith, “Roche Cited for 2 Ethics Violations,” *Washington Post*, February 10, 2005.) The IG's final report concluded that four other senior DOD officials were guilty of evading Office of Management and Budget (OMB) and DOD acquisition regulations that are designed to demonstrate best business practices and to provide accountability. The DOD IG found that senior DOD officials knowingly misrepresented the state of the KC-135 fleet and air refueling requirements.( Department of Defense, Office of the Inspector General, *Management Accountability Review of the Boeing KC-767A Tanker Program*, OIG-2004-171, May 13, 2005.) “ Source: Congressional Research Service Report “Air Force KC-X Tanker Aircraft Program: Background and Issues for Congress,” 30 July 2009.

deal, developed in a sole source environment, had been carefully evaluated and shown to be very expensive compared to just buying the aircraft (acquisition costs were assumed, not known). There was also growing criticism about the lack of competition—basically from European competitor, Airbus (which was developing a tanker).

As mentioned several times in this book, a major issue is requirements generation and stability. The cheapest and less risky CDA program will always be one wherein the requirements are flexible enough to match the fixed capabilities of the green aircraft. So did the KCX program have well defined and researched requirements? Yes and No. On one hand there were multiple studies which made numerous suggestions—but there was also a wide range of possibilities. It is fair to say the Air Force had more help than it really wanted or needed:

- a) Defense Science Board Task Force Report on Aerial Refueling Requirements, May 2004.
- b) Analysis of Alternatives for KC-135 Recapitalization, RAND Corporation, 2006
- c) GAO Report: Military Aircraft, DOD needs to Determine Its Aerial Refueling Requirements. June 2004
- d) Defense Science Board National Military Strategy 2004
- e) HQ Air Mobility Command White Paper: KC-X—the Next Mobility Platform, The Need for a Flexible Tanker. February 2007
- f) GAO Report: Defense Transportation: Opportunities Exist to Enhance the Credibility of the Current and Future Mobility Capabilities Studies, Sept 2005
- g) Quadrennial Defense Review Report, Feb 2006
- h) GAO Report: Defense Acquisitions: Air Force Decisions to Include a Passenger and Cargo Capability in its Replacement Refueling Aircraft was Made without Required Analysis. Mar 2007

The most influential report ended up being the Rand report which looked at a wide range of options and determined the overall best option would be a new commercial derivative aircraft. The new tanker would need upgraded defensive systems in order to operate closer to the area of combat operations. A 2007 report indicated that tankers were fired upon 19 times while operating in hostile zones during 2006 alone. The report also considered other roles (cargo, electronic, etc) for the aircraft and found them feasible but said that was a decision for the combatant commanders.

In January 2007, after multiple meetings and data exchanges with all possible bidders, the USAF released the final Request for Proposal (RFP). For a simple commercial derivative, the RFP was quite lengthy with a long list of data for the offerors to submit. In contrast, Section M was relatively small compared to section L. It listed the major evaluation factors and their weightings:

- Factor 1—Mission Capability. Mission capability includes five subfactors listed in descending order of importance:
  - Subfactor 1.1—Key System Requirements
  - Subfactor 1.2—Subsystem Integration and Software
  - Subfactor 1.3—Product Support
  - Subfactor 1.4—Program Management
  - Subfactor 1.5—Technology Maturity and Demonstration
- Factor 2—Proposal Risk
- Factor 3—Past Performance
- Factor 4—Cost/Price
- Factor 5—Integrated Fleet Air Refueling Assessment

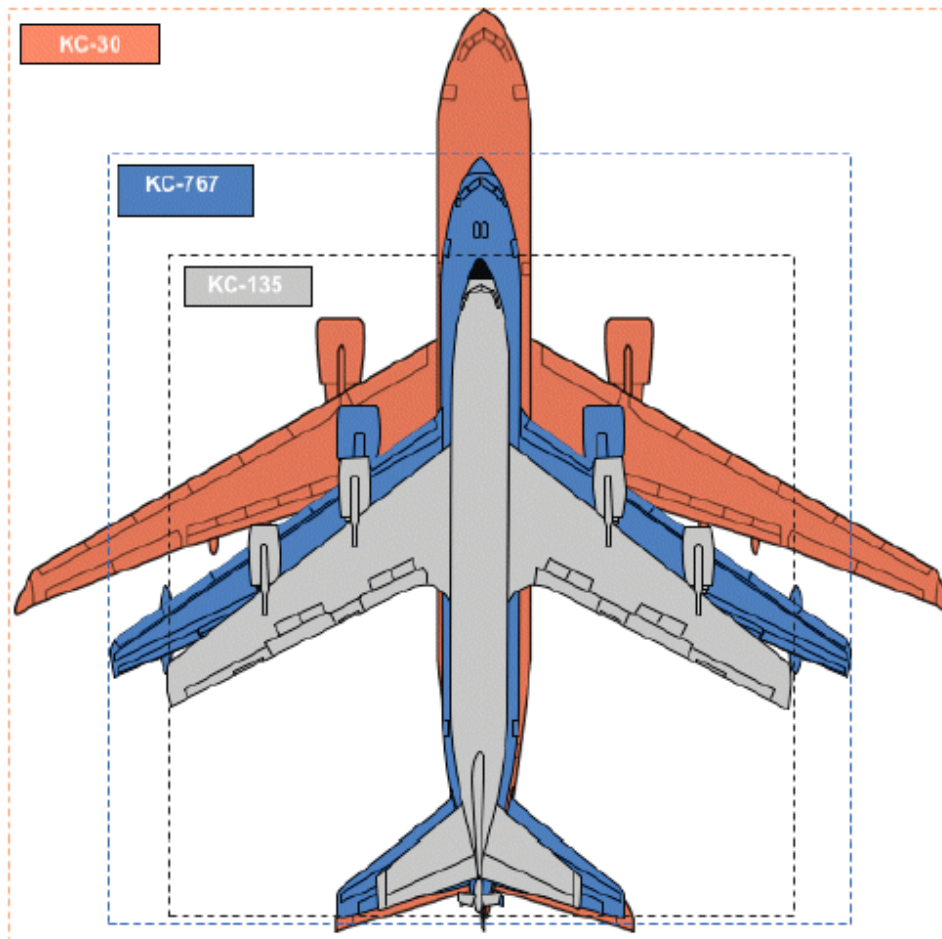
The Air Force considered the first three KC-X evaluation factors of equal importance. The final two factors were considered of equal importance, but less important relative to the first three criteria. Lastly, the Air Force regarded “Factors 1, 2, 3, and 5, when combined, [to be] significantly more important than factor 4.”

This final RFP clearly stated that the primary mission of the KC-X would be to “refuel DOD and allied aircraft with the flying boom mechanism.” It went on to say that “any passenger or cargo carrying capability was deemed a secondary mission.” Boeing had the option of offering up the 767, 777 or even the new 787 (which would have carried a significant risk since it hadn’t flown yet). They chose to propose the 767 since it met all requirements and was only slightly larger than the existing KC-135 footprint—yet with significantly more capability. Northrop Grumman and EADS/Airbus chose the A-330 since it was much larger and offered substantial capability compared to the 767 and was already well into development of a tanker variant for several foreign countries. Due to its size and capability, it theoretically would require fewer total aircraft compared to the 767 for comparable levels of service. With its size, the A330- also offered more capabilities in the “secondary mission” areas. Both bidders had tankers either in production or flying based on these basic airframes which undoubtedly was a major part of their proposal decisions.

With these two aircraft, the USAF ended up trying to compare a big tanker against a medium sized tanker in a best value source selection using relatively broad requirements that both satisfied. The size difference is apparent in Figure 33 which shows the two competitors aircraft as compared to the existing KC-135. The USAF spent months evaluating the large data call and lengthy proposals they had requested in Section L. During this period, the program office and source selection team continued to get additional “help” from Congress, the contractors and anyone else with an opinion on



how they should make their decision.<sup>62</sup> For the USAF, there was a great deal at risk. They had just lost the protest on the CSAR-X program which ultimately was cancelled, but only after the USAF lost most of its budget. They had suffered a protest on the C-27J competition, but were able to go ahead and award with only a minor delay.



**Figure 33. Comparison of KC-30, KC-767 and KC-135**

On February 29, 2008, the Air Force selected a consortium consisting of Northrop Grumman and the European Aeronautic Defense and Space Company (EADS)—the parent company of Airbus—over Boeing to build the KC-X tankers. In early March 2008, both offerors were debriefed by the USAF source selection team. On March 11, 2008 Boeing filed a protest. Two weeks later the USAF and Northrop Grumman filed motions for a quick dismissal—which the GAO rejected. This brought the contract to a

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<sup>62</sup> While not discussed here, there were major issues about Buy American, World Trade Organization disputes over possible subsidies to EADS/Airbus, American jobs and domestic content of the individual aircraft.

halt. After a four month investigation, on 18 June 2008, the GAO upheld the Boeing protest. In the end, the contract was terminated and the USAF was left with no choice but to redo the competition.

What did the GAO find—and was any of it remotely related to commercial derivative aircraft competitions? The Congressional Research Service<sup>63</sup> studied the documents and summarized the seven basic areas of the protest that were sustained:

1. The Air Force evaluation did not follow the prioritization of technical requirements specified in its own solicitation. Nor did it give credit to the Boeing proposal for satisfying the greater number of non-mandatory technical criteria, though the solicitation expressly requested.
2. The Air Force used the degree to which the Northrop Grumman bid exceeded a specific key performance objective as an important discriminator between proposals, despite the solicitation's provision stating that this would not be the case.
3. Solicitation required that proposed tankers be able to refuel all fixed-wing, tanker-compatible Air Force aircraft using existing Air Force procedures. The protest record did not support the Air Force's determination that the Northrop Grumman proposal did so.
4. Air Force discussions with each of the bidding companies were unequal and misleading. Boeing was told that it had fully satisfied a key operational utility parameter, yet the Air Force later reversed their assessment without informing Boeing that it had changed.
5. Northrop Grumman refused to agree to a specific solicitation requirement regarding the development of Air Force maintenance capability within a specified period. The Air Force unreasonably assessed this to be an "administrative oversight" and awarded the contract improperly in light of this exception to a material solicitation requirement.
6. The Air Force unreasonably evaluated the military construction (hangars, runways, parking aprons, etc.) required to sustain each of the proposed aircraft. During the protest proceedings, the Air Force conceded that calculations properly performed would have resulted in a most probable life cycle cost for the Boeing offer lower than that for the Northrop Grumman proposal.
7. The Air Force improperly adjusted upward Boeing's estimate of the non-recurring (i.e., one-time) engineering portion of its most probable life cycle cost value. The Air Force would have been able to do so had it found the cost to be unreasonably low, but it did not. Additionally, the cost model used by the Air Force to adjust this cost estimate was found to be unreasonable.

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<sup>63</sup> "Air Force Refueling: The KC-X Acquisition Program," Christopher Bolkcom and William Knight, CRS Report for Congress, August 4, 2008, RL34398

The first CDA issue is in #1 and #2. As discussed, CDAs are each built for unique requirements initially, so when compared in a DOD competition, they will each bring some unique or differentiating capabilities. These were the non-mandatory technical criteria. The RFP and USAF used the concept of “trade space” saying that “optional capabilities or attributes could be traded away for better or different performances in other areas depending on the offeror’s unique approach.” The GAO found that they failed to do this in their evaluation.<sup>64</sup> The second finding also deals with how the evaluation teams should deal with secondary discriminators. In this case, the team apparently “weighted” a discriminator despite words to the contrary in the RFP.

Issues #5 and #6 were related to CDA product support characteristics which the source selection could not evaluate. On Issue #5, Northrop did not refuse to develop Air Force maintenance capability within a specified period (5 years); rather it was that the capability would not be needed due to the slow build-up of flying hours before the first depot maintenance repair at approximately 9 years. The Air Force RFP was not aware of the extended Maintenance Planning cycle for newer commercial aircraft, thus the first aircraft input to depot extended beyond the AF required timeframe. Issue #6, was actually a commercial competitive advantage for Northrop’s offer, as the use of hangers, parking arrangements or runway use were proven in the proposal to be far less than the Air Force estimated, therefore, fewer hangers and parking areas would be required to support the aircraft. Boeing did not present the same rationale, therefore the AF evaluation did not account for any unique commercial experience supporting the airframe. It was the GAO’s opinion that the life cycle cost analysis should be conducted as parity.

The other major CDA issue dealt with #7. A major part of the evaluation of a CDA is the assessment of risk and the amount of remaining development work or non-recurring costs. In this case the GAO decided that the USAF improperly assessed risk against Boeing. The key detail is that the cost evaluation team used studies based on traditional acquisition programs and studies that looked at overall total program cost growth. The GAO correctly assessed that evaluation teams should not directly compare CDA programs with minor modifications to traditional acquisition programs when assessing cost risk.

The remaining issues are common to all acquisition source selections and not the result of the CDA competition. The major finding here in terms of CDAs is that the evaluation teams must have a plan to evaluate secondary discriminators that are not part of traditional acquisition program data for comparison or parametric analysis of CDAs.

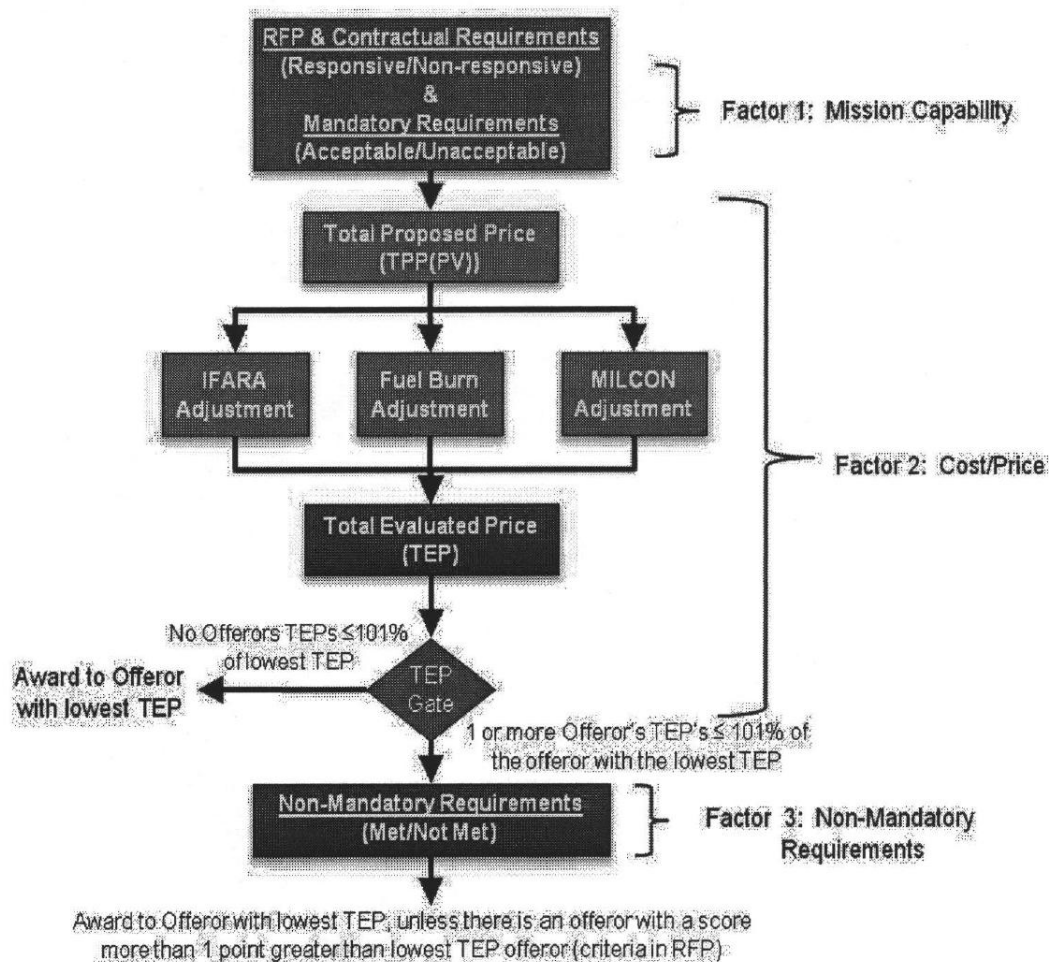
In February of 2010 after months of debate and probably excessive oversight, the USAF posted the new RFP<sup>65</sup> for the KC-X. It still required a large amount of data and that became multiple volumes and boxes of information. The biggest change was the selection criteria. While labeled a “best value” approach, it was closer to a low price,

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<sup>64</sup> GAO Decision Report on Boeing Protest, 18 June 2008.

<sup>65</sup> FA8625-10-R-6600, Section M, Evaluation Factors for Award, 24 Feb 2010

technically acceptable strategy. The technical evaluation considered 370+ technical parameters that were all pass/fail. As written, it was expected that both companies would pass all criteria. The actual Section M evaluation process is shown in Fig. 34.



**Figure 34. KC-X Evaluation Methodology**

If both offerors passed the mission capability evaluation, then a comparison of the total evaluated price (TEP) would be done. The TEP was composed of the acquisition price of the aircraft and equipment, an adjustment based on the number of aircraft to meet the mission, an adjustment for the operational fuel cost and finally, any MILCON requirements.

The previous RFP had multiple trade-offs to consider advantages and disadvantages of large versus medium size aircraft. These tradeoffs were eliminated, but the IRAFA and fuel burn adjustments were meant to trade-off large versus medium aircraft characteristics in limited areas. At this point, if the two TEPs were within 1% of

each other, then a series of 93 non-mandatory technical requirements would be considered with points being awarded. The offeror with the most points would be the winner. This data was shared with the offerors. Final proposals were submitted in late Summer 2010 with final selection announced in February 2011—the Boeing 767 was chosen. This was a complete reversal of the previous decision. It was reported that the Boeing TEP was more than 1% cheaper so the final tradeoff methodology was not required. After being debriefed on the evaluations by the government, the EADS team elected not to protest.

## **JOINT CARGO AIRCRAFT (JCA)**

In 2006, the US Army issued a solicitation to replace its fleet of C-26 (Fairchild Metro) and C-23 (Sherpa) aircraft Figure 35. This program was meant to provide the Army and USAF with a light cargo aircraft to supplement the C-130 fleet. The program goal was to acquire existing aircraft already in production either commercially or militarily that could meet the Army's requirements without the cost or schedule of a traditional development program.



**Figure 35. C-26 Metro and C-23 Sherpa**

Three teams offered proposals:

1. Lockheed Martin proposed a modified C-130J which had been in production since the mid-1990s. It, like the other offerors, would require upgrades to its GPS and communications systems.
2. Raytheon teamed with EADS North America and offered a CASA-295. This was the smallest aircraft proposed, but met all of the basic requirements. It had been in service almost a decade and many were already in use by other country's militaries as well as in commercial use.
3. L-3 Communications Integrated Systems teamed with Alenia to offer their C-27J aircraft. This aircraft was in production and a few variants were in service. It was an upgraded version of a previous aircraft.

In this case, the chosen aircraft would be used by the US Army and the USAF to provide tactical cargo and special operations missions. As with other CDAs, the Army set minimum requirements for cargo, operational capabilities, etc. in order to maximize

competition. This allowed for a wide variety of potential aircraft that ranged from the large four engine C-130J (\$65M) to the smaller two engine CASA 295 (\$25M).



**Figure 36. CASA 295**

In the Summer of 2006, Lockheed Martin was informed by the Army that their proposal had been eliminated from further consideration as being non-compliant. Lockheed filed a protest with the GAO which temporarily halted the evaluation. The RFP required that all proposed aircraft be delivered with a Selective Availability Anti-Spoofing Module (SAASM). This module allows military GPS receivers to receive and decrypt GPS coordinates with a high degree of precision. Lockheed was already under contract to retrofit the existing USAF fleet of C-130s with this module. However, the existing production and retrofit dates did not meet the JCA schedule requirements. The Army specifically questioned Lockheed about this and they failed to explicitly update their proposal to meet JCA requirements. The GAO determined<sup>66</sup> that Lockheed had indeed failed to meet the requirements and upheld the government elimination of their bid.

With GAO resolution of the protest, the Army continued their evaluation of the remaining two proposals. In June 2007, the Army announced that they had selected the C-27J as the winner of the competition (Figure 37). In this case, similar to the CSAR-X and KC-X, the Army chose the larger, more expensive alternative. The Raytheon-led team immediately filed a protest. The US Army believed the CASA 295 performance was marginal compared to the larger C-27J and apparently felt the additional

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<sup>66</sup> GAO Decision, B-298926, November 21, 2006



performance was worth the extra costs—Raytheon bid \$1.77B compared to L-3's \$2.04B—about 15% more.



**Figure 37. C-27J Trojan**

The GAO began a four month re-evaluation of the proposals and the Army's evaluation process.<sup>67</sup> Both proposals were found to be similar on technical, management, production and logistics issues. The major difference was operational capability. A threshold requirement for both was that the aircraft had a minimum service ceiling requirement of 25,000 ft. pressure altitude while carrying a crew of four, a 12,000 lb. payload and enough fuel for a 1200 nm mission plus a 45 minute reserve. The CASA-295 could only meet this through the use of a "new operational mode" defined in the proposal, but not yet certified by the FAA or other flight test methods. Raytheon argued that while they did require the use of this new operational mode, they had confidence it would be certified by the FAA and none of the other RFP mission profiles required all three of these cruise criteria. The GAO disagreed and found for the Army.

The problem with this protest (and similar issues with KC-X and CSAR-X) was that it allowed the Pentagon to rethink the program requirements. This resulted in program management being transferred to the USAF but at the cost of the half of the fleet as a budget reduction (from 78 to 39). In the case of the CSAR-X, the USAF decreased the budget \$123M during the protest to fund other programs. Eventually, they killed the entire CSAR-X program and the total budget was lost—meaning the warfighters got nothing and will have to start over in the POM competition for funds.

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<sup>67</sup> GAO Decision, B-298626.2, B-298626.3, September 27, 2007.

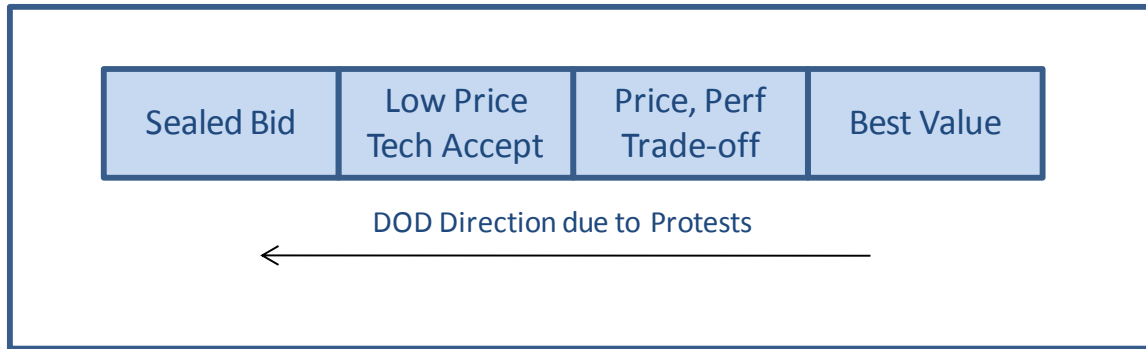
As with the first two protests, did the CDA nature of the program play a role in the protest situation? In this case, like the previous two, the Army was faced with generating real competition without making the requirements too broad so that anything qualified or too restrictive so only one or two aircraft qualified. In this case, the Army essentially “drew a line in the sand” in terms of minimum cruise capability. It may be confidently assumed that the Army did not know that the C-295 would fall short of the requirement. Obviously it did and they correctly evaluated the performance and took the appropriate action as specified and allowed by their Section M criteria in the RFP. The CDA issue is whether this should have been a hard requirement. As mentioned several times, a lesson learned about CDAs is that requirements for existing aircraft should be flexible since it’s often very expensive if not impossible to modify aircraft to meet certain requirements. Instead, the Army (had they known in advance) might have lowered the threshold to allow inclusion of the C-295. Had this been the case (and the performance delta was small), it is conceivable that the Army might have chosen differently and saved 15%. The key point to be made is that the military should seriously reconsider having hard thresholds (pass/fail) and instead consider the trade-off. What is not known from the GAO report is how much credit the C-27J received for all the other performance improvements it had over the smaller C-295.

## **What Has Been The Result of these Protests?**

The immediate result has been noticeable and heightened caution regarding source selection activity by the USAF and probably similar concerns by the other services. The DOD was using a best value approach during most of the 1990s and into the next decade. However, as Figure 38 indicates, the selection methodology is moving away from best value and toward low price, technically acceptable.

When the services had a source selection challenge like the KC-X, CSAR-X or even the Presidential Helicopter, they often erred toward the side of an overly-detailed evaluation. These evaluations appeared to suffer from the fallacy that there is a single best value solution that can be found through an objective calculation by the source selection team if only they had sufficient data. The theoretical belief is that they can consider hundreds of important performance, maintenance, operational and cost factors which can then be rank ordered, weighted and then recombined into a single objective evaluation score to find the best choice. While it puts a gleam in every operations research analyst’s eye, these approaches prove to be unwieldy, overly complex and almost unexplainable. For a single factor, it makes sense. But with each new factor to consider, it becomes hard to determine how they should relate (weighting) or worse, do they interact with each other?





**Figure 38. Award Methodologies**

Recent experience has shown this is not a feasible approach. While this is a reasonable theoretical approach, it does not work in today's environment. The current approach is to determine key parameters before the evaluation (and don't change!) and make them pass/fail. This is the desired acceptable performance level—more is better, but not worth paying extra. Then, once all qualified candidates have been determined, pick the one with the lowest total life cycle cost (TLCC). The TLCC must be based on a realistic modeling of the expected use of the system that must be shared with the bidders. This approach is called Low Price/Technically Acceptable (LPTA) and is similar to what was done on the recent successful KC-X Tanker competition.

This however, has generated a healthy fear of any approach that allows for decision flexibility on the part of the decision makers. This means the source selection team must generate an RFP that lists requirements as pass/fail and does not allow consideration of other non-listed capabilities. This makes CDA competitions more difficult since it essentially requires the team to pre-determine which factors and system metrics are to be considered and to decide in advance how to rank them. Thus, the USAF and others are moving toward an approach that is closer to low price, technically acceptable than the previous preference for a best value approach. While this might make the decisions easier and less vulnerable to protest, it may also diminish the USAF's ability to choose the best systems to meet mission requirements.



## Chapter Eight

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### Commercial Derivative Aircraft Case Studies

#### **FOR SALE or TRADE**

*High-performance jet fighter, fully armed with missiles, guns. ECM equipment, fresh paint (stars and bars painted over), single seat, 97% reliability rate, will outclimb, outturn F-16, outrun F-14, low fuel burn (relatively), all digital avionics, radar, terrain following, INS, GPS, Tacan, used only for testing and sales promotion. Now in storage.*

*Contact Northrop Corp. Will trade for Mig-25 and home address of Air Force Acquisition officer.*

*— Ad found in 'Pacific Flyer' magazine, shortly after the F-20 program (a commercially developed fighter) was cancelled*

#### **The Choice to Use Commercial Derivative Aircraft**

In the next few pages, we discuss a variety of recent CDA programs with differing outcomes. In hindsight, the good and bad decisions are easy to spot and criticize—something any “Monday morning quarterback” can do. The challenge for the DOD is to determine if these were flukes—perfect storms—or is there a fundamental flaw in how we acquire aircraft or manage our programs, or fail to train our acquisition corps. As we’ve stated multiple times, the value of a CDA is normally its broad commercial use which in effect provides ample market testing prior to DOD acquisition. This testing in a normal environment establishes a safety record and reveals any operational issues—all information of vital use to the government. It also establishes a baseline for determining acquisition and logistics costs. As long as the military buyer maintains the commercial configuration and operates in a commercial like environment there are few problems. When you veer off this commercial path without detailed evaluation and testing, then the program risk will increase.

## A Long History of Aircraft

A quick review of US DOD aircraft history lists over 170 different military aircraft that were derivatives from existing commercial aircraft. The following table shows the most recent list of CDAs used by the DOD.<sup>68</sup> A quick review of the listing (see Table 5) speaks volumes on CDA history.

- By far, the vast majority of CDAs are for cargo, utility and observation missions.
- Most required minimal modifications as the civilian mission was similar to the military. Prior to WWII there was no significant military aircraft industry focused on R&D or production. With some minor exceptions, most development was being done by the commercial industry.
- Most were structural modifications to convert passenger planes to cargo or light utility planes. This involved minor door and floor modifications after removing the interiors.
- Many of the WWII CDAs were simply the result of the US confiscating most civilian aircraft prior and during the war. Most only required paint and minor radio installation work. Minimal effort was invested to achieve standardization, since most left the factories with the same equipment.
- After WWII, the number of new CDAs dropped dramatically as the DOD began to design and build new cargo, observation and utility aircraft.
- Many were helicopters—which is a testament to the extreme environment in which commercial helicopters operate.

The data shows some other interesting trends. There were few cargo planes that were modified into bombers or attack aircraft. This sort of derivative modification is similar to our CDA study in that it attempted to save development and production dollars by using an existing military airframe and radically changing its mission. Two of the few success stories in this area would go to the AC-47 and AC-130 gunships.<sup>69</sup> Both took well established and successful cargo airframes and added weapons and tactics normally reserved for ground attack fighters and bombers. As one might expect, most aircraft designed as passenger or cargo haulers don't perform aggressive warfare type missions very well. Both of these however were quite successful.

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<sup>68</sup> Note the list includes the C-130 variants with commercial L-100.

<sup>69</sup> Note the C-47 was a traditional commercial derivative, but was modified into a ground attack aircraft almost thirty years later. The C-130 was designed for the military, but a version for the commercial market was produced.

**Table 5. DoD Commercial Derivative Aircraft**

<b>Military Aircraft Type/ Civilian Counterpart</b>	<b>Coast Guard</b>	<b>Army</b>	<b>Air Force</b>	<b>Navy/ Marines</b>
E-3B/C AWACS (Boeing 707)			33	
E-4B (Boeing 747)			4	
VC-4A (Gulfstream I)	1			
E-6 A/B Mercury (Boeing 707)				16
E-8A/C JSTARS (Boeing 707)			4	
E-9A (de Havilland Dash 8, Model 102)			2	
C-9A/C (McDonnell Douglas DC-9)			23	
C-9B (McDonnell Douglas DC-9)				28
KC-10A (McDonnell Douglas DC-10-30-CF)			59	
C-12 (Beechcraft/Raytheon King Air)		122		
C-12C/D/F/J (Beechcraft/Raytheon King Air)			39	
RC-12 (Beechcraft/Raytheon King Air)		47		4
UC-12B/F/M Huron (Beechcraft/Raytheon King Air)				57
EC-18B (Boeing 707 ARIA)			3	
TC-18E (Boeing 707)			2	
UV-18B (de Havilland Twin Otter)			2	
C-20A/B (Gulfstream III)	1		8	
C-20 D/G (Gulfstream III, IV)		3		7
C-20H (Gulfstream IV)			2	
C-21A (Learjet 35A)			78	
C-22B (Boeing 727)			3	
C-23B+ Sherpa (Shorts)		43		
HU-25 Guardian (Falcon 20)	41			
VC-25 (Boeing 747-200B, Air Force One)			2	
C-26B/UC-26C Fairchild (Metro III)		11	12	7
VC-32A (Boeing 757-200)			4	
UC-35B/C Cessna Citation (560 Ultra)		23		8
C-37GV/A (Gulfstream V)		1	2	4
C-38A (Astra SPX -Israeli)			2	
C-40A Clipper (Boeing 737-700)				29
CT/T-43A (Boeing 737-200)			11	
C-130E/H (Lockheed Martin L-100)			525	
C-130T (Lockheed Martin L-100)				20
HC-130 Hercules (Lockheed Martin L-100)	30		34	
KC-130 F/R/T (Lockheed Martin L-100)				77
KC-130J (Lockheed Martin L-100)				52
C-150 (Cessna)			3	
T-1A (Beechjet 400T Jayhawk)			180	
T-3A Firefly (Slingsby T67M260)			114	
T-34C Turbomenter (Beechcraft Bonanza)				307
T-39 D/N/G (Rockwell Sabreliner)				26
T-41D (Cessna Mescalero C-172)			3	
T-44A (King Air)				55
HH-65 Dolphin (Aerospatiale SA365N)	95			
HH-60J Jayhawk (Sikorsky S-70A)	42			
UH-60A Blackhawk (Sikorsky S-70A)		1,523		
HH/MH-60G Pavehawk (Sikorsky S-70A)			110	
CH-60S Knighthawk (Sikorsky S-70A)				247
HH-60H HCS (Sikorsky S-70B)				39
SH-60B/F Seahawk (Sikorsky S-70B)				232
SH-60R (Sikorsky S-70B)				248
TH-57 B/C Sea Ranger (Jet Ranger 206)				119
VH-60N Whitehawk (Sikorsky S-70A)				8
UH-1N/Y Iroquois (Bell Model 204/205)		Unknown	64	204

There are several examples of bombers being converted to cargo type aircraft. Almost all of the WWII bombers were eventually tried as cargo type aircraft to include refueling (such as the C-87 in Figure 39) below). While most had moderate success, they often failed to meet all of the requirements needed for an effective cargo aircraft. The basic reason was that bombers were designed for strength, speed and the ability to carry a large load of very dense cargo—bombs. Cargo aircraft tend to carry less dense cargo and require maximum volume. Cargo aircraft also require large, ground accessible doors to easily load and unload at remote sites. Most bombers were designed for bombs to be inserted through the belly bomb bay doors. Cargo aircraft (and especially commercial variant) are also designed with fuel efficiency in mind—not so for most bombers.



**Figure 39. C-87 Cargo Aircraft, Adapted from B-24**

The following case studies were chosen because they each illustrate how deviations from the basic rules of success CDA integration can cause major problems--if not cancellation of what might have been a very successful program. They range from the relatively successful KC-10 program which made few deviations to the ill-fated T-3 Slingsby which was eventually cancelled. In each case, the reader can compare the program decisions to our four basic rules and those that followed the rules were successful, and those that didn't were cancelled or had major programmatic issues.

## USAF ENHANCED FLIGHT SCREENER: T-3A FIREFLY

***"The T-41 is your grandmother's airplane . . . . . Our mission is to train warrior-pilots, not dentists to fly their families to Acapulco."***

***—General Merrill McPeak, Former USAF Chief of Staff***



Under the category of *"things I bet people wish they hadn't said,"* this quote might make the list. A few years later, six Air Force members would be dead flying the new USAFA flight screener aircraft that replaced grandma's airplane that never had a fatality in over thirty-plus years of service with the Air Force.

The saga of the T-3 Slingsby Firefly appears to be a case of not following the underlying requirements of a commercial derivative strategy. At its simplest, the Enhanced Flight Screener (EFS) strategy was to competitively identify through flight demonstration and a detailed proposal the best commercial-off-the-shelf (COTS) certified aerobatic trainer that could meet the United States Air Force Academy (USAFA) requirements. The underlying assumption was that the Air Force evaluators would only pick an aircraft that clearly met all requirements and then execute a reasonable test and evaluation program to make sure the aircraft met all training and safety requirements before putting it into operational use. It appears that the USAF team made multiple program decisions that contributed to six deaths and the termination of this program.

For thirty years, the United States Air Force Academy and other military units flew a commercial derivative of the Cessna 172 called the T-41 Mescalero. It performed well over that period and provided the first flight training for a generation of Air Force officers. While not exactly fast or aerobatic, it set a standard for safe and reliable flight

training (not a single USAFA fatality in thirty years<sup>70</sup>). This same aircraft (as the Cessna 172) is used today throughout the United States and Europe with most flight training programs and is considered a bullet-proof trainer. It is apparently quite popular with grandmothers and dentists flying to Acapulco.

The Air Force has had a requirement for some version of a screening program dating back to 1917.<sup>71</sup> At its simplest, the services have all looked for a simple, economical way to evaluate and screen Undergraduate Pilot Training (UPT) candidates to minimize attrition in the more costly flight training programs. In addition to medical and knowledge test, the services have long focused on using relatively simple and safe light aircraft as a screening device. During the period of the 1960s-1980s the USAF aircraft of choice was the T-41, a very basic commercial derivative. While the program was modified every few years, the basic aircraft used remained the same. There were multiple attempts to use simulators, psychomotor test devices and other ground based methods to predict UPT success, but in the end, flying the T-41 prevailed for basic USAF flight screening.

In 1989, the Air Training Command (ATC) commander set in motion a Broad Area Review (BAR) that looked at all aspects of flight screening.<sup>72</sup> The initial meetings focused on modifying the existing programs (adjusting flight hours) and the differences between commissioning sources. After much “out of the box” discussions, it was generally agreed that the T-41 program, while good, did not provide discriminating flight experience in the areas that were causing attrition in UPT. Command planners and experienced flight instructors felt they needed an aircraft that could do light aerobatics, fly real military overhead patterns (steep, moderate G turns) at higher airspeeds and provide exposure to moderate G maneuvers. Additionally, they wanted all flight screening consolidated at Hondo Texas and at the USAFA using the same curriculum. The major ultimate requirement for this new program and aircraft was to reduce UPT attrition which was in the 25-30% range for the 1980s despite a myriad of attempts to fix it.

To validate the theory and determine requirements, the Air Force conducted a test in 1990 at Hondo TX comparing the existing T-41 program against the new Enhanced Flight Screening (EFS) program. For EFS, the Hondo contractor (Doss Aviation) leased seven Augusta Siai Marchetti SF-260 aerobatic trainers. The EFS program had 57 students enter the program and 47 graduated, which was better than they had predicted, so the experiment was considered a success. In addition to the flight program evaluation, the aircraft was also evaluated to determine the requirements for the new EFS aircraft acquisition.

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<sup>70</sup> “The Fall of the Firefly: An Assessment of a Failed Project Strategy,” by Dr. Bud Baker, *Project Management Journal*, Sept 2002.

<sup>71</sup> “Air Force Flight Screening: Evolutionary Changes, 1917-2003,” Ann Krueger Hussey, Office of History and Research, Headquarters Air Education and Training Command, Randolph AFB, TX, Dec 2004

<sup>72</sup> “Broad Area Review of the Enhanced Flight Screening Program,” Secretary of the Air Force, Inspector General, 17 March 1998.



ATC instructor pilots who flew the plane, decided on the following as must-have requirements for the T-41 replacement:

- Retractable landing gear
- Air Conditioning
- Electric trim button
- Safer fuel system with a reliable low fuel warning system
- Capability to fly IFR so training could continue with low cloud cover

At the same time of this test, the Air Force supported an operational suitability demonstration opportunity at the USAFA to allow potential sources to demonstrate their prospective aircraft and to see for themselves how their aircraft performed in the demanding USAFA environment as well as WPAFB. They wanted an off-the-shelf aircraft to save on development costs and schedule. A fairly large number of aerobatic capable trainers existed, so it was decided to go the commercial-off-the-shelf (COTS) route if possible. Ten companies responded offering a total of seven different COTS aircraft to fill the requirements:

- LoPresti Piper Swift Thunder (flew 10 sorties)
- Aerospatiale Trinidad (flew 8 sorties)
- FFA Bravo (flew 9 sorties, German Flugzeugwerke Altenrhein AS.202/26A1 Bravo)
- Glasair IIS/III (flew 15 sorties, this was an experimental, non-certified aircraft)
- Slingsby Firefly (flew 9 sorties, this was original aircraft prior to modifications)
- Siai Marchetti (flew 9 sorties plus was the demo plane used at Hondo)
- Mooney M-20K/TLS (flew 20 sorties)

The seven aircraft are shown in Figure 40.

The Slingsby Firefly was by no means a clear winner at this demonstration, but it had satisfactory performance. The Air Force assessment<sup>73</sup> at the time stated:

Aircraft were evaluated by AETC, USAFA, and AFSC pilots in ambient temperatures ranging from 42-80°F, and density altitudes ranging 6,670-8,350 ft. The Firefly model evaluated was equipped with an AEIO 360 (200 hp) engine and comments included:

- *Aircraft Performance: relatively slow rate of climb; lowest cruise speed; engine response good; deceleration good; overall stability very good*

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<sup>73</sup> "Broad Area Review of the Enhanced Flight Screening Program," Secretary of the Air Force, Inspector General, 17 March 1998.



**Figure 40. USAF Enhanced Flight Screener Competitors**

- *Aircraft Physical Layout: no inertial reels; fixed seat–rudder pedal adjustment difficult; brake effectiveness poor; visibility over nose difficult; wing blocks view in pattern; good cockpit layout; visibility excellent*
- *Communications System: voice activated–pilots preferred “hot mike”*

- *Handling: slight yaw; trim responsive; stick forces good; good stall characteristics; energy maintenance poor if maneuver entry weak; spins easy to enter and recognize; rudder input breaks spin; flies well in pattern; very responsive to input; relatively easy to land*
- *Maintainability and Logistics: logistically capable for EFS; proposed changes for improved maintainability; composites okay; mix of standard and metric measurements; lack of US support network*

USAF officials used this opportunity to gather data that they then used to prepare the Request For Proposal that was released in early 1991. On 17 January 1991, ATC released the Operational Requirements Document (ORD) which called for a 125 total buy with 69 going to ATC (Hondo) and 56 to USAFA. The first aircraft for flight evaluation would be due in May 1992 with flight training to begin in October 1992 at Hondo. The Chief of Staff of the Air Force, General Merrill McPeak, was a former fighter pilot and a major supporter of replacing the aging, docile T-41. He was widely quoted as saying: “The T-41 is your grandmother’s airplane. . . . Our mission is to train warrior-pilots, not dentists to fly their families to Acapulco.” His direction was obvious, buy a plane that was more fighter-like than a T-41.

At this point it appeared that the USAF had done everything by the book. They had taken a serious look at requirements both for the EFS program and for the required aircraft to execute that program. They had invested almost a year in actual pre-RFP flight and program demonstrations to make sure their training theory was sound. They had made a good attempt to involve industry in their market research and make sure the candidates and eventual winner would be able to deliver a low risk, safe program. The program had major support from the Chief of Staff of the Air Force, so what could possibly go wrong?

The T-3A program was classified as an ACAT III/IV, non-OSD oversight program which would take advantage of stream-lined acquisition strategies. This is the normal process when the government buys a system off-the-shelf with either no or only minor, non-substantive changes to the system. That was the intent of the strategy and based on what the Air Force has seen during the demonstrations, it appeared they would be able to buy a suitable aircraft off-the-shelf with no needed modifications.

A year later during the Jul-Aug 1991 timeframe, the USAF conducted an operational evaluation of all competing aircraft. By this time the Firefly had been upgraded with a Lycoming AEIO-520 (260hp) engine to its final configuration. It was flown multiple times both at USAFA and at WPAFB by USAFA and ATC pilots. The report on the Slingsby stated:

- The Firefly had “levels of redundancy such that normal and emergency procedures are compatible with the skill levels of inexperienced student pilots.”
- The takeoff and landing performance exceeded requirements, climb capability and cruise performance were adequate, and stall characteristics were acceptable; but, the stall warning horn was too quiet.

- Spins were downgraded because established recovery procedures would require additional training for low-time pilots and to maintain instructor proficiency. The test pilots stated the flight manual spin recovery required accurate timing and correct application of opposite rudder, neutral aileron, and forward stick which could be difficult for a low-time pilot.
- Pilots noted the brakes could not prevent the aircraft from creeping during static engine run-ups (i.e., the more powerful engine exceeded the brakes capability).
- The engine sputtered when the throttle was reduced to a lower power setting. During one demonstration flight, a pilot had an uncommanded engine stoppage which was successfully restarted during a spin recovery.

Overall the aircraft was found to be suitable for the training environment even with inexperienced pilots. There were minor downgrades in the final report noting that the aircraft did not provide consistent engine starts, the starting procedure was unsuitable with student training operations and that the aircraft had uncommanded engine shutdowns during ground operations on three of seven sorties, all attributed to vapor lock.<sup>74</sup> It's not clear from the official reports if Slingsby made any further modifications to the aircraft prior to its proposal to remedy these issues or if they proposed modifications to their production trainers.

Shortly after the flight tests, the RFP was released in Sept 1991 with the previous stated requirements along with additional requirements dealing with the need for quick ingress and egress to and from the training areas.<sup>75</sup> Despite its apparent engine and brake issues, the Slingsby T-3A was chosen as the best overall trainer on 29 April 1992. The plane was to be produced by Slingsby Aviation Limited of Great Britain and Northrop Worldwide Aircraft Services. The winning bid had Slingsby build components and Northrop do the final production, assembly and test in Texas. Several of the other competitors filed protests that delayed the final award to Slingsby until 22 Sept 1992. There was also a challenge by the DOD IG against the program asserting there was no need for a new trainer and the USAF should cancel the program and save the \$28M. This was also dismissed.

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<sup>74</sup> Vapor lock on fuel injected aircraft engines are normally the result of the fuel lines running too close to the engine and the fuel vaporizing at low engine RPM due to the heat and reduced fuel pressure. While this is a common issue on some aircraft after the engine is shut down (fuel pressure low and fuel lines are uncooled by airflow), it is unusual for this to happen while the engine is running.

<sup>75</sup> A major issue for USAFA was the large block of time it took for a cadet to fly a one hour mission without missing a significant amount of normal classroom time. This drove a requirement for the aircraft to cruise at 140 kts.



**Figure 41. Slingsby T-3A**

The first production aircraft was delivered to the Air Force in June 1993 to begin Qualification Test & Evaluation (QT&E). Most green CDA aircraft by definition arrive with full FAA certification or a reciprocal certification from other countries. This very important aspect of CDA theory is that the airplane prior to modifications has been thoroughly tested and found to be airworthy for its intended purpose. This was not the case with the Firefly. The new engine and propeller (plus other changes) were significant modifications and had never been certified with either the CAA or FAA. Thus, the USAF started QT&E on an unproven and uncertified aircraft—closer to what one faces when the military builds a new aircraft. Slingsby was pursuing CAA and FAA certification in parallel.

Combined QT&E/QOT&E occurred from 23 September to 1 October of 1993 at Hondo TX and Ruidoso NM to use a higher altitude site (6800 ft) to simulate USAFA. This was a streamlined test program lasting less than ten days<sup>76</sup> so Slingsby personnel and pilots were a major part of the test team. Slingsby flew all of its missions to include special emphasis on spin testing and report that the T-3A demonstrated full compliance with system specifications. The 4950<sup>th</sup> Test Wing issued their report<sup>77</sup> and gave it a passing grade but with several recommendations:

- Slingsby should conduct an analysis of the spin modes, spin recovery and improve the flight manual to provide a better description of the flight systems and flight characteristics.

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<sup>76</sup> This short period was a result of acquisition reform to streamline the process plus the impact of the late production start due to the protests and reviews.

<sup>77</sup> “Broad Area Review of the Enhanced Flight Screening Program,” Secretary of the Air Force, Inspector General, 17 March 1998.

- The team recommended that aircrew wear parachutes during aerobatics and spins. This is a normal requirement for civilian aircraft and most military aircraft.
- AFOTEC perform typical student training profiles at USAFA prior to operational deployment to fine tune instructional techniques and evaluate flight manual procedures at high density altitude airfields. Particular attention needs to be given to simulated forced landing procedures and energy management
- The team made no mention of any engine issues at this time.

At the same time, Slingsby was pursuing FAA and CAA certification. The Firefly (T67M260) was CAA certified and then FAA certified in December 1993<sup>78</sup> under a standard FAR Part 23 type certificate. FAA certification was a prerequisite for whatever type was selected for the USAF's Enhanced Flight Screener (EFS) requirement. The USAF T-3As operated under dual civil/military identities, with civilian N-numbers and military serials. Of interest, the flight testing was done by the CAA on the first two production aircraft fully produced in England. They were test flown and found to meet all requirements to include aerobatic flight. In particular, the FAA airworthiness note directly addresses vapor lock:

#### 5.8 Indirect Demonstration of Compliance

FAR 23.961-Fuel System Hot Weather Operation.

Flight tests on the T67M260 have been conducted at temperatures up to 104°F. The requirement specifies 110°F. It has been demonstrated that the design of the fuel system is not conducive to the formation of vapor on the basis of a read across from satisfactory test results at 110°F on the similar fuel system on the T67M200, satisfactory operational experience with the M200 at these temperatures and the high fuel flow margin of 3.5 provided by the fuel pump on the M260 fuel system.

Note that the FAA report uses an analogy to the older T67M200 aircraft with the original, well proven engine installation—this is not the aircraft delivered to the USAFA or being certified.

The IO-540 was a widely used engine and provided good performance when properly installed. The flight tests were done in England at sea level (vice at 7000+ feet at USAFA) so it raises the question about the applicability of the CAA flight tests.

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<sup>78</sup> Airworthiness Approval Note No: 24385 and DOT FAA Type Certificate Data Sheet A73EU. The last sentence “grandfathers” the installation based on the previous 200hp model, the T67M200 which had a smaller 200 horsepower engine and a different installation. The CAA never tested the installation to the actual temperature requirement of 110F.

While this engine normally operates on aircraft up to 25,000 ft in cruise flight, the issue is what happens at 7-12,000 feet either on the ground or in flight at low idle, low airspeed and thus minimum cooling and low fuel pressure. It should also be noted that the certification and testing occurred in mid to late 1993, almost two years after the apparently poor performance in the pre-award flight trials. This was also done concurrently with QT&E and QOT&E.

In early 1994 the USAF began dedicated QOT&E at Hondo TX. The purpose of the test was to provide an independent “missionized” evaluation of T-3A operational effectiveness (How well does it perform its mission?) and suitability (Is it supportable at the operating location?). The test was designed to answer one Critical Operational Issue (COI): Does the T-3A perform its screening mission? The COI was answered by measuring attrition, aircraft availability, aircraft reliability, aircraft maintainability, and subjective instructor pilot surveys.

The first phase was shortened from a planned 14 weeks to only 5 due to late test aircraft delivery. This was done in parallel with initial instructor training. The second phase was conducted in parallel with student training and had to be shortened due to extended grounding of the fleet as a result of several uncommanded engine stoppages. The program requested additional funding to do a full and thorough test program but was denied by Aeronautical Systems Division at WPAFB. The test team issued their final report in November 1994 and stated “the T-3A was operationally effective but not suitable.”

- The T-3A was effective at performing all syllabus maneuvers.
- Full Mission Capable rate was failing—15.8% achieved against a contract requirement of 81%--primarily due to the engine stoppage groundings.
- Commercial maintenance manual lacked sufficient detail to troubleshoot and perform some repairs.

The USAF officially accepted the aircraft in October 1994 at Hondo and the first aircraft arrived at USAFA in January 1995. This was the official go ahead for the aircraft to begin training students. While maintenance issues remained, there were no plans on record at this time to research or fix any perceived problems with the engine. Despite the recommendation for the crew to wear parachutes and complaints by EFS instructors,<sup>79</sup> this was considered unnecessary at the start of training by USAFA and Hondo leadership.



The Hondo training actually began in March 1994 (prior to the official handover) and from the start, the squadron experienced engine malfunctions. Between February

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<sup>79</sup> “The Deadly Trainer,” by Mark Thompson, TIME, 12 January 1996.



and July 1994, there were 12 uncommanded engine shutdowns while idling or at low RPM. The fleet was grounded temporarily to attempt to determine a cause. After several months, Slingsby made a modification to the fuel system and the problem was declared fixed.

On 22 February, 1995—less than two months after receiving its first aircraft—the first fatal crash happened. While in the normal practice area at altitude, either the student or instructor put the aircraft into a spin as part of the curriculum. According to the AF IG report, the instructor pilot failed to apply anti-spin rudder as directed in the flight manual. The board report stated “The IP’s spin academic instruction, flying training, and error analysis experience did not adequately prepare him to recognize his improper rudder application.” After the accident, no major changes were made to the program or aircraft except in April 1996 parachutes were provided to the aircrews.

By November of 1995, the fleet had experienced 34 engine stoppages with 32 on the ground and two in the air. These problems were in addition to wing bonding issues and a delay in the installation of a new air conditioner. A few months later, on January 9, 1996 the last T-3A was delivered to the Air Force. With the full complement of aircraft, AETC initiated a Follow-On Test & Evaluation (FOT&E) of the aircraft to see if it met its operational and effectiveness requirements. After researching UPT graduation data before and after deployment of the aircraft, the analysis showed that the T-3A was a success. Students who had flown the T-3A and went into SUPT had an attrition rate of 8.6 percent which is half the previous rate of 17.8 percent for students who flew the T-41.



The FOT&E<sup>80</sup> showed a much bleaker image when maintenance and availability was considered. The aircraft failed to meet three of its five criteria especially a mandated 95 percent fully mission capable rate or a 98.5 percent mission completion success probability rate. The engine stoppages were continuing—especially at USAFA during the warm months.

While this was being discussed, a second fatal accident occurred on 30 September 1996. During a simulated forced landing (part of the curriculum), the engine quit and would not restart. The aircraft entering a stall close to the ground and the instructor pilot was not able to recover prior to ground impact. The immediate solution was to take this out of the flight training curriculum—an ironic fix since they removed the one part of the training curriculum (emergency landings) that seemed to be needed the most.

Oklahoma City ALC had management responsibility for the CLS maintenance contract and had been working on solving the engine problem. With this latest accident, they contracted with Scientific Applications International Corporation (SAIC) to help resolve the problem. Later the next year in May 1997, AETC reported to the Chief of

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<sup>80</sup> “Air Force Flight Screening: Evolutionary Changes, 1917-2003,” Ann Krueger Hussey, Office of History and Research, Headquarters Air Education and Training Command, Randolph AFB, TX, Dec 2004



Staff of the Air Force that they had a good handle on the problem with a proposed solution in hand. Unfortunately on 25 June 1997, the third fatal crash occurred. The aircraft had entered the pattern to land, turned base and entered a stall and spin. The instructor pilot was unable to recover the aircraft in time to prevent the crash. A few days later, another aircraft lost power while landing and this caused AETC to ground the fleet. The T-3 Firefly had a total operational life of only 39 months at Hondo and only 30 months at USAFA.

Shortly after grounding the fleet, AETC initiated a Broad Area Review (BAR) to do a full investigation of the program. This was quickly overcome by a Secretary of the Air Force BAR. The SECAF BAR<sup>81</sup> was published on 17 March 1998. The review team made 48 specific recommendations and a list of conditions to be met before the aircraft could return to duty with a goal date of mid-1999:

### ***Broad Area Review Recommendations for T-3 Return to Fight***

#### ***Prior to Re-qualifying IPs***

- Complete FOT&E Phase I testing (Recommendation 10)
- Complete fuel system modifications on training aircraft (Recommendation 36)
- Define and establish measurable standards for engine stoppages (Recommendation 37)
- Publish flight manual and maintenance procedures for modified aircraft (Recommendation 4)
- Publish guidance on spins, aircraft departure characteristics, and common student errors (Recommendations 4, 11)
- Publish a standard instructor techniques manual (Recommendation 29)
- Reinstitute realistic Simulated Forced Landing (SFL) training (Recommendations 1, 24)

#### ***Prior to Resuming Student Flight Screening at Hondo***

- Evaluate Doss Aviation, Inc., IP daily sortie requirements for safety and screening effectiveness (Recommendation 17)
- Implement new student syllabus (reinstating solo, reducing aerobatics, adding spin demonstration) (Recommendations 1, 5, 21)

#### ***Prior to Resuming Student Flight Screening at USAFA***

- Complete FOT&E Phase III testing at USAFA (Recommendation 10)
- Convert the USAFA EFS program assigned military pilots to contractor pilots (Recommendation 15)
- Improve the Mission Qualification Training to emphasize high-altitude operations (Recommendations 26, 27)

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<sup>81</sup> "Broad Area Review of the Enhanced Flight Screening Program," Secretary of the Air Force, Inspector General, 17 March 1998.

During this period, SAIC continued work on the engine problems. They developed a solution using a modified fuel system which appeared to eliminate the engine stoppages. It also reduced the unrestricted flight operations time to one hour—which was insufficient since the average sortie was 1.4 hrs previously. At the same time, the chief of staff wanted an ejection system installed in the aircraft before AETC would be allowed to fly students—this would require a major modification.<sup>82</sup> By summer 1998, the AETC Director of Logistics decided to slow down the program and the T-3A was put in “minimal maintenance status.” The Air Force tasked the Air Force Flight Test Center to do a full flight test program using four T-3A’s with and without the SAIC modifications. After 15 months, 417 sorties lasting 604 hrs, the aircraft was declared to be safe for training. They also recommended 27 changes to the aircraft, flight procedures and training curriculum.

In the end, the Air Force decided to ground the aircraft on 9 October 1999 rather than invest several million dollars in required modification that would take another 24 months.<sup>83</sup> Several proposals were made on what to do with the fleet of aircraft to include sale to the commercial market of the full aircraft, sale of the components, and conversion to a utility aircraft for pilot currency. In the end the USAF took decisive action and crushed the problem—literally. In September 2006, it was decided to scrap the fleet. A contract was awarded to TOTALL Metal Recycling of Granite City, Illinois to crush and scrap the entire aircraft with the final aircraft destroyed on 25 September, 2006.



**Figure 42. Scrapping of T-3A Fleet**

### **T-3A Firefly—What Happened**

At a basic theoretical level, CDAs work best when the green aircraft performance matches the requirements. If there is a mismatch, then it is better to modify the requirements rather than attempt a major modification of the aircraft. It appears in hindsight that the T-3A program, as implemented, failed to meet the performance and training requirements.

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<sup>82</sup> Installing an ejection system would have been impractical and likely resulted in a new aircraft development effort.

<sup>83</sup> At this point, the Air Force had already invested \$10M trying to fix the fleet, which initially cost \$32M.

**Requirements mismatches:**

1. While a basic acquisition source selection issue, the T-3A appears to have not met the basic RFP requirements as demonstrated during the pre-RFP flight demonstrations. They failed to enforce their basic requirements.
2. The mission required an aircraft that could operate at high altitude, low RPM and in a hot environment—the T-3A could not do this.
3. The program evaluators and management failed to appreciate the difference in operational requirements between Hondo Texas (sea level) and USAFA (7500 ft).
4. A basic flight screening trainer must match the skill level of the instructors and the students—in the case of USAFA, this did not happen.
5. The common sense solution here appears to have been simple—all aircraft must be ready to demonstrate full compliance with the RFP during the demo program. Any disconnects with requirements bears a large risk and cost penalty.

**Buyers must understand the green aircraft performance and its test data and test it in the new military mission space:**

- There was a gross underestimate and undervaluation of the need to test this new trainer. Compared to a “real” airplane by USAF standards, it was assumed that small aircraft are simple with few real problems, so why waste valuable test resources. The evidence shows the Air Force had several opportunities to fully test the new airplane, but failed to do so. There were multiple instances of the USAF compressing schedules and reducing tests in order to deliver the aircraft, rather than taking the time to see if the aircraft met mission and safety requirements.
- There appeared to have been little previous flight test data on the final aircraft configuration (from other programs or sales), so it was imperative to do a full flight test program which did not happen. The CAA flight test was insufficient compared to the USAFA requirements.
- Most of these test requirements or risk could have been eliminated if the USAF had actually purchased a green aircraft that met their requirements.

**Buyers must understand the green aircraft operational modes and what kind of trainer and pilot skills are required:**

- The T-3A required a much higher skill and experience level than the old T-41. Some USAF instructor pilots apparently lacked the experience and training to fly this new aircraft and to execute the curriculum. To paraphrase General McPeak—the T-41 was a dentist’s airplane, the T-3A was a fighter, and the USAF tried to let a “dentist” fly their new fighter. The Hondo contractor (Doss) IPs averaged almost 6300 flight hours with 3600 flight hours in small propeller aircraft. Most were retired military with 10-20 years of flight instruction in small

aircraft. The workforce was well-trained, highly experienced and stable. At the time of the last accident, Time Magazine did a story and quoted one of the Hondo instructors: *"If the engine quits, we know how to land the airplane and walk away from it,"* a civilian pilot at Hondo says. *"The Air Force guys just know how to bail out when that happens."*<sup>84</sup>

- The USAFA IPs primarily had scant small aircraft experience (other than their minimal T-41 flight screening), flew large cargo or bomber aircraft, performed other duties at USAFA in addition to flight instruction, and rotated out of the job every two to three years. The USAFA IPs did get an orientation course upon arriving with dual instruction, but in hindsight, it was insufficient to handle the expected flight regimes on this new aircraft. Most outsiders would assume that a USAF pilot, regardless of their previous aircraft assignments, could easily handle a "training" aircraft—this proved to be a bad assumption. The source selection evaluation clearly stated that the aircraft had unusual handling qualities (especially involving spins) that were unsuitable for a pilot with low hours in this type or a lack of experience in aerobatics.<sup>85</sup> The TIME article quotes General McPeak as having stated *"Maybe if you'd had three fighter pilots in there instead of three C-141 pilots, you wouldn't have had the same result."*
- The aircraft was also a stretch for the students. Many had little aircraft time prior to this course other than USAFA glider flights. Since this was a flight screener program, the students were given flight control relatively early. Unlike the T-41 which was docile, this aircraft could depart controlled flight much easier and enter a dangerous spin or stall which then required quick execution of the recovery inputs either by the student or else the instructor. Thus the students were placed in an aircraft that was too advanced as an initial trainer along with instructors who lacked the experience to avoid dangerous flight regimes. The evidence clearly shows that the Hondo operations had no difficulty with loss of control accidents due to their more experienced instructors.
- In this case, the clear solution at USAFA was to provide contractor support with experienced pilots. Potential USAFA IPs would need a much more thorough orientation program prior to taking over cockpit duties.<sup>86</sup>

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<sup>84</sup> "The Deadly Trainer," TIME Magazine, 12 March 1998 by Mark Thompson

<sup>85</sup> USAF fighter pilots constantly train in aerobatics and unusual attitudes, something that is never done in large transports or bomber type aircraft.

<sup>86</sup> There are several references that focused on the difficulties of the non-fighter pilot IPs. While this appears reasonable to suggest that only fighter pilots should have been T-3A IPs, there is not data in the literature to suggest that F-16 or F-15 experience was more applicable to small, low speed, propeller drive aircraft.

## T-3A Summary

This was good case study of how a commercial derivative program can fail when the acquisition and user communities attempt to ignore the basic concepts. The USAF bought a modified green aircraft that failed to perform and then assigned personnel to operate it that weren't well qualified.

1. The USAF followed correct pre-RFP theory and hosted two separate fly-offs/demonstrations, yet selected an aircraft that appears to have performed poorly in those pre-source selection tests.
2. It appears likely that the USAF failed to pick a tried and proven trainer (such as the SF-260) due to cost concerns and a belief that Slingsby could fix all of the issues that appeared during the flight demonstrations.
3. The USAF and Slingsby underestimated the development and test requirements when one puts a larger engine in an aircraft—for this type of CDA, you should not have to “fix” the green aircraft. Slingsby and the Air Force underestimated the schedule and cost risk of this major engine modification.
4. The USAF failed to follow USAF rules and test the system thoroughly in its operational environment at USAFA with USAFA IPs.
5. Once the USAF discovered the engine/brake issues, they failed to fund the needed research/acquisition/test to fix the problem prior to operational use.
6. Once the USAFA IP issues become apparent, the USAFA failed to quickly evaluate and fix the issue.
7. The concurrency in this program was fatal. There was no reason to rapidly deploy the aircraft other than to save budget. The T-41s were in good operational shape and could have been flown for years more.<sup>87</sup> In this case, the USAF attempted to make major fixes and tests while still operating the aircraft. Only at the end, once the fleet was grounded did the USAF do a full up required test program.

Having said all of this, the aircraft did lower SUPT attrition which was its primary purpose. While a sunk cost, the USAF invested over \$42M in the program with several million more needed to attempt a fix to the engine, brake, and other system issues. The USAF IG Broad Area Review report recommended that with additional funding the aircraft could be fixed and the instructor issues at USAFA could be addressed (either with a contractor or more IP training). So the final mistake may very well have been the premature termination of a fixable program.

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<sup>87</sup> Most of the T-41s were transferred to other agencies and many eventually were sold on the civilian market. It is likely most are still flying today.

Looking back at the program, one wonders what was the rush to bring it on line, and then, what was the rush to kill it. One ex-AF program manager<sup>88</sup> and researcher offers up a possible motive: “the sacred cow syndrome.” The theory is that a senior person in the organization suggests there is a problem and offers a solution. The junior personnel “salute smartly” and then “aggressively executes” the suggested solution. In this case, a few generals decided the T-41 was too old and wanted a screener aircraft with more fighter-like features. Then, once the program ran into trouble, the leadership quietly killed it.

The reason the program died so easily is that the USAF already had another commercial solution in hand<sup>89</sup>—this time with a proven aircraft, flight instructors and maintenance support. In 2006, AETC finalized a new flight screening program called Initial Flight Screening (IFS) based in Pueblo, Colorado. It was a commercial competition and was awarded to Doss Aviation, the same firm who had provided flight screening at Hondo Texas. The RFP had many of the same elements of the previous EFS program, only this time the USAF was leasing the service, not buying its own trainer and attempting to operate it. A similar program with the same aircraft and curriculum operates out of the USAFA.



**Figure 43. Diamond Aircraft Used in New Flight Screening Program**

As a final note on the Firefly, the Slingsby T-3A aircraft (with the larger engine) was sold to about a dozen countries as a military trainer. Other than the USAF, there were no other significant issues and the plane operates successfully today around the world.

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<sup>88</sup> “The Fall of the Firefly: An Assessment of a Failed Project Strategy,” by Dr. Bud Baker, *Project Management Journal*, Sept 2002.

<sup>89</sup> “IFS Operations Began October 2006,” by Tech. Sgt. Mike Hammond Air Education and Training Command Public Affairs, 11/19/2006

## United States Air Force Academy Powered Flight Program

In addition to the flight screening mission, the US Air Force Academy has traditionally had an airmanship program for all of its cadets, whether destined for undergraduate flight training or other non-rated careers. There have traditionally been three parts to the airmanship instruction: Soaring, parachuting, and powered flight. These elective courses are meant for potential flyers and non-flyers alike. They are intended to round out cadets' knowledge and familiarity with airmanship principles. The powered flight portion had previously been supported with the initial flight screening assets, but that program moved to Pueblo Colorado where all USAF flight screening now takes place.<sup>90</sup> This put a temporary end to the powered flight program.

In 2008, the USAF decided to re-introduce the powered flight program to USAFA. Powered flight was reintroduced in three phases. The first test phase began in January 2009 and included a small number of cadets using a combination of Air Force and aero club aircraft under the operational control of the 306th Flying Training Group, a 19th Air Force unit based at the academy.



**Figure 44. USAFA Powered Flight Aircraft  
2009, Diamond DA-40**

The second phase involved an interim, competitively selected services contract to provide aircraft and maintenance for a short interim period. This was a normal source selection with multiple bidders and pre-award aircraft evaluation. The USAF was strict about aircraft being truly off-the-shelf with no modifications. The 557th Flight Training Squadron operates the aircraft from the USAFA at Colorado Springs, Colorado, under a contract managed by the competition winner, Blue Sky Aviation, the primary contractor, and their partner Doss Aviation. During this phase, student numbers will increase to 600 annually. Doss Aviation bid Diamond DA40's as the aircraft. It is a four passenger, 180 hp aircraft with a composite airframe. This is the same aircraft used by Doss for the USAF flight screening program at Pueblo Colorado. As of this writing, the program was successfully being executed with no accidents.

The final phase was planned to begin in the Fiscal 2012/13 timeframe, with the acquisition of permanent Air Force-owned aircraft. That source selection was completed in early March of 2011 and Cirrus Aircraft won with a modified SR-20 airframe. It is also a four passenger composite aircraft but with a larger 200 hp engine and a whole aircraft parachute system for safety. Unlike the DA40, the Cirrus aircraft was the top

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<sup>90</sup> The cancellation was the result of the T-3A termination.

selling four passenger general aviation aircraft in the world with extensive commercial support infrastructure.

Doss Aviation and its partners submitted two proposals—apparently one for the DA20 and one for the DA40. These are both aircraft used in the existing USAF flight screening program. The DA20 is a 125 hp, two passenger training aircraft. It was apparently disqualified for not meeting the new USAFA performance requirements. The DA40 proposal lost on price. Doss filed a protest arguing that as the incumbent, its aircraft were already technically qualified and it felt that no one could beat its pricing. Apparently they were wrong. This competition was low price, technically acceptable award criteria with no flight test requirement prior to the source selection decision. While all proposed aircraft were off the shelf and in use around the world, it seemed odd that the USAF would ignore their previous T-3A flight screening problems and not thoroughly test all aircraft as part of the evaluation.

Once the 25 Cirrus SR20s are delivered, the student load will increase to a planned 750 juniors and seniors annually. An all-military instructor pilot force, consisting of 65 instructors from AETC and the academy, will train the cadets and mentor them on Air Force missions.



**Figure 45. 2011 Cirrus SR20 USAFA Powered Flight Aircraft**

Despite the protests, the powered flight program and the flight screening have been successful CDA programs. Both the interim and final phases specified CDAs as the airframes of choice. All were required to be COTS with FAA airworthiness which would be maintained. No modifications were made to the aircraft and all were maintained to FAA standards. To an outsider, the CDAs were sustained and operated in a manner identical to other commercial flight programs at major universities or flight training centers. The only change required was to paint them in a military scheme with basic identifying markings. As of this writing, the program has worked flawlessly. The aircraft are maintained and operated as required in a typical commercial flight school and maintained as such. Compared to the previous T-3 Slingsby experience, this program has been a case study on how the military should utilize CDAs.



## Joint Primary Aircraft Training System (JPATS)

At the same time the T-3 was being studied (1989), the Congressional Armed Services Committees tasked the DOD to submit a report which outlined DOD plans for future Navy and Air Force Aircraft. The delivered master plan laid out the two services requirements and plans to meet training needs into the next century. A key part of the plan was how to identify and capitalize on joint training opportunities—the most significant being the development of a joint primary trainer. It was realized at the time that the only way this would work was an early agreement on requirements, budget and schedule. The Air Force and Navy had begun work in 1988 on the requirements as part of a Joint Primary Air Training System (JPATS) committee with members from USAF ATC and Navy OP-59.<sup>91</sup>



**Figure 45. Cessna T-37 “Tweet” Primary Trainer**

The new aircraft (JPATS) would be replacing the 1950s era USAF T-37 jet and the Navy T-34 turboprop. A previous attempt was made in the early 1980s to develop a new trainer using the traditional acquisition approach. That trainer, the Fairchild T-46, was estimated to cost over \$5M per aircraft and take several years to develop and test. It was a clean sheet development design based on USAF requirements. While there was an effort to use some off-the-shelf technology, it became apparent early in the design that a new jet engine would need to be developed. The engine development and other issues eventually caused the cancellation of the program. This left the USAF with an old trainer (T-37) and no new aircraft in development. At the time the USAF made the decision to do a life extension program on the T-37 and move the decision downstream on a new aircraft.

From the beginning of the JPATS program, it was intended to be a commercial based program. At the time, the Pentagon Acquisition Reform Office was looking for low risk programs that would be successful Defense Acquisition Pilot Programs (DAPP) as intended by the Federal Acquisition Streamlining Act (FASA). During this period

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<sup>91</sup> DOD 1989 Trainer Aircraft Masterplan, AD-B132-069. 15 February 1989

(early 1990s) there was significant support to identify these DAPP programs in order to demonstrate new and innovative approaches in the use of commercial practices.<sup>92</sup>

From the initial acquisition strategy meetings, it was decided that the JPATS aircraft would be an existing military trainer. After the T-46 failure (Figure 46), there was no desire to face the possible risk of a long, expensive development program only to produce an aircraft similar to what already existed in the field at that time. The aircraft selected would have to serve both the Air Force and the Navy's flight training requirements. This was the bridge aircraft that would be used by new pilots coming out of the T-3 or T-41 at the time and moving on to the advanced trainers such as the T-1 or T-38. The winning aircraft would have to provide significant improvements over the existing T-37 and T-34 in the areas of:<sup>93</sup>

- Modern cockpit design and avionics capability similar to operational aircraft.
- Sufficient power to do aerobatics, high speed cruise mission scenarios and some fighter and bomber maneuvers.
- Improvements in crew egress, pressurization, seating geometry and g-induced loss of consciousness protection.
- Improved high altitude performance, crosswind landing capability, and noise abatement.
- Significant maintenance and supportability improvement.
- The aircraft must be part of the full training system (Ground Based Training System) to include ground based training and an improved training syllabus specific to the chosen aircraft.
- Improved bird strike protection.



**Figure 46. T-46 Primary Trainer**

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<sup>92</sup> "Acquisition Reform and the Joint Primary Aircraft Training System (JPATS) Program," Kenneth W. McKinley, Naval Post Graduate School Thesis, June 2000.

<sup>93</sup> Single Acquisition Management Plan (SAMP), Rev.1, JPATS, 3 September 1998.

A final key element of the requirements was to provide an aircraft that permitted the accommodation of a minimum of 80 percent of the eligible female population<sup>94</sup> as defined by the OSD Cockpit Working Group standard deviation from the Natick 1988 Anthropometric Survey of US Army Personnel. It must also have an escape system capable of handling a range of pilots from 110 to 245 pounds.

The plans also called for the aircraft to be derived from an existing FAA certified aircraft. The final delivered aircraft would have to have an FAA production certificate. The plane would have to comply with the FAR part 23 aerobatic category, FAR Part 33 engine standards and FAR Part 35 propeller standards. Any deviations for military unique equipment would have to obtain a military qualification.

The source selection process started with the receipt of proposals in May 1994 from seven contractors. Most candidate aircraft were already in use as trainers while some were developed but ready to be transitioned to a US produced site. Each offeror supplied a detailed proposal, a flight evaluation aircraft and a full-scale mockup of the JPATS cockpit.

A decision was made in June 1995 to award to Raytheon Beech Aircraft which proposed a Pilatus PC-9 (Figure 47). The aircraft would complete final development and manufacture in Wichita KS. Three of the other competitors filed protests (Cessna, Rockwell and Lockheed) which delayed the actual program start until February 1996. Prior to the receipt of proposals, the generic government estimate for the total program was roughly \$7 billion, but with the acquisition reform and the commercial derivative push, the awarded program for development, production, training and support of 700 aircraft was closer to \$4 billion. The contract was FAR 15, fixed price with fee but with multiple waivers as allowed under FASA of 1994.

To meet the requirements, Raytheon had bid a modified version of their existing turboprop trainer that was widely used. The JPATS contract required that the aircraft be government-quality airworthy at the time of delivery. This meant that the aircraft had to have an aerobatic civil certificate from the FAA or an equivalent military certification. As part of the contract, the civilian aircraft had to be missionized with military equipment not normally found on most civilian aerobatic aircraft per the RFP. The final changes to base aircraft included:

- Pressurization
- New engine (from 950 SHP to 1100 SHP)
- New four bladed propeller
- Increased weight (25-30%)
- New ejection seats (0/0 capability)
- Redesigned, stronger canopy
- Multiple ergonomic cockpit modifications
- Change to wing incidence angle and enhanced leading edge
- New tail

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<sup>94</sup> The issue was with small females that were short with short leg length and short sitting height.

- Stronger landing gear
- New On Board Oxygen Generating System
- Liquid Crystal Cockpit displays
- New fuel system and fuel tank arrangement



**Figure 47. USAF T-6B Texan**

When development was done, there were very few parts left common with the original aircraft. This missionization had essentially turned this non-developmental, commercial derivative program into a development program. While this normally spells disaster for a CDA program, Raytheon used its experience in aircraft of this size and was able to make the changes with only a one year slip in the schedule. The original IOC date was May 1999, with the first squadron actually achieving IOC in May 2000.

Unlike the T-3A, the T-6A had a thorough test program to complete. Raytheon wanted the plane to maintain its FAA certification since this would bolster anticipated foreign sales. The downside of this investment was that the FAA certification process involved testing requirements that neither the USAF nor USN needed—hot fueling was a good example. The USAF had expected to do the FAA flight certification tests themselves. They later found out this was not allowed and that only type-rated pilots with FAA pilot licenses could fly the planes during the tests.<sup>95</sup> This added cost and schedule slip that provided little benefit to the USAF.

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<sup>95</sup> This was not a new FAA requirement, but rather an instance of DOD not understanding the FAA requirements.

AFOTEC also conducted a thorough multi-service Operational Test & Evaluation (IOT&E) in 2001. They found the T-6A to be “operationally effective but not suitable due to maintenance and support issues.” They returned for another IOT&E in 2003 with the same outcome. One of the major findings was failure of the Training Integration Management System (TIMS) which was the grading and scheduling software. This triggered a 2003 GAO report that came to the same conclusion.

While not the fault of the JPATS program management or Raytheon’s production program, things took a turn for the worse in 2006. Due to a series of overruns on FAR 12 programs and a distrust of commercial programs started or supported by Darleen Druyun (SAF/AQC), the Air Force made the decision to convert most its FAR 12 contracts to FAR 15 contracts at the government’s earliest convenience. This included the JPATS program (JPATS had converted to FAR 12 contracting after initial production was underway) which was getting ready to negotiate its last three lots of aircraft for the Air Force and Navy. At this point in time, the JPATS program was ahead of schedule on deliveries (approximately 40 A/C ahead), had good quality and minor issues with performance. AETC was happy with the aircraft and Raytheon was delivering aircraft for the agreed upon price. It appeared the commercial FAR 12 approach was working.

Despite being one of the few major acquisition programs at ASC (or DOD for that case) that was delivering a quality product on time and on cost, the AF was convinced they had to convert this contract to a FAR 15. This totally contradicted the theoretical and actual data that had supported the move to FAR 12 commercial products in the first place. In 2006, the GAO did a short study on Air Force commercial acquisition risk.<sup>96</sup> In the report, the GAO researchers discussed the expected benefits to both the government and the contractors. They listed the expected FAR 12 benefits to include the government being able to:

- Rely on the contractor’s quality assurance processes and warranties in lieu of government inspections
- Decrease the amount of time it normally takes to award a contract,
- Employ a streamlined contract clause structure
- Use simplified acquisition procedures

The FAR 12 benefits to the contractor were listed as:

- Not required to submit cost or pricing data to the government.
- Not required to adhere to cost accounting standards on firm fixed price contracts.
- Not required to disclose more technical data to the government than they would customarily disclose to the public.
- Able to propose more than one product that will meet the government’s needs.
- Able to submit existing product literature in lieu of unique technical proposals.

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<sup>96</sup> “Efforts Needed to Address Air Force Commercial Acquisition Risk,” GAO-06-995, September 2006

A study of savings to the JPATS program from its CDA approach and its commercial acquisition strategy was done in 2000 by the Naval Post Graduate School<sup>97</sup> and the Air Force Institute of Technology in 2009.<sup>98</sup> The DOD established the Pilot Program Consulting Group (PPCG) in the mid-1990s to track key performance metrics of the pilot programs—which included JPATS—to measure and quantify reform success.

1. Regulatory and Statutory Relief: This measured the benefit from waivers and deviations to the FAR. The panel estimated this as a broad range of \$18K to \$1.8M. This was driven by the acquisition reform elements and not the CDA aspects.
2. RFP Preparation and Content: There was a large increase in RFP preparation time but a reduction of 82% in military specifications and standards. The RFP delays had little to do with CDA, but the reduction in milspec items was totally driven by the CDA approach. This savings was also apparent on the Navy T-1A Jayhawk program.



**Figure 48. T-1A Jayhawk**

3. The third metric considered savings from allowing Raytheon to compete training system portions of this program. The data was considered inconclusive so no metric was published.
4. Program Office Manning Levels: The program had much fewer personnel than comparable acquisition programs. While this was a result of the CDA approach, there were also mandatory program office reductions during this period which clouded the results.
5. CAS Impacts: This measured the amount of program oversight that was required and JPATS data indicated 26,000 hours were saved at the time of the

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<sup>97</sup> “A Case Study: Acquisition Reform and the Joint Primary Aircraft Training System (JPATS) Program,” Kenneth McKinley, Masters Thesis, Naval Postgraduate School, June 2000.

<sup>98</sup> “The Impact of Acquisition Policy Variation on Program Strategy and Execution: A Case Study of the Joint Primary Aircraft Training System (JPATS) Program,” Major Jason Vitas, USAF, Masters Thesis, Air Force Institute of Technology, AFIT/GIR/ENV/09-M05, March 2009



study in 2000. This savings has increased steadily as the program has continued.

6. **Baseline Cost:** The initial program that was planned and estimated (using a business as usual approach) did not match the acquisition reform program that was executed. This fell apart since the initial estimates were based on a jet aircraft that was basically off the shelf. The JPATS program used a turboprop aircraft with moderate development costs.
7. **Program Cost Comparison:** This was to compare the baseline cost to the actual program. This lack of a well defined baseline caused a variety of claims from program advocates and critics. Estimates of JPATS savings ranged from 49% to 18% total cost savings over a traditional program. There is data to show that the time from contract award to first unit production occurred much faster (and was less costly) than a traditional acquisition approach for a new trainer. The CDA approach contributed to this—but there was also significant development and redesign of the existing aircraft.
8. **Budget Stability:** Basically, did the program successfully maintain its budget profile. The answer is yes—despite regular oversight by Congress and challenges to the program. This had nothing to do with its CDA origins. It may have had more to do with being a pilot program that likely got favorable treatment and oversight by the Air Force.
9. **Would Cost:** this was not used in favor of comparing baselines.
10. **EVMS vs C/SCSC:** JPATS began development and production as the DOD changed over from the older C/SCSC oversight to the new Earned Value Management System (EVMS). At this time EVMS was considered a commercial approach and the data on JPATS indicated that it did save almost 12,000 hours of government oversight effort. These savings were primarily from the commercial acquisition reform and not from the CDA aspects.
11. **Contractor Team Composition:** The idea was to measure the impact of the acquisition reform on the composition of contractor teams submitting proposals. Due to the protests, the resultant delays and a lack of funding, this item was not studied.

In the summary of these studies, the researchers considered how the CDA approach impacted the program and what if any changes should be considered:

- They felt the CDA approach made sense for the JPATS in its trainer role, but that the strategy and evaluation should have driven to a solution with fewer required modifications for missionization. The offerors should have been required to provide a fully compliant aircraft for test prior to the final RFP.
- The Clinger-Cohen decision of 1996 to waive cost and pricing data (this was originally a FAR 15) for an aircraft that had never been built (considering the fact that Raytheon redesigned the original Pilatus) may have been too lenient. The authors recommended that if there was no sales data or competitive forces to drive the price down, then cost and pricing data should not be waived on this type of CDA.

- Despite the major changes to the aircraft design and that Raytheon had never built the aircraft, the authors thought this type of CDA was appropriate as a FAR 12 program.
- The research indicated uneasiness about the Lot pricing (while the price changed from Lot to Lot, Raytheon did not overrun) due to the lack of cost and price data. Other than cost & pricing data, the source selection should require pricing data on similar products if the actual price history is not provided with the proposal. However, commercial means doing things commercial which means limited data. If the contracted aircraft is not really a green aircraft off the existing production line (like the B-737) then one should question why you would not do FAR 15 (with full cost and pricing data) and why are you calling this a CDA program.
- The data seems to show that once you take a CDA down a FAR-12 path (JPATS had already delivered 421 out of 783 aircraft), you should not change course and convert to FAR-15. The JPATS experience clearly shows that it was disruptive, did not lower the price and caused a major schedule shift—all with no benefit to the user. This experience caused significant damage to the contractor-government relationship.
- The application of the Berry Amendment<sup>99</sup> to JPATS after 421 aircraft had been delivered (out of 783) was a ridiculous waste of taxpayer money. A CDA program is a package deal with vendors and an established bill-of-material. Common sense says the Berry Amendment should only be enforced on new programs and only on old programs if it makes economic sense. This was significant failure of Congress to show true leadership and instead bow to a few small special interest groups. Congress finally came to their senses and passed H.R.4986 which provided relief to the Berry amendment for most CDA or COTS systems.
- There has been one recent development with the Pratt & Whitney engine. Since the engine was acquired as a commercial subsystem (it has a common core with many commercial business jets), the government does not have much insight into the detailed engineering or production operations. A subcontractor to P&W made a change to the material in the propeller sleeve and now they are suffering engine malfunctions. Had this been a typical government development, all changes would have been reviewed by a joint design IPT and possibly this problem might have been avoided.

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<sup>99</sup> The Berry Amendment (USC, Title 10, Section 2533a), requires the Department of Defense to give preference in procurement to domestically produced, manufactured, or home grown products, most notably food, clothing, fabrics, and specialty metals. Congress originally passed domestic source restrictions as part of the 1941 Fifth Supplemental DOD Appropriations Act in order to protect the domestic industrial base in the time of war. Recent modifications have provided relieve to certain off the shelf products.



In the end, the JPATS was a successful program that delivered its aircraft on time and at the contracted prices. Unit prices on the aircraft have increased from the first lots, but they were all at negotiated prices agreed upon by the government.

## KC-10A Extender

The DOD often uses a CDA approach because it tends to shorten delivery times for new aircraft and sometimes does it at a much lower cost. In the case of the KC-10, schedule was not one of its strong points. The Strategic Air Command (SAC) issued the Required Operational Capability (ROC) for the KC-X in June 1967. The first flight of a KC-10 did not occur until July 1980—over thirteen years later.<sup>100</sup> The fault was not due to CDA theory, but rather a long drawn out debate over requirements and budget priorities.

The initial ROC was based on an evaluation by SAC that the KC-135s (Figure 49) would wear out sooner than expected and it was prudent to begin the replacement program.<sup>101</sup> This is fascinating since today (42 years later) the USAF is having the same debate. This requirements and budget debate continued for several years until a new twist was added. In 1973 the Air Staff began debating the idea of a combined tanker-cargo aircraft with wide-body capabilities. Several studies and flight demonstrations occurred, but the Air Force could not get enough support to push the program forward. By 1975, the USAF had decided on a CDA approach, but continued to have problems with budget as it was considered less important than other competing weapon systems—like the new B-1 bomber.



**Figure 49. KC-135 Stratotanker**

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<sup>100</sup> "History of the KC-10A Aircraft Acquisition," by Major Thomas E. Holubik, 88-1260, Air Command and Staff College, April 1988.

<sup>101</sup> The KC-135 production line had shut down in December 1964. The new contract for the third generation KCX was issued to Boeing in 2001—47 years later.

Finally, in August 1976 after many false starts the program office got the go ahead to issue an RFP. The source selection plan dictated that two contracts would be awarded: one for the acquisition of an undetermined number of aircraft and one for the logistics support of those aircraft. The Section M evaluation used a concept of capability per dollar over a six year period vice the normal tech review and cost volume. There was no required quantity but rather a budget over the period and the offerors had to determine how many aircraft they could provide for each scenario:

1. The first profile asked for the number aircraft that could be purchased after all nonrecurring costs were paid.
2. The second profile asked for the number of aircraft that could be purchased if the USAF split the buy.
3. The last profile was the number of aircraft at the OEM's optimal rate of production without yearly funding constraints (but total program the same.)

Proposals were received in November 1976 and the evaluation began. Part of the evaluation was the logistics proposal and total life cycle cost that each provided. There were four initial candidate aircraft: C-5, L-1011, B-747 and the DC-10. The C-5 was eliminated since it was not in production and the L-1011 did not have a freighter version.

<sup>102</sup> In February 1977, the President's budget cut funding for FY78 and the source selection was stopped and put on hold. After a great deal of debate and discussion of requirements up through President Jimmy Carter, the funding was reestablished in August 1977 and the evaluation continued. The decision was announced on 10 December 1977 that McDonnell Douglas Company had won the competition and was awarded 10 aircraft for the first year's buy. The contract required that all development be completed in the first year and that the first production aircraft with all modifications fly by April 1980. All additional OT&E had to be done by 31 October of 1980. First flight occurred on 12 July 1980-roughly three and a half months early.

The green aircraft had to be modified with the following changes:

- Integral fuel bladders under the cargo floor
- Aerial refueling operator station
- Aerial refueling boom and a hose and drogue refueling system
- Cargo handling system and passenger accommodations
- Military Avionics

The green aircraft was produced on the existing DC-10 line with modifications done later. The contract required that the plane maintain its FAA certification. The FAA was very involved in the source selection and was prepped on the design to plan for any contingencies.

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<sup>102</sup> "Issues Concerning Air Force KC-10A Advanced Tanker/Cargo Aircraft," GAO Report to Congress, PSAD-79-8, 5 January 1979.



**Figure 50. McDonnell Douglas KC-10 Extender**

The acquisition strategy also gathered proposals for the contractor logistic support approach to maintenance. Twenty firms responded, but McDonnell Douglas was the cheapest. The maintenance concept gave USAF personnel responsibility for performing all flight line maintenance tasks, including engine changes with the contractor responsible for everything else. McDonnell Douglas also proposed to subcontract much of the work to existing commercial sources.

One of the risks of procuring a CDA for military use is that the military mission may be significantly different and thus place stress on the aircraft that it wasn't designed to handle. At the time the first KC-10s entered service, the commercial fleet had aircraft with over 30,000 hours and nine years of flight exposure. McDonnell Douglas used the fourth commercial airframe that was produced for fatigue testing to a 120,000 flight hour lifetime and 84,000 flights (cycles). This made each commercial sortie 1.43 hours at an average landing weight of 386,000 lbs. The military KC-10 was predicted to average 6.6 hours per flight and thus has significantly fewer cycles and landings while landing at an average weight of 274,000 lbs. In this case, the military mission caused significantly less fatigue damage than the commercial mission. On top of that, the KC-10 would fly significantly fewer hours per year than the equivalent commercial DC-10. The USAF eventually bought 60 KC-10s and as of this writing has 59 in the inventory. One aircraft was destroyed in a fire at Barksdale AFB while undergoing maintenance.

The KC-10 was a very successful program by any measure and has provided reliable service to the USAF since the early 1980s. However, there were some minor issues during the development and test process. The major benefit of maintaining the FAA certification is it reduces the size of the flight test program, reduces the amount of

data required and reduces the time to IOC. During the KC-10 FAA supervised flight test program, the plane had to meet all FAA requirements. The issue that came up at the time was that several of the tests were strictly for civilian type operations—not military—but were still required and could not be waived. Estimates at the time indicated these tests added about 70 hours to the flight test program. Several of the tests were for environmental issues (such as cabin air circulation) that were likely irrelevant to the military aircraft.

A second issue that surprised the program office was the assumed performance of some off-the-shelf hardware systems. While there were few major changes, there were multiple minor changes that impacted aircraft systems. Early evaluation of all planned changes to consider how it impacts systems would save budget and schedule. A key example of this was the change to the pressurized cabin area which generated significant, unpriced development work.

A third issue was that the FAA was (and is) only concerned about airworthiness—not about mission accomplishment. Thus, the FAA will make sure that the test program (and of course the aircraft and its equipment) thoroughly investigates all requirements to meet FAA requirements. The problem is that meeting the FAA requirements in no way insures that the aircraft will be capable of meeting its military mission. The challenge to military program offices is to attempt to plan a flight test program that minimizes duplication of test flights because of differences between FAA and military requirements. As an example, in civilian programs, contractors normally fly the missions first to make sure there are not issues—then they repeat the missions with the FAA flight test crewmembers. Military flight test members fly on all flights to reduce test time.

A fourth issue that surfaced was that the FAA certification does not substitute for risk specific testing. In the case of the KC-10, the FAA conducted a simulated icing test of the refueling boom, but not of the entire system—the KC-10, a receiver aircraft and refueling boom. The KC-10 was certified for operations in icing conditions, but without actual mission testing by the USAF; it didn't mean the aircraft was safe.

A fifth issue from the USAF viewpoint was test control. The FAA is not bound by USAF safety protocols. As a result, during FAA testing of engine out takeoff procedures, the FAA pilot failed to follow USAF protocol and over-rotated, striking the refueling boom on the runway. The lesson learned was that the USAF must make every effort to maintain control of the tests to insure safe operations.

Finally, McDonnell Douglas conducted testing at their Yuma Arizona facility which is a normally equipped civilian facility. However, it doesn't meet USAF standards for flight test operations in terms of rescue equipment, instrumentation and chase aircraft. The USAF had to supply additional fire trucks, safety equipment and personnel. The lesson learned was that when deciding if a contractor site is cheaper than a DOD facility, a thorough site survey is mandatory.

In summary, the KC-10 stands as a shining example of how to procure a CDA with a fair amount of modifications. This aircraft program should serve as a guide for the Air Force as it faces the challenge of the KC-46 program.

## C-130J and Commercial Acquisitions

Up to this point we have discussed three examples of commercial aircraft that were procured and modified for military use—traditional CDAs. This next case study is a minor but very important variation on the theory. In this case, we examine a successful military aircraft that has been in production for many years under a traditional FAR 15 procurement program; it also has commercial variants; and suddenly it is considered a “commercial acquisition.” Does this really qualify as a commercial derivative? Even if it’s a stretch of theory, what could be the harm to DOD?

Let’s review—what is the normal definition for a commercial program? At its simplest, it is a program conceived, developed and produced in the commercial market under competitive conditions with significant sales to the commercial market. The sales base in this competitive market establishes a competitive price. If this occurs, then the DOD is encouraged to use FAR 12 commercial practices with relatively minimal oversight and minimal cost and pricing data. This is the case when we buy fleets of government cars or Boeing 757’s. Another advantage is that with this broad commercial sales base, the development costs are spread over the total customer base vice the traditional military program where DOD pays for everything.

**Table 6. Comparison of KC-10 and C-130J**

	<b>KC-10</b>	<b>C-130J</b>
<b>Originally a Commercial Product</b>	<b>Yes</b>	<b>No</b>
<b>Sold in relatively large numbers to Public</b>	<b>Yes</b>	<b>No</b>
<b>Shared Development Costs</b>	<b>Yes</b>	<b>No</b>
<b>Competed</b>	<b>Yes</b>	<b>No</b>
<b>Established Commercial Price</b>	<b>Yes</b>	<b>No</b>
<b>Highly common with existing aircraft</b>	<b>Yes</b>	<b>No</b>

As the table above shows, when compared to the KC-10 commercial derivative, the C-130J appears to violate the basic theory of commercial derivative aircraft and commercial acquisition.

To understand how the DOD got into this predicament, one must first look back on the history of the C-130 and Lockheed Martin. The C-130 was developed in the 1950s with first flight in 1954. At this time the DOD has moved from a policy of primarily commercial derivatives for cargo aircraft to clean sheet designs based on military requirements. This was driven by two major factors. First, military strategy had caught up with the aircraft technology and now military planners were learning that optimizing air mobility across the battlefield could provide significant combat capability. These new approaches required aircraft with capabilities not available in the existing

commercial fleets. The second reason was more political and policy driven. In 1955, the Hoover Commission Report<sup>103</sup> on government operations declared that “the acquisition of military transport aircraft to carry peacetime and wartime loads that could be carried in commercial aircraft was tantamount to “military socialism”—that is, improper government competition with private industry.” While this policy debate<sup>104</sup> may have centered on the size of the military airlift fleet (which had stayed relatively large after WWII and Korea) vice the growing Civil Reserve Air Fleet and the commercial airlines, the military understood the immediate impact to them. If they wanted large numbers of military aircraft, they would have to design their own.

Lockheed won the competition and went on to sell over 2100 C-130s through the mid-1990s ending with the C-130H. They even created a commercial version, the L-100, and sold 114 with the last one delivered in the mid 1990s. By all standards, this was a very successful program and it was basically unchallenged by any competition in its four-engine, turboprop niche. Within DOD, it also had a unique acquisition heritage. Most DOD aircraft are purchased after a careful and grueling requirements process that places the planned fleet buys in the DOD budget. This was not the case for the C-130 during the 1980s and early 1990s. A 1995 GAO Report<sup>105</sup> made the statement that “For the past 21 years, with the exception of five aircraft, Congress has directed the procurement of C-130s for the Air National Guard and the Air Force Reserves.” What this meant to the USAF, was that they didn’t have to expend any of their planned budget resources on C-130s; they were just added by Congress. Further, the existing C-130s both in the DOD and around the world had a very good performance record and the planes were lasting far longer than expected.

Lockheed had made many upgrades to the C-130 since 1954 culminating in the C-130H version produced into the mid 1990s. While considering upgrades for the next variant, Lockheed questioned customers about future needs and also considered the latest technologies available on the market. Lockheed business development came to the conclusion that based on the age of the fleet, the USAF ordering historical trend, and the next generation of engines/propellers/avionics—that they would make a significant change with the next model—the C-130J.

Lockheed did a study of the demand for its next C-130 version and came up with a sales profile that indicated a large FMS and commercial market—at least as large as the expected DOD sales. They also evaluated their marketing data and decided the market required a fully upgraded aircraft that would also have full FAA certification. Based on their market projections, they believed that they could structure the program as a commercial endeavor and offer commercial pricing. This would mean that all customers over a defined period would share in the common development costs and each

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<sup>103</sup> House Commission on Organization of the Executive Branch of the Government Subcommittee on Transportation, Report on Transportation, 83<sup>rd</sup> Congress, 1st Session, March 1955.

<sup>104</sup> “The Airlift System: A Primer,” Lt. Col. Robert C. Owen, USAF, Air Power Journal, Fall 1995.

<sup>105</sup> . Intratheater Airlift: Information on the Air Force's C-130 Aircraft, Government Accountability Office, GAO/NSIAD-98-108, April 21, 1998, p. 6.



**Figure 51. C-130J**

would only pay for any unique development efforts to integrate special equipment. If the basic aircraft came with most options that its military customers required and with FAA certification, they believed little additional testing would be needed.

During this period, the USAF continued their normal C-130 program management—which meant they relied on Congressional adds. When the opportunity arose to possibly procure the C-130J, the USAF did not initiate their normal requirements process, or their logistics support process, or their operational effectiveness process, etc. Instead, according to a 2005 Inspector General report,<sup>106</sup> the only thing the USAF did was to consider force needs (# of aircraft) and affordability. The impact of this on Lockheed Martin was the USAF did not put a large number of C-130s in the future budgets as Lockheed had assumed.

At the same time, the DOD was making a major push to pursue commercial acquisition strategies whenever possible in order to save money and to encourage non-traditional firms to enter the defense market. This change in strategy was not overlooked by Lockheed Martin who requested a commercial contract from the USAF for the new aircraft. Lockheed convinced the USAF that the C-130J was a commercial venture based on expected sales of the aircraft to foreign countries and to commercial firms prior to USAF deliveries. Lockheed and the USAF at the time claimed that 95% of the features of the aircraft were common on both the military and commercial versions. Lockheed also made the claim that the commercial pricing with the shared non-recurring

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<sup>106</sup> Statement of the Honorable Joseph E. Schmitz, Inspector General, USAF, before the Airland Subcommittee of the Senate Committee on Armed Services. 6 April 2005



costs by all customers would significantly lower the price to the USAF. At the same time, Lockheed reduced the decision space by shutting down the C-130H program leaving customers no choice but to buy the new aircraft. In 1995,<sup>107</sup> the basic price for the first two DOD C-130Js was \$33.9M which was only slightly more than the C-130H but with significant performance improvements and new capabilities.

## **What Could Go Wrong?**

On most programs, the next variant usually has a smooth production and test program, with only minor risk. Unfortunately, the C-130J wasn't "the next variant." Rather, it was almost a new airplane that just happened to look like a C-130H. When the new design was done, it was less than 30% common with the C-130H it replaced. In reality, it was more like a new development program. When viewed in that light, its problems were not so bad nor would they be unexpected. However, that is not the program that was sold to the USAF or the other customers. Lockheed Martin should have known better since the same thing happened to them less than five years earlier on the cancelled P-7 program. This was a program to upgrade the P-3 Orion aircraft in which they proposed a minor modification and ended up redesigning over 90% of the aircraft and moving production to a new plant. There were major development and cost overrun issues which ended in program cancelation. In that case, the Navy was promised a low risk modification or derivative of the existing aircraft that was in production.

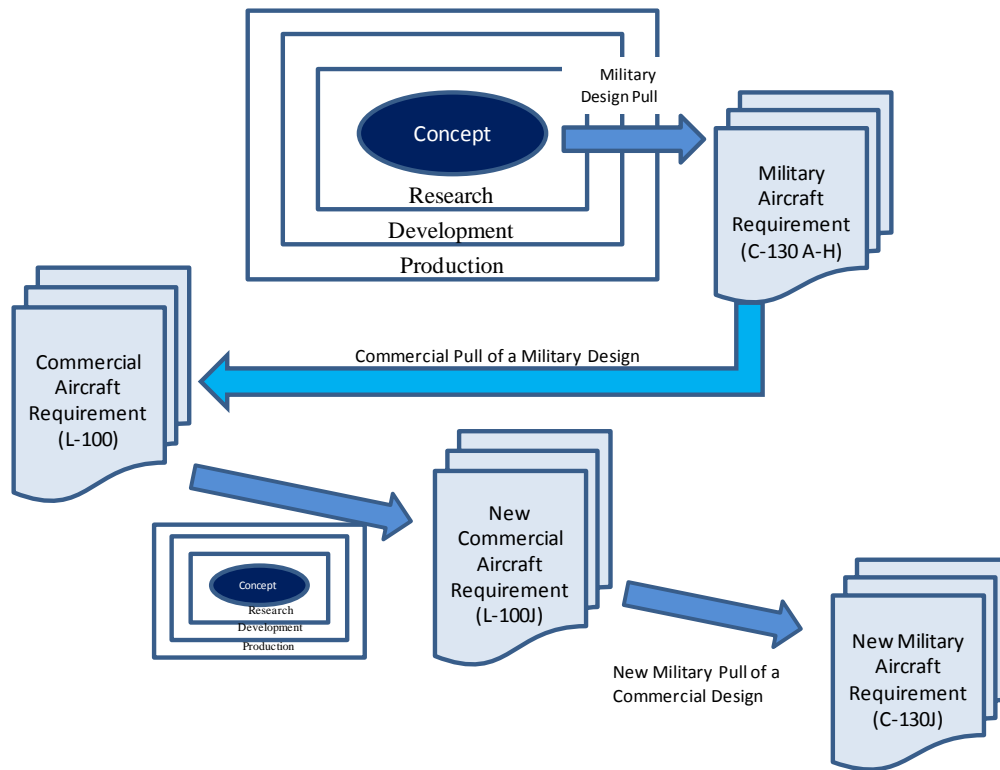
In terms of the theory, the government attempted to characterize the program as shown in the figure below. In their scenario the original C-130 line was well established along with a commercial variant. In their fable, a new L-100J was to be produced and sold on the commercial market. The military C-130J would then be a normal commercial derivative from that design.

Figure 52 (next page) would be a reasonable justification if in fact Lockheed had sold a significant number of L-100s and then created a new variant (L-100J) that also was selling significant units in the market place to establish a competitive price. Unfortunately, this isn't what happened. In the real world, Lockheed did sell about 200 of the L-100s which included some as military transports to smaller countries. However, there is no truth whatsoever that the L-100J was designed, built or sold as part of a "history of commercial aircraft production." Instead, Lockheed designed the C-130J as a military transport from day one with core military capabilities. Any claims that there might be substantial commercial sales in a competitive market that would establish a fair and reasonable price bordered on ridiculous. The USAF was not fooled.

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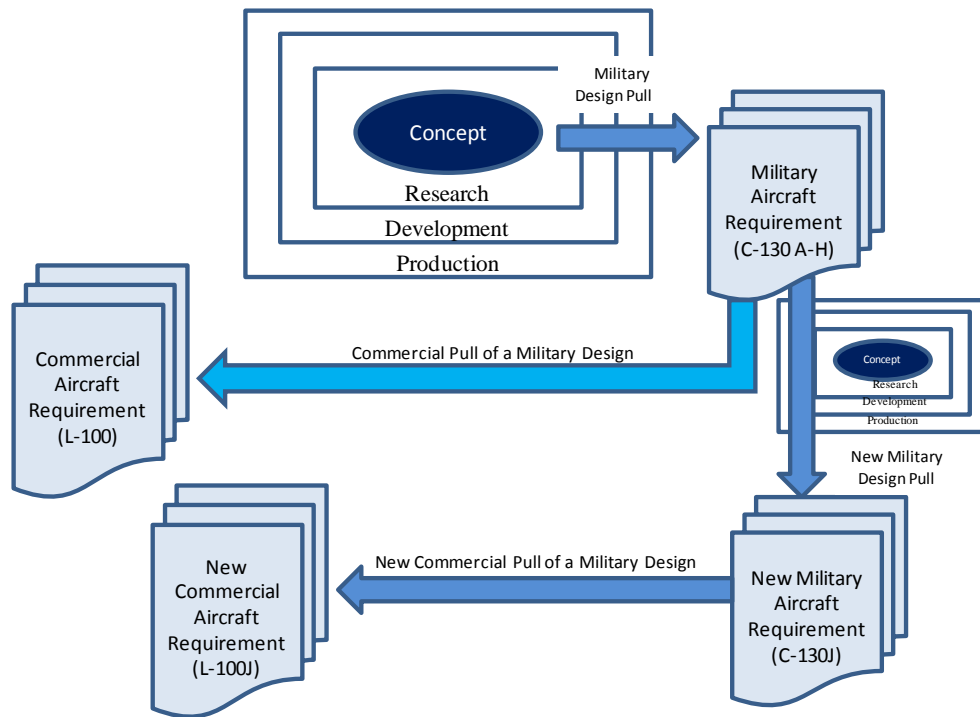
<sup>107</sup> "Contracting for and Performance of the C-130J Aircraft," DOD IG Report D-2004-102, 23 July 2004.





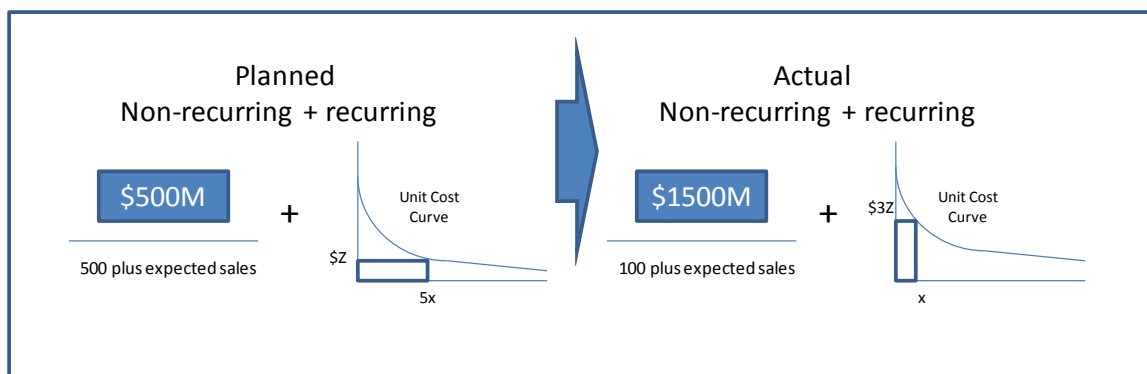
**Figure 52. Government Theory of the C-130J Commercial Program**

The real temptation to the DOD was the chance to share in a large group buy and thus lower the total acquisition cost. Lockheed would be taking the risk on the development, and DOD would buy aircraft well down the learning curve of the production run. This was the real strategy all along since it theoretically would lower the cost to all parties, especially the US military. At this point in time (mid-1990s), the USAF was not that excited about buying large quantities of C-130s and was happy to wait until later after a few hundred were sold to FMS customers or even the mythical commercial customer. The early prices were comparable to C-130H so this would not have raised any alarms. The only real change was the pressure to go with a commercial FAR 12 contract. Even this did not raise too many warning flags since Lockheed had been delivering C-130Hs on time and on cost prior to this program change.



**Figure 53. Actual Relationship of the C-130J Program**

So what happened to the business model? The model was totally based on achieving the sales projection and keeping costs in line. As shown in the notional figure below (Figure 54), two major things happened that doubled the price of the aircraft to its customers and further eroded sales.



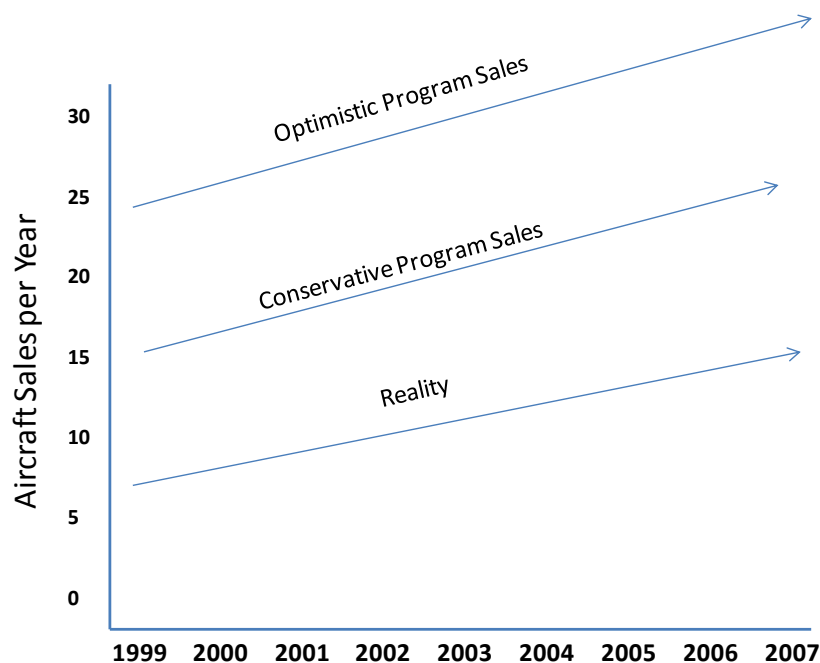
**Figure 54. Lockheed Pricing Model**

The original model assumed a fixed cost of development and test that would be spread over a significant sales base. The recurring unit cost on average would be low

due to the large sales quantity—which meant later customers (like the US) would buy their aircraft later in the program and at a lower cost. In reality, neither occurred. The development program and test program overran significantly—possibly costing almost \$2B. With sales down, this meant each future buyer would pay a larger share of the development and test costs. The recurring costs per unit were higher since slow sales meant little progress down the cost learning curve. Since Lockheed had already signed up a few customers on fixed price contracts, they lost money on almost all of the early airplanes. This quickly caused the price to increase to the \$60M range from the early \$30M pricing as shown in Figure 54.

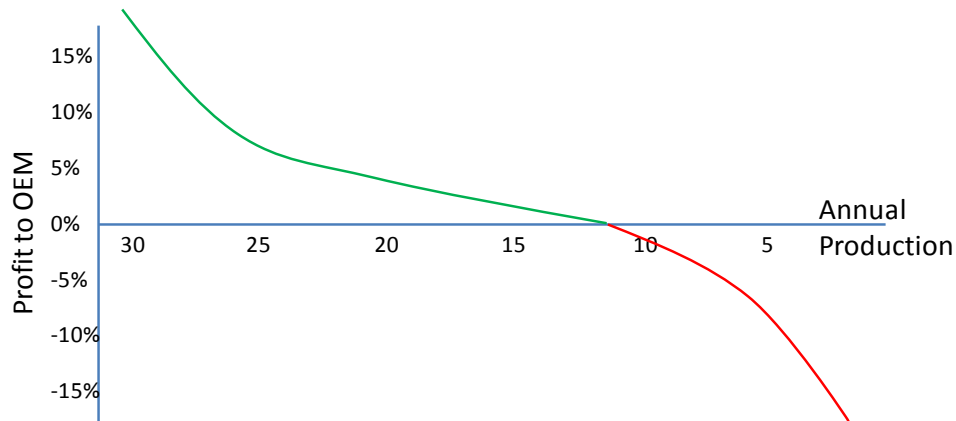
While a multitude of traditional development problems occurred, we will restrict this to the main issues that might also occur on a CDA program.

1. The USAF signed a commercial contract that provided minimal oversight and cost data to the program office. Thus, as prices began to rise (from \$33.9M up to almost \$70M), the USAF had little ability to audit the pricing to see if it was fair and reasonable.
2. The assumptions that the Lockheed Martin business model was based upon proved to be very optimistic and impossible to achieve. From day one, the FMS sales lagged and no commercial versions were ever sold. As shown in the notional Figure 55, Lockheed based their pricing on optimistic numbers of aircraft over which they had to recoup their non-recurring costs.



**Figure 55. Notional C-130J Sales Projections**

With little ability to quickly raise prices, profits plummeted. As shown in the notional figure below, the company needed 10-15 aircraft per year just to break even, much less to make a normal return.



**Figure 56. Notional Profit Chart**

3. Lockheed had planned on Congress and the USAF to continue buying relatively large quantities of aircraft—especially the Congressional adds. Unfortunately, this didn't happen due to budgetary and political changes. This also had a secondary impact on the FMS market, since many of the foreign militaries will only buy aircraft after the US buys the aircraft and thoroughly tests them.
4. In some ways, Lockheed was their own worst enemy in the sense that they had built such a good aircraft that just kept on flying. Many countries (including the US) decided that it was cheaper to modernize their existing older C-130s with new engines, propellers and avionics, than to buy a C-130J.
5. Lockheed underestimated the cost of development and test. They assumed it would be similar to previous model upgrades, but in reality it was closer to a new development. The especially underestimated the cost of FAA certification which ended up costing almost \$500M.
6. While a good engineering decision, Lockheed revamped the entire production facility based on a high production rate, but sales never materialized to offset the cost.
7. The USAF commercial strategy and its assumptions were fundamentally flawed. A commercial strategy at its basis normally assumes a flying aircraft with most customers ordering a common set of features. In this case, the aircraft wasn't

flying since it was new development. It wasn't being sold to large numbers of customers. The features on the USAF aircraft<sup>108</sup> were also not common at the time to any commercially available version of the aircraft—aerial delivery of cargo and troops, defensive systems, secure voice communications, combat control computer system, night vision system and a satellite communication system. Further, the USAF strategy alleged that the C-130J came from a series of Lockheed commercial variants, which was plainly not true. At the time of the 2005 DOD IG audit, the proposed L-100J did not even exist in the market.

## **How did this impact the USAF?**

In the beginning Lockheed's C-130J strategy was not a major issue. The USAF was not running out of C-130s and was well on the way to upgrading the existing fleet. However, as the first planes became available, issues arose. The biggest initial problem was that since these planes didn't initially arise from the formal requirements generation process, the Congress (and the USAF) did not buy a weapon system—they just bought the planes. Normally, this had not been a problem since a C-130H required the same basic support equipment and facilities as a C-130E, etc. In this case, the C-130J was a new aircraft and required a new set of support equipment. This meant that the initial units that were to receive aircraft were unprepared. As a result, the USAF ended up paying Lockheed Martin to store the aircraft until the units were ready for delivery and initial standup. The old C-130s and the new C-130Js were so different, the pilots in the units were not qualified to fly the new aircraft which caused additional budget and operational problems.<sup>109</sup>

Not only were the aircraft delivered late, but they failed to meet the contract specifications. At one point in the program, the USAF had conditionally accepted the first 50 aircraft at a cost of \$2.6B and not a single one met the contract specifications.<sup>110</sup> As a result of the commercial specification not meeting user needs, the Air Force decided to revise their requirements document to reduce the initial capabilities required and to satisfy operational requirement deficiencies through block upgrade programs at DOD expense.<sup>111</sup>

Lockheed Martin and the USAF began several block upgrades to existing and production aircraft in an attempt to fix problems and meet contract specifications. After the first two upgrades blocks were begun, the USAF began Phase 1 testing in September 2000. The report stated that the C-130J aircraft was not suitable in its current configuration because its integrated diagnostic capability was poor, including high built-in-test false alarm rates and deficient technical orders. The Air Force stopped the

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<sup>108</sup> Statement of the Honorable Joseph E. Schmitz, Inspector General, USAF, before the Airland Subcommittee of the Senate Committee on Armed Services. 6 April 2005.

<sup>109</sup> "Taxpayers Carry the Load: The C-130J Does Not," POGO Report, 15 March, 2005.

<sup>110</sup> "C-130J Logistics Problems—Did the Commercial Acquisition Strategy Doom the Aircraft From the Start," Major Patrick Butler, Air Command and Staff College Research Report, AU/ACSC/1751/2005-2006

<sup>111</sup> "Contracting for and Performance of the C-130J Aircraft," DOD IG Report D-2004-102, 2-3 July 2004.

suitability evaluation on August 30, 2000, due to the extent of the deficiencies identified. The next year AFOTEC performed an operational assessment with the aircraft. AFOTEC identified that deficiencies remained in the defensive systems, global air traffic management compliance, the mission planning systems, interoperability with the existing

C-130 fleet, training, publications, and the ground maintenance system. The report stated that the C-130J Program was also progressing unsatisfactorily in the suitability area. Based on these test results, a further block upgrade (5.4) was developed in an attempt to remedy all of these issues. While these types of issues may be expected from a commercial aircraft attempting to meet military requirements, it should not have occurred on a “legacy aircraft” with forty years of successful flight operations.

The net result to the operational units was they had a new aircraft that couldn’t perform as well as the 20-40 year-old aircraft it was replacing. According to the 2004 DOD IG report,

*“Operational limitations restrict the C-130J from performing night vision goggle operations, combat search and rescue, visual formation, global air traffic management, and air dropping paratroopers and containers. Because the aircraft performed poorly during testing, the Air Mobility Command could not release the C-130J to perform required heavy equipment air drop, coordinated aircraft positioning system/station keeping equipment formation, and hostile environment missions.”*

Since most of the aircraft was new, there were great number of development, production and operational problems—much like a clean sheet development program and its first production aircraft. The aircraft had a great deal of software compared to the C-130H and this contributed to many of the delays and operational issues. One in particular, was the Enhanced Cargo Handling System which allows a single crew member to load, unload and handle all cargo bay operations during the flight. Software glitches discovered in test showed that the pallet locks could randomly release at any point in the flight creating a dangerous if not fatal situation for the cargo bay passengers and the aircraft. The weather avoidance radar on the Hurricane Hunter aircraft didn’t work right, so the hurricane planes couldn’t fly in bad weather.

Other problems centered on the aircraft’s new six-bladed propellers. The early aircraft were seeing mean time between failures on the props that were only 34% of contract specification—and this was in a rather benign environment, not combat. The composite propellers were suffering from delaminations and from failure of the anti-ice boots during heavy rainfall. Worse, the maintenance approach required the USAF to remove the entire propeller in one piece and ship the whole assembly back to the factory. Not only was this expensive, but the fully assembled unit is huge and took up valuable cargo space in other aircraft. The Marines discovered this problem early and invested \$800K which allowed them to disassemble the units and repair individual blades. The USAF did not order a propeller brake for their aircraft which limited usage during high winds and made maintenance more dangerous.

The USAF either didn’t buy the data rights to the aircraft or Lockheed would not sell the data. The result was the USAF had very limited ability to maintain or modify

the aircraft other than to go to Lockheed Martin. This normally is not a big deal for a traditional CDA (like a B-757) where it will remain in a commercial configuration and leverage commercial maintenance opportunities. The C-130J will operate in remote, combat locations where the military normally maintained and modified their own aircraft. The USAF also failed to initially buy sufficient spare parts. This was due to funding shortages as well as a lack of logistics planning.

Was there anything good about this new aircraft? Yes, definitely. When it worked, it had outstanding flight performance in terms of speed, range, payload and other operational considerations. In 1999, a Lockheed Martin crew flew a stock C-130J on four missions over two days and set 50 aeronautical world records for speed, payload, time to climb, etc. New pilots who got to fly the aircraft came away true believers with the modern cockpit and the major reduction in cockpit workload. With the flat panel displays, heads-up-display and integrated computer system, the plane was considered safer and easier to perform complicated military missions (Figure 57).



**Figure 57. C-130J Advanced Cockpit Design**

### **From a CDA Viewpoint, What Went Wrong?**

The biggest lesson learned is that the C-130J was not a commercial derivative aircraft despite the SAF/AQ direction at the time. It should have been a traditional new-start development effort under a FAR 15 contract—at least for the development effort

and initial test aircraft. The USAF saw this as a hoped for opportunity to let a large customer base pay for their development effort and hopefully lower the cost of this gold-plated aircraft (compared to the C-130H). The contractor saw this as an opportunity to turn a normal FAR 15 program into a FAR 12 program and eliminate most of the government oversight as well as increase the profitability of the effort. In hindsight, there are some specific mistakes and misguided actions that led to this poor start for the C-130J program:

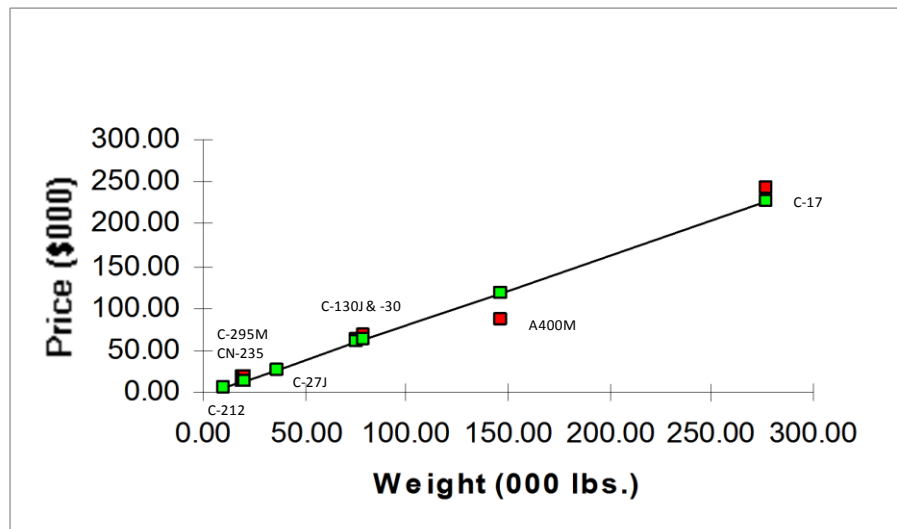
1. Lockheed misjudged the market when they developed their business model for this aircraft. The USAF failed to critique this estimate and used it to justify their “commercial” determination. The lesson learned here is for the DOD to not use sales projections in lieu of actual competitive market sales.
2. The DOD failed to do a realistic market survey to establish that a competitive market existed for the C-130J. While there was a relatively successful market for the L-100, it was obvious that the C-130J was not the L-100.
3. As the other case studies have shown, the lowest risk CDA programs are those where DOD is buying an existing commercial aircraft that with minimal modifications will meet the military requirements. It was obvious to everyone at the time that the C-130J was not a simple modification of the existing C-130H.
4. The USAF history of receiving C-130s each year as “Congressional-adds” caused them to not follow the required requirements generation process or the acquisition milestone process. The Air Force did not carefully take the time to spell out reliability, maintainability, and sustainability requirements in the original requirements documents and therefore had nothing to hold LM to when it came down to accepting the aircraft. At best, the USAF assumed that since the old aircraft (C-130H) met the requirements, the new one would also while at the same time delivering new capability.
5. Whether the USAF wanted the aircraft or not, they ended up accepting aircraft that did not have sufficient logistics plans or funding in place. The acquisition community accepted the aircraft because they did not have sufficient logistical knowledge of the new technology on the C-130J to make sound logistics decisions and did not understand the implications of accepting the aircraft as it was.<sup>112</sup>
6. The USAF program office was not prepared to manage a “new” program. Prior to this, the program office was in a long term production and modification mode. It appears they were not focused on a new development start. Worse, due to the commercial contract, they were denied the opportunity to gain insight and oversight of the effort.

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<sup>112</sup> “C-130J Logistics Problems—Did the Commercial Acquisition Strategy Doom the Aircraft From the Start”, Major Patrick Butler, Air Command and Staff College Research Report, AU/ACSC/1751/2005-2006



7. The USAF entered into a business agreement that became unsustainable. They understood the proposed Lockheed business model but ended up as the sole customer who was stuck with paying most of the non-recurring development and test costs. This was during a lean acquisition period (late in the Clinton administration) and DOD did not have sufficient acquisition dollars to fund large quantities of aircraft to get the best pricing. The DOD leadership would have preferred to defer buying aircraft, but were unwilling to face the possible termination and restart costs that Lockheed Martin would charge (\$500-\$1,000M). Lockheed was in a financial bind with large losses (due mainly to the C-130J) and was quite serious about shutting down production. To add to the misery, the commercial contract provided little meaningful cost data to the government to validate any of the pricing. The USAF was left to consider top level parametric analysis like that in Figure 58 to “validate” their pricing. The USAF failed to learn the lesson that the Navy experienced on the P-8A.



**Figure 58. Price versus Gross Weight Comparisons of Cargo Aircraft**

In the end, the USAF and others have bought over 300 C-130Js. Most of the production and technical problems have been addressed, though mainly at the expense of the DOD. The USAF changed the contract to a traditional FAR 15 with full cost and pricing data in 2006. In retrospect, the total development was probably in excess of \$2B, which is relatively low when compared to other military development programs—such as the F-22, C-17 or F-35. Had this program begun life as a traditional military development, the resulting program costs and issues would be seen as normal.

## VH-71 Presidential Helicopter Program

The Navy approached the Presidential Helicopter program as one that would be relatively low risk, based on a proven airframe in production and with updated self-protection and communications capability. The new squadron of aircraft was to replace the existing fleet of 11 VH-3Ds and 8 VH-60Ns (Figure 59) which dated backed to an IOC of 1975. While the existing fleet satisfactorily handled the mission, the Navy began initial work on a replacement program with an operational needs document as early as 1998. This was quickly followed by a mission need statement in 1999. This early program plan would have an Initial Operational Capability (IOC) of 2008 and Full Operational Capability (FOC) no later than 2014. After the 9/11 attacks, the White House urged the Navy to fast track and move up the IOC to at least 2007.<sup>113</sup> This was primarily driven by then Chief of Staff, Andrew Card, who told the Secret Service he was very concerned about how old and ill-equipped were the existing Sikorsky VH-3s. Obviously these issues still exist today for the Obama administration. As an example, on a trip to Colorado, the H-3 could not be used to transport the President due to the high altitude and relatively low power of the VH-3Ds.



**Figure 59. Current Presidential Helicopters, VH-60N & VH-3D**

The program was accelerated and on 13 December, 2003, the Navy issued the request for proposal for 23 helicopters to replace the fleet. Two teams formed to propose

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<sup>113</sup> "VH-71/VXX Presidential Helicopter Program: Background and Issues for Congress," Ronald O'Rourke, Congressional Research Report, 30 October 2009.

for the program. Sikorsky led an all American team, many of whom worked on the legacy system. They proposed a variant of the S-92 which was in service around the world both as a military and commercial helicopter.



**Figure 60. Sikorsky S-92 Helicopter.**

The Sikorsky aircraft (Figure 60) was the smaller of the two helicopters, but proposed to meet all requirements. It could cruise at 175 mph, had two engines and a rotor diameter of 56 ft. The second team was led by Lockheed Martin but its design was based on the Augusta Westland EH101 aircraft (Figure 61). It was powered by three engines with three independent hydraulic systems. The aircraft was a foreign design from Great Britain and Italy with Lockheed Martin avionics and electronics equipment.



**Figure 61. Lockheed Martin Augusta Westland US101**

The program was to be conducted in two phased buys. The first increment was to be operational in 2010 with the second group to enter service in 2017. The definition and number of helicopters changed over the life of the program, but by late in the program there were plans for 8 Increment I and 26 Increment II aircraft. The increment I aircraft were a stop gap replacement and only expected to last until Increment II was introduced. The Increment II aircraft would basically have been a new design with new engines, new gearboxes, new rotors, new tail and upgraded avionics.

The program apparently was in trouble before a source selection decision was even made. The Navy was under pressure from the White House to fast track the program. According to the first program manager<sup>114</sup>:

“This aggressive acquisition strategy included a source selection process that was shorter than desired and contributed to confusion regarding specifications between the program office and the contractor and concurrent design, testing, and production that resulted in increased program risk, an unsustainable schedule, and inaccurate cost estimates.”

The Navy actually took over a year from proposal receipt to evaluate the two competitors and eventually picked the larger of the two. One of the problems was likely the Navy’s inability to solidify the requirements prior to the source selection and then to develop a solid evaluation plan for all of the data in order to come at a balanced decision that realistically evaluated the risk in each proposal. A 2009 Defense Science Board study stated the Navy removed two appendices of significant technical requirements from the RFP in order to maintain competition.<sup>115</sup> According to the report:

“These requirements were reinserted post award, leading to communications breakdowns and eventual reengineering of entire subsystems and structures. Confusion over these mission requirements led to confusion over safe operation. Some requirements plainly exceeded the limits of available technology and schedule.”

A news release by Sikorsky supports the evaluation problem the Navy created for themselves. Sikorsky reported that the RFP required them to work 200 technical staff almost 24/7 from 18 December 2003 until 26 January 2004 (they likely were already working long hours prior to the RFP release). Their proposal, which was similar to Lockheed’s, comprised thousands of pages with over 1500 charts and graphs and placed into multiple volumes. At the same time they were investing this huge effort, the period of performance to complete the proposal was over the last two holiday weeks of December. If the Navy had exercised some common sense and made the proposal due

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<sup>114</sup> VH-71/VXX Presidential Helicopter Program: Background and Issues for Congress,” Ronald O’Rourke, RS22103, 20 October 2009

<sup>115</sup> “Buying Commercial: Gaining the Cost/Schedule Benefits for Defense Systems,” Report of the Defense Science Board, Task Force on Integrating Commercial Systems into the DOD, Effectively and Efficiently. February 2009

earlier or later, the contractors might have done a better job<sup>116</sup> and the Navy might have been at work to answer questions or produce a better RFP. Despite the Navy's desire to quickly receive the proposals on January 26, they appeared to have taken a considerable amount of time to make their decision.

A year after the proposals were received, the Navy awarded the contract on 28 January 2005 to the Lockheed Martin led team. The program was a cost plus award fee System Development and Design contract. At the time of award, the program was estimated to cost \$6.5B in then-year dollars. By January 2008, that had risen to \$11.2B, by December 2008, \$13B. The costs break down to about \$9.9B for development (\$4.6B for Increment I and \$5.3B for Increment II), \$2.9B for production and about \$200M for MILCON. Assuming Increment I aircraft were included in the development dollars, this predicts the average procurement cost of the Increment II aircraft at \$112M each. With deference to the budget world, that still works out to almost \$400M per aircraft in total cost. For "off the shelf" aircraft, this price seems to contradict the purpose of CDA acquisition. As a reference, most commercial EH101s cost around \$50M.

As mentioned before, the Increment I aircraft were intended to be similar to the CDAs with "minor" development work. Minor apparently is a relative term since the development budget initially was \$4.6B. To put that in perspective, that would buy approximately 90 of the current EH101s off the shelf rather than the five to eight in the program plan. These new Increment I aircraft would not actually meet all program requirements and would have to be retired after 5-8 years as the Increment II aircraft replaced them. To put that in further perspective, the cost of these 5-8 aircraft would pay for the entire air wing on a new Navy super carrier and have flown for 30+ years. The second Increment was to be a redesign with a new airframe and some common parts, but take another \$5.3B in development and \$2.9B in production costs—for an average cost of about \$356M each. With the exception of the B-2 bomber, these would be the most expensive production aircraft in the DOD fleet.<sup>117</sup>

## What Happened?

According to the GAO, program office and others, the number one problem has been requirements creep. The White House and DOD have never frozen the requirements. Lockheed and its partners are happily making engineering change proposals to cover the ever increasing design costs. As the requirements shift, this has caused them to add newer, less developed technologies that were not mature enough for a

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<sup>116</sup> There is no doubt that the two contractors both had significant parts of their proposal done prior to the RFP, yet all offerors will work up until the last minute to improve their proposals. No company is going to risk losing a multi-billion dollar proposal because of a holiday break. Yet it shows a total lack of judgment on the part of the Navy source selection team to release the RFP on 18 December and risk getting a less than perfect proposal.

<sup>117</sup> This could be surpassed by the upcoming Presidential Aircraft program which should exceed that average cost.

production vehicle. At the time of the award, it was stated that there were no critical technologies in the program and that the design was close to completion. Instead, several technologies were still in the laboratory (such as the Communication and Subsystem Embedded Resource Communication Controller) and not demonstrated in a realistic environment or production system. As of May 2008, only 90 percent of the Increment I drawings were complete. The Increment I aircraft were to have flown in 2007 or earlier with IOC in 2009. As of Fall 2009, only six of the nine Increment I aircraft had flown, but only one was considered missionized and meeting contract requirements. The Increment II helicopters were to have achieved IOC by 2011. As of Fall 2009, Increment I had slipped IOC to mid 2012 with Increment II IOC in 2019 (a delay of almost eight years).

As the program slips and the overruns continue to rise, Congress and the Navy adjusted the budget which contributed to program instability. These budget adjustments increased the cost overruns and schedule slips. The Navy has commented to Congressional inquiries that:

*“The program is executing an accelerated schedule driven by an urgent need to replace existing aging assets. Concurrency in development, design, and production was necessary to meet the accelerated schedule”*

While the Navy may have felt it necessary to attempt some concurrency, it is hard to believe they are actually saying an eight year slip constitutes an “accelerated schedule.” While President Obama<sup>118</sup> may not been an acquisition expert, he probably had it right in a speech on 23 January 2009 that the VH-71 program was “an example of the procurement process gone amuck.”

In response to these problems, SECDEF Robert Gates decided to terminate the program as part of his FY2010 budget. As expected some in Congress don’t want to lose the current jobs. Others, notably the states that supported the Sikorsky team think it’s about time and that the Navy should now let the Sikorsky team try their aircraft. On June 1, 2009, the Navy announced that it would terminate the main contract for the development program, called the System Development and Design (SDD) contract. At the time of this termination, it was not clear what the Navy would do with the Increment I helicopters that were produced, since only one was close to being mission ready.

While funding instability and a loss of faith on the part of DOD leaderships may have terminated the program, these were not the basic issues that led to its demise. The real issues appear to have been:

1. The Navy failed to nail down the requirement prior to RFP release (or afterwards).
2. The Navy appears to have totally misunderstood the cost and schedule requirements to modify and redesign an existing CDA. It is not clear that this much work would have been required with the Sikorsky proposal or that it was critically evaluated during the source selection.

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<sup>118</sup> Comments by President Obama on 23 January 2009 during the Fiscal Responsibility Summit.

3. It is not clear that the Navy did an initial cost benefit analysis to see if designing a clean sheet aircraft might have been less risky and costly. It is hard to argue that over \$9B in development costs justifies the use of a CDA over a clean sheet approach.
4. Apparently the White House and others believed this was a continuous spiral development effort and never froze requirements.
5. The facts seem to support that the Navy did a poor job of evaluating the proposal for risk even though they had a whole year to do the evaluation. It is not clear that the two contractors understood the total requirements and included proper risk mitigation in their proposals.
6. It appears that the RFP required excessive proposal data that the Navy was unable to properly evaluate, probably didn't need and didn't do a proper risk analysis on.
7. It is possible that the contractors both didn't understand the full requirements and or underbid in order to win. Either way, they might have believed that since this was the Presidential Helicopter, it was relatively safe from ever being cancelled regardless of the cost.

Was this program really a good candidate for a commercial derivative aircraft? Yes, it probably was. There were many variants of this aircraft (and the competitors) flying both in the military and commercial versions. The EH101 is used by a dozen nations and is even used as a VIP or Presidential aircraft in several countries (India, for instance). There have been multiple versions with high end communications, survival and performance equipment similar to what the Navy required. What happened on this program was that the customer failed to understand that there are practical limits to what can be done to a CDA and keep program costs and schedule within reason. At some "cross-over" point it is cheaper and quicker to just design a new aircraft. That appears to have been the case with the EH101. Even then, if the Navy can't stop the requirements creep, they would still be doomed to failure on a new development program.





## Chapter Nine

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### If It Already Works, Why Are We Testing It?

*The Wright Brother's design . . . . . allowed them to survive long enough to learn how to fly.*

**--Michael Potts, spokesman, Beech Aircraft, 1984**

### Why Are We Testing?

We test commercial derivative aircraft for a simple reason—they may not work in a military environment. Even though a target aircraft may have extensive commercial experience, there is always significant risk when moving to a military environment. It is essential that when practical, commercial aircraft are flown in a representative military environment prior to source selection. It is quite expensive after the decision is made to redesign an aircraft to meet requirements.

Most large commercial aircraft are designed to meet a specific business need and thus, are optimized for a specific operating environment. The closer a designer can build an aircraft to its operating environment without having to add additional, unneeded capability, the more profitable and useful the aircraft will be. In contrast, most military systems are designed to be operated over a wide variety of environments over a long lifetime with new and emerging missions. Unique military requirements place significant temperature, vibration and stress loads on aircraft unlike most normal commercial environments. The more the military mission deviates from typical commercial missions, the more testing is required and the less likely a CDA will meet the mission needs of the user.<sup>119</sup> While the benefits of leveraging a commercial aircraft are clear, these militarized versions tend to operate in significantly different flight conditions and in significantly different manner than the typical commercial mission. These military missions make it highly likely that they will exceed the normal flight envelope for which the aircraft was designed.

### What Should We Be Looking For?

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<sup>119</sup> "Complicating Issues in Adopting Commercial Contracting Practices in Defense Acquisition," Michael E. Heberling and Mary E. Kinsella. NCMA White Paper. 1997.

A new aircraft must meet all of the latest FAA safety requirements which are effective at the date of certification. A CDA often times only has to meet the original “green aircraft” requirements if the modifications are minor. Thus, many CDAs may not have to meet or comply with the more stringent certification requirements of new aircraft. While this makes the CDA cheaper, it does so at the expense of safety.

Don’t confuse FAA certification testing with DOD testing. The FAA is only interested in vehicle airworthiness in a relatively benign environment compared to some military applications. The FAA does not worry about mission accomplishment; safety is their sole concern. In many cases, FAA certification can result in additional flight tests that are of no useful value to the military and ignore other areas that are critical to mission accomplishment.

Significant differences exist between FAA and DOD flight test programs. The commercial Boeing 767 program delivered its first certified aircraft to a customer less than four years from program start. This included a nine month flight test program for certification. By comparison, the Navy and Air Force will often have a flight test program that takes ten years or more—F-22 is a good example. The reason of course is that the military programs may require 5-10,000 hrs but cover much more than simple safety of flight ferry-type missions. The sheer quantity of military missions and integrated weapons and avionics drives a much longer flight test program.

Commercial aircraft, especially smaller general aviation aircraft, normally do not provide detailed flight manuals or access to detailed flight data. Detailed data collected during FAA certification may not be available to the future buyers even if they attempt to purchase the data. This makes it imperative that military testing be done to determine and document full aircraft and performance data comparable to that for traditional military aircraft.

The large commercial manufacturers often invest in significant aerodynamic modeling and wind tunnel testing to predict aircraft behavior and mission performance.<sup>120</sup> Current FAA certification for commercial airliners allows for significant extrapolation of wind tunnel data, especially for the full motion flight simulators that simulate unusual attitudes or situations. Such extrapolation has been acceptable for the commercial community since the likelihood of encountering those flight scenarios is small. However, this extrapolated aero data does not capture the complex aerodynamics and physical phenomena present at extreme altitudes or flight attitudes. It definitely doesn’t consider changes due to multiple weapons or external stores.

Complete commercial testing may not have debugged everything (may not work as advertised and may require further testing). A new item may have new functional capabilities that can interfere with system performance once integrated. Reliability tests may not have been enough for the military application and may require further testing. Evolutionary development means the item may not be static, and tests conducted may not have been conducted on the exact equipment or fielded systems. Environmental testing

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<sup>120</sup> “Innovative Techniques of Modeling and Simulation for Commercial Derivative Aircraft Upset Recovery,” SBIRs archives. N08-004 (Navy)

may not meet all military specifications, and safety testing may be inadequate for the military application. The commercial market may be unwilling to provide descriptions of performed testing or may not release specific data. Lack of government control over the schedule of upgrades for commercial items may mean mandatory re-testing of interfaces to ensure they haven't changed.<sup>121</sup> Bottom-line, commercial testing does a great job of testing aircraft that fly from point A to B, just don't try going to C while flying upside down with 5000 lbs of bombs attached.

## What Can Go Wrong?

Most major aircraft firms that develop large commercial aircraft do significant testing, so they are often quite confident that their aircraft will meet military requirements. Boeing has built a variety of aircraft using the tried and true B-707 airframe—KC-135 Tanker, JSTARS, AWACS, and others. Thus, when the Navy decided to use it for the E-6 program (Figure 60), there was little perceived risk in terms of aerodynamics and the airframe.<sup>122</sup> Boeing derived the E-6A from its commercial 707 to replace the EC-130Q in the performance of the Navy's TACAMO ("Take Charge and Move Out") mission. TACAMO (Figure 62) links the NCA with naval ballistic missile forces during times of crisis. The aircraft carries a very low frequency communication system with dual trailing wire antennas. During tests of the flight profile required for the mission, parts of the tail failed and fell off. The plane had over four decades of operational flight time and this was the first time this failure mode had been seen.

The following are two more examples of the differences between the FAA and military needs.<sup>123</sup> During testing of the KC-10 with the FAA, it was discovered that the crew could get locked in the latrine and could only be released by a crewmember from outside. The FAA had no problem with this issue as long as the latrine itself did not compromise other systems (electrical for instance). The USAF felt that with a minimal flight crew, this could create a dangerous situation if an emergency occurred. The second incident with the KC-10 involved the specification for a rotation rate of the aircraft during engine out procedures. The military uses a slower rate, but during actual testing the FAA test pilot attempted to use the standard FAA rate and struck the tail boom doing significant damage.

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<sup>121</sup> USAF Commercial Derivative Aircraft Guide, November 2009

<sup>122</sup> "A Comparison of Military and Commercial Aircraft Development," Michael S. Mutty, Industrial College of the Armed Forces, Executive Research Project, 1993.

<sup>123</sup> "Federal Air Regulation Certification," USAF Test Pilot School, Volume IV, Flight Test Management, January 1983,



**Figure 62. Navy E-6B Tacamo**

In the previous chapter we mentioned the difficulties that the Air Force has had in buying trainers. The T-3 showed how a change in operating environment and major modifications can significantly alter flight performance. The T-6 JPATS completed its initial flight testing and the report was published in November 2001. As tested and configured, the aircraft was operationally effective with numerous limitations, deficiencies, and workarounds and not operationally suitable. In addition, several safety issues were identified to be addressed and sufficiently rectified. Problem areas included the engine, ECS, UHF and VHF radio performance, flight manuals and checklists, the emergency oxygen system, ground egress, the trim systems, the power control lever, the wheel brakes, cockpit storage, and rear view mirrors. In addition, the aircraft broke more often and took longer to repair than predicted which impacts the sortie generation rate, which affects cost, manpower and student training. Both of these were aircraft already being used commercially and by other military training organizations. In both cases, major changes were made which resulted in significant planned and unplanned test flights.

The JSTARs aircraft had its own unique problem. The original plan for the program was to buy new B-707 off the production line. Due to delays in the program start, Boeing eventually shut down production leaving the USAF without an airframe. The USAF decision was to take advantage of the numerous B-707s in the used market. Unfortunately, the USAF failed to carefully inspect several of the aircraft prior to purchase. At least one aircraft had been used to carry cattle whose urine had leaked into the bottom of the aircraft and caused major corrosion issues.

The above data and experiences point to three basic conclusions. First a thorough analysis of the military mission must be done and compared to the commercial profile. If different, then significant testing might be justified. The second is that if the aircraft has been changed, this also drives the need for significant test and evaluation. Finally, carefully inspect the green or used aircraft to make sure it meets your requirements.

## Part Four

# What Do The Experts Think?





## Chapter Ten

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### Does Time Heal All Wounds?

“I must place on record my regret that the human race ever learned to fly.”

--Sir Winston Churchill

A major part of this study was to contact experts in the field who had actually worked or were currently working on commercial derivative programs. We spent a great deal of time and effort attempting to find and interview former and current program managers, engineers, acquisition and logistics SMEs, pilots and senior leadership to get their opinions on CDAs and the process.

The interview questions were designed to map to the major areas contained in the CDA Guidebook as modeled below in Figure 63. This functional approach is a standard method to make sure we covered most of the common issues that arise in typical acquisition programs. In our case, we targeted these areas to determine which areas the experts felt were lacking in execution or needed better definition or training.

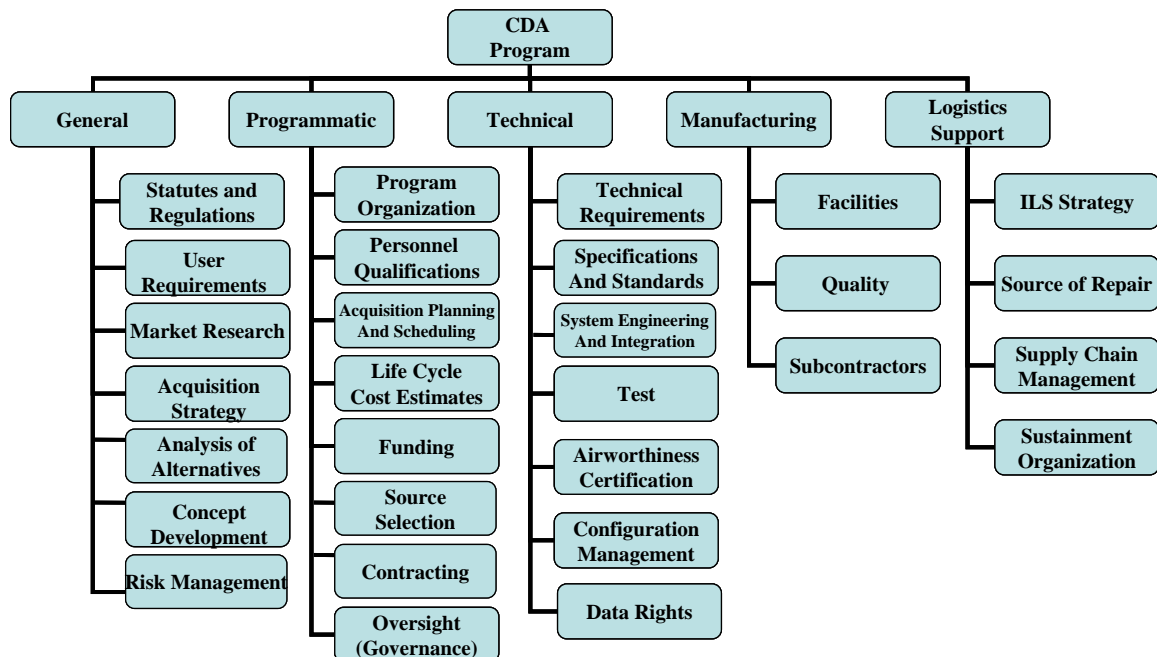


Figure 63. Functional Structure of the Survey and Questionnaire

The interviews were conducted over a three month period (July – September 2009) with interviewees selected from the government and current and past program office staff. As mentioned, the chosen experts were provided with a list of the interview questions prior to the meeting and several provided us with detailed written responses prior to the interviews. The meetings were either done in person or over the phone and each generally lasted about two hours. Detailed notes were taken during the meetings and some follow up questions and phone calls were conducted. All interviews were non-attribution, so no names will be used when discussing interview results.

## **The Interviews**

We spoke with personnel that ranged from ASC Commanders to FAA certification experts to program office functional personnel. They provided a wide range of facts and opinions and like the saying says: “Where you sit affects what you see.” All had some degree of general acquisition training and experience, yet most admitted they were unprepared to take on the responsibilities and challenges of CDA programs. Based on what type of CDA programs they worked on, they had widely differing opinions about certain areas.

## **Who Should Work CDA’s**

The majority of our interviews focused on acquisition organizations in DOD so most had acquisition backgrounds in traditional major aircraft programs. Opinions on who should work CDAs really did depend on where their program fit on the CDA continuum. If it was a relatively simple green aircraft purchase with minor modifications, then qualifications would include ALC modification background along with industry experience. Programs that required major development and modifications required more traditional acquisition and engineering backgrounds. Industry experience was still a plus, but not as critical.

Several experienced CDA personnel stated that they had no prior CDA experience before their first CDA assignment and this put them at a major disadvantage when dealing with their customers. The USAF CDA office at WPAFB (formerly the 655<sup>th</sup> Group) has a rather lean operation with small focused teams for each aircraft (five or less per program) so new personnel face a major challenge when arriving at this new assignment. The Big Safari group on the other hand is rather large and has numerous programs with dozens of experienced engineers and program managers—so they have fewer issues due to experience on their CDA teams.

Finally, at any given time there is a pecking order for all programs that define which are considered most important, which are most desirable and which are seen as best for career progression. There is not a long line of program management or functional personnel waiting to work most CDA programs. Thus, the newer KC-X or CSAR-X programs will likely attract a large pool of people for assignment compared to the recent C-27J. Even these volunteers may be tainted by the recent protests and intense scrutiny they underwent.



Another factor mentioned by several of the experts was interaction and pressure from outside the program. This includes the users, higher headquarters and Congress (among others). It was stated several times that this required a degree of past experience that normally came from working in ASC or ESC major program offices.

A last issue was the conflicting nature of acquisition regulations, politics and policies that often limit or deny program offices the opportunities to leverage CDA benefits for a program. Many felt there was a need to modify acquisition policy and procedures to recognize differences for CDAs.

## **Is DOD Smart Enough to do CDAs?**

With one exception, the majority of those interviewed did not have any significant CDA training or knowledge of FAA certification. Many of the current CDA professionals felt this was a problem. The government personnel (military and civilian) all had the requisite functional Defense Acquisition University (DAU) training provided for normal acquisition programs. The exception was a few of the FAA certification personnel who had a long list of CDA specific short courses provided by the FAA. Several were aware of the FAA certification short course and most were aware that Kansas University offers an outstanding short course. A few of the CDA professionals listed a variety of current sources which are discussed below.

Several mentioned that the FAA had a series of courses available to government personnel, but not widely known outside of the FAA. The FAA has its own curriculum available on line.<sup>124</sup> The program is called the **Aircraft Certification Technical Training Program** and contains an initial set of standard courses:

- Aircraft Certification System Evaluation Program
- Aviation Safety Inspector Job Functions
- Aviation Safety Engineer(Airframe) Job Functions
- Aviation Safety Engineer (Propulsion) Job Functions
- Aviation Safety Engineer (Software) Job Functions
- Aviation Safety Engineer (Systems) Job Functions
- Using the Object Oriented Technology in Aviation (OOTiA) Handbook
- Type Validation Procedures

There is also a more detailed set of courses by the FAA that are available:

It appears that the FAA has done an excellent job in creating onsite, in-house training for its personnel. Unfortunately, it appears the USAF or other services have not been able to leverage this valuable training. Each course is approximately 12-40 hours and could be made available to other government TDY students.

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<sup>124</sup> [http://www.faa.gov/training\\_testing/training/air\\_training\\_program/](http://www.faa.gov/training_testing/training/air_training_program/)

Several mentioned and praised the Kansas University program. Kansas University offers a military focused program<sup>125</sup> in the form of a three day short course entitled “FAA Certification Procedures and Airworthiness Requirements as Applied to Military Procurement of Commercial Derivative Aircraft/Systems.” The course provides an overview of FAA functions and requirements applicable to Type Design Approval, Production Approval, Airworthiness Approval, and Continued Airworthiness associated with military procured commercial derivative aircraft and products. The program focuses on the unique military needs in procurement (customer versus contractor) of products meeting civil airworthiness requirements which are aligned with military-specific mission/airworthiness goals.

Kansas University also offers a long list of aerospace short courses in addition to the FAA Certification short course. Others specifically targeted to CDA include:

- Commercial Aircraft Safety Assessment and Design Analysis
- FAA Functions and Requirements Leading to Airworthiness Approval
- FAA Production Quality and Airworthiness Approval Requirements

Several mentioned that the USAF Test Pilot School and the National Test Pilot School have courses that deal with FAA certification. The National Test Pilot School<sup>126</sup> in Mojave California has an excellent short course designed to assist flight test engineers, FAA Designated Engineering Representatives and Industry representatives in the flight test portion of an STC program. This course is specifically tailored to the civil community, particularly to FAA Part 25 (23) certification of new or upgraded avionics systems. The course pays particular attention to FAA recommended/approved practices and guides the student through a step-by-step approval process. The course covers basic theory and operation of each of the systems, test requirements, test planning, data collection and analysis. Completion of the course will allow a student the necessary knowledge to successfully undertake the flight test portion of an STC Compliance matrix relating to avionics system upgrades. This is a hands-on course that provides actual flight test experience as part of the curriculum.

Several of the more experienced DOD managers mentioned that **Education With Industry (EWI)**<sup>127</sup> should be emphasized and used more. The primary mission of EWI was to provide military and government civilians with commercial business experience. The EWI programs can provide Air Force officers and civil service employees with CDA specific on-the-job education, experience, and exposure to private sectors of the economy or other government agencies not available through formal courses of instruction. Few

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<sup>125</sup> [http://www.continuinged.ku.edu/aero/course\\_list.php](http://www.continuinged.ku.edu/aero/course_list.php)

<sup>126</sup> [http://www.ntps.edu/HTML/Courses/Descriptions/academiconly.htm#FAA\\_Part\\_25\\_Systems\\_Certification\\_andTes](http://www.ntps.edu/HTML/Courses/Descriptions/academiconly.htm#FAA_Part_25_Systems_Certification_andTes)

<sup>127</sup> **EWI Program Manager**, Email: [enel.ewi@afit.edu](mailto:enel.ewi@afit.edu), DSN: 785-2259 ext 3039, Comm. (937) 255-2259 ext 3039

of the CDA PMs or functionals participated in EWI, yet most were aware of older colleagues who had done EWI in the past. Of interest, most thought the program had been eliminated several years ago. As it turns out, EWI is alive and well at AFIT/ENEL. Eligibility for EWI is based on possessing the right AFSC and having a strong performance record. EWI is currently available for scientists, engineers, acquisition managers, contracting officers, public affairs officer, communication-information officers, and services. What is missing is a strong advocacy from the CDA leadership and support from ASC to focus part of this program on CDA personnel and their targeted contractors (Boeing, Gulfstream, etc.)

## **What Does a CDA Program Manager and Staff Need To Learn**

Despite the list of schools mentioned in the previous paragraphs, most CDA PMs and technical staff come into the program office “green.” We asked the experts what they felt the staff needed to know different from their traditional training in order to be CDA experts. First, most agreed that specialized CDA acquisition training is required—learning the key lessons on the job is not satisfactory or efficient. Second, the staff and leadership need to understand commercial business practices. Last, but not least, the military needs to track these personnel, document their experience and continue to use them throughout their careers. A major problem today is that the few experience CDA acquisition professionals “disappear” after their assignments and little in their acquisition or civilian records track their valuable experience.

We ask the experts for input and condensed their list of topics to the following:

- Basic knowledge of FAA regulations
- Contact list of experienced CDA personnel with real work experience and a list of all relevant CDA program offices and FAA offices
- Detailed insight into FAA and its terminology
- FAA organizational structure
- FAA operational philosophy
- Airline operations , servicing and maintenance, letter checks, and repair manuals
- Boeing commercial process for doing aircraft disposition for standard and non standard repairs
- FAA and Military Certification processes
- How do airplanes get type certificates
- Modification process
- Evolutionary nature of the Federal Aviation Regulations (FARs) and how they change
- Responsibilities of certificate and license holders,

- Service bulletins, Airworthiness Directives, service process, letters, alternative means of compliance
- Responsibilities of AF officials
- What are AF requirements that contradict FARs
- Aircraft statusing, log books, etc
- AF maintenance responsibilities
- Commercial business practices

Many expressed concern that the Air Force did not already have a prepackaged course to provide this information. Much of this information can be obtained in the FAA and civilian programs mentioned earlier.

## **Where Should CDA's Live?**

As quoted in the beginning of this chapter, "Where you sit affects what you see." The senior leadership and experienced ASC personnel believed that CDAs should be run out of the product centers. They felt these programs required extensive interaction with the user community, higher headquarters and Congress which impacted budget, schedule and requirements on almost a daily basis. These were all attributes of typical ASC or ESC programs, so they felt the product centers developed and provided the most experience pool of functional and management experts.

Many of the functional staff and those with ALC experience felt many of the programs (especially the VIP aircraft) fit better at the ALCs. The rationale was that this type of minimum development, traditional commercial modification easily fit into the depots workload experience. Several believed that the ALCs could handle the budget and requirements instability as well as the product centers. Further, even major programs with significant development (KC-X, CSAR-X) could also be managed out of the depots since these are similar to major modifications that they normally perform. More important, a few mentioned that these major programs (with significant numbers of aircraft) will likely end up using a depot logistics approach vice CLS, so starting life at the depot will provide multiple benefits and reduce transition risk.

## **Would DOD be better off with a pure development effort?**

Most of the experts agreed that pure development efforts are riskier, more costly and often fail to produce optimal results. One of the retired program managers stated that "the key is determining if the military mission has enough commonality with the civil usage of the aircraft to warrant a COTS/CDA approach." A common statement was that while the commercial firms develop and produce many outstanding aircraft, most are not suited for harsh military environments or operations. A rather simple example was the early KC-10 operations and limitations stated in the commercial flight manual. The flight manual cautioned the pilots not to stall or apply abrupt elevator

movements above a certain gross weight. While being refueled during an exercise, a KC-10 was over controlled while breaking away from its tanker and the elevator's top skins were severely damaged. While this type of maneuver would be anticipated for a pure military aircraft, the basic DC-10 was not designed for that type of flight operation.

A current example of this may be the tail structures on Airbus commercial airliners<sup>128</sup>—the very plane considered as a tanker by the USAF. The Airbus vertical tail and rudder system has been shown to be susceptible to significant damage if not failure if the rudder is fully deflected at medium to high airspeeds. There have also been numerous reports of uncontrolled rudder and rudder trim issues coupled with often violent oscillations of control surfaces. As demonstrated by the KC-10, military missions often take aircraft into severe flight environments. This is why testing of commercial derivative aircraft is still critical to long term, safe operation. Commercial aircraft are optimized with thinner technical margins—which often fail to cover many military flight regimes.

One of the retired senior officers felt that while CDA's offered savings on the initial acquisition cost, the savings often came with compromised performance. Due to the limited number of aircraft in a specific class or mission area, the statement of work must be broad in order to encourage competition. This compromise attracts competitors whose airplanes often deviate significantly from the desired capabilities and often require significant modifications to meet ultimate user needs. As one person noted, this attempt to attract competition boxes in the SSA. Every time the SSA issues a requirement (through the RFP and SOW), it tends to favor one competitor over another since neither usually has the option to modify their aircraft. This encourages calls for "split-buys" and facilitates protests. As one engineer commented, over a long 40-year lifetime, the cost and time for development may not be significant compared to the benefits of having an optimally designed aircraft.

One senior OSD participant noted that: "Instead of starting with a commercial approach which we militarize, we should think about starting with a military approach which we commercialize to the maximum extent possible." Many noted that this translation of military requirements to commercial aircraft was often misunderstood. Worse, some felt that many SSA's were swayed by low green aircraft cost while not understanding or appreciating the cost to missionize or militarize the aircraft.

### **If DOD buys the CDA aircraft, shouldn't they provide total support?**

The vote on this one was almost unanimous in favor of contractor logistics support. The typical CDA aircraft acquired by the DOD is one with several years of commercial service and a world-wide network of service facilities, heavy maintenance centers and spare parts distribution. The commercial users have already invested and

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<sup>128</sup> In 2005, an Airbus 310 lost its rudder while cruising at 35,000ft. In 2001, an Airbus 300 lost its rudder after excessive control inputs. In 2009 an Airbus 330 apparently lost its tail during weather induced turbulence and failure of the pitot-static system.

paid for most of the non-recurring costs. This network usually provides a level of service not available in any of the military depots.

Several of the experts pointed out that buying CDAs and maintaining the FAA certification allows the DOD to leverage the global commercial supply chain and support infrastructure. For example, the 89<sup>th</sup> Air Wing could return a B-757 engine to the engine support contractor and swap it for a new or rebuilt engine. The old engine goes into the support contractors supply system to be repaired and resold to other customers. Without the FAA certification and the commercial contract, the DOD would have to maintain an inventory and depot support system for engine repairs on a small group of engines. This ability to leverage commercial supply chains and maintenance facilities provides major cost savings.

### **Should we invite the FAA over to dinner?**

While no one gave glowing commendations about the FAA bureaucracy, the overwhelming feedback was that DOD programs needed to make contact early and often with their FAA counterparts. Part of this was just common program management sense: involve all of the key players early. However, a more basic need was that most lacked knowledge of the FAA or its certification procedures prior to coming to the program offices. Most saw the FAA as cooperative and quite helpful, so there was no indication that early contact was detrimental or that it contributed to anything but a good working relationship.

Several did provide the warning that the FAA is only interested in maintaining aircraft certification according to their rules. The flip side of this is that they are not going to help you much with determining unique military testing requirements or modifications. Further, they are interested in FAA certification—not military certification. This leaves the responsibility of making the decision to go for full or partial military certification with the DOD management.

Most of the experts (including a former senior FAA official) agreed on one thing about FAA Certification and the process—it's overkill. The rule-making processes used in each of the FAA field directorates appear to go well beyond what is required in the basic regulations. Each aircraft being certified for commercial use has a unique set of rules tailored by the FAA and OEM in a process of negotiation. After the initial certification (the green aircraft), Supplemental Type Certificates (STC) must be obtained for each aircraft modification. On a large aircraft, there can eventually be hundreds of STCs to consider. The resulting cost of certification (to include test) can be very expensive and be cost prohibitive for small aircraft manufacturers. Several of the experts quoted a popular FAA saying, *"When the weight of the paper equals the weight of the aircraft only then can it be certified."*

One final thing was quite clear from the interviews. Most did not have a detailed understanding of airworthiness either how to attain it initially or how to maintain it. At the time of the interviews, the USAF was changing its processes for military

airworthiness—something that only contributed to the confusion. At the time of this writing, there is no one-stop training course for airworthiness in the USAF.

### **If I buy a green aircraft with minimal modifications, what else do I need but the price?**

The responses in this area ranged from desires for full insight, cost and pricing data and on-site government teams to just email me when the plane is ready. Focusing on the green aircraft production, most former program managers desired little more than to have the aircraft delivered on time and on cost. Most contracts were fixed price and in most cases, they were not disappointed. There were a few that felt full insight was needed to include certified cost and pricing data—despite the fact that the DOD often got better prices than the commercial sector.

If we turn our attention to the modifications, and especially modification in line, then most agreed they wanted oversight and insight during this phase of the production and modification. A few mentioned that DOD often had unrealistic expectations about cost and schedule. The issue was that while building the same plane 100 times was very predictable—making significant changes totally changed the situation. The reality is that changes are very expensive and don't follow a simple linear pattern. What may seem like a minor change—adding additional electrical capacity to run larger kitchens—may impact multiple systems in a very expensive way. In this case, cost and pricing data should be required, but it doesn't mean the price will be any cheaper.

One of the former program managers commented that the real insight and oversight problem is with the original requirements IPT. They need to carefully understand the green aircraft design and capabilities before making hasty decisions on modifications. As we heard repeatedly during the interviews, minor changes make for major program problems. As detailed in Chapter 8, the USAF made what they thought was a minor change on a simple aircraft—upgrade the engine on the T-3—and instead it triggered major problems that eventually led to the program's cancellation.

There is also a misunderstanding by some military and government personnel about the real competitive market that exists outside of traditional DOD acquisition. Aircraft producers live in a very competitive environment so not only must they optimize their aircraft to meet very narrow operational requirements, they also have to worry about protecting their investment. This means they only sell the aircraft and retain as much of the remaining rights as possible—especially design and test data. Since most commercial aircraft heavily leverage off the previous design, this information is a closely held trade secret. Further, this information allows them to provide a wide variety of services (logistics support and supply chain) that will often generate as much revenue and profit as the original aircraft sales. DOD acquisition personnel often think the contractor should provide data (design, logistics, flight test, etc.) for free or for a small price at the time of the sale. This not only shows a lack of basic business knowledge, but

also fails to recognize that the DOD has become a major competitor against the aircraft industry itself.



## Chapter Eleven

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### What Does the Industry Think?

*“It is not necessarily impossible for human beings to fly, but it so happens that God did not give them the knowledge of how to do it. It follows, therefore, that anyone who claims that he can fly must have sought the aid of the devil. To attempt to fly is therefore sinful.”*

— Roger Bacon, thirteenth century Franciscan friar

### The Interviews

Much of this book looks at CDAs from the DOD program manager’s viewpoint, but the Industry viewpoint is equally important. To compile this addendum, industry inputs were solicited by formal letter from 15 separate companies and the Aerospace Industries Association (AIA). These companies were viewed to be industry participants in CDA programs with various Government buying offices. The AIA serves as a representative of, and advocate for, all aerospace companies, especially in matters relating to Government policy and interface. Formal interviews were conducted with personnel from seven of these 15 companies plus representatives from the AIA. Eight of these companies declined participation in interviews for varied reasons (e.g., too busy to participate, claimed to do no relevant CDA work, possible suspicion of the researchers’ intent, or could see no advantage in it for their company).

Each interview spanned from one to three hours and loosely followed the list of questions listed at the end of this chapter. The interviewees were all senior management, engineering, and business specialists within their respective companies and all had extensive experience with CDA programs. All interviewees were assured of non-attribution regarding their responses and they were all exceptionally candid and helpful. Extensive notes were taken during the interviews and these notes, along with information obtained from research in open source literature, comprise the basis of our findings.

Since it is human nature to complain about the things that make your life difficult, or that have forced you to endure failures or disappointments, we took precautions to scrub the industry inputs we received to eliminate those that seemed to be isolated circumstances or that seemed to be “sour grapes” type responses. Where relevant criticisms of Government activities were substantiated with concrete examples, they were included in this study. While wholesale acceptance of industry opinions and desires is probably not a wise posture for the Government CDA program manager to take, it is

nevertheless important to understand, as well as possible, what motivates and restricts the CDA industry and what the Government team can do to elicit this industry's best work.

It is essential to state that two major CDA companies were intentionally not approached for participation in this study. Boeing Aircraft Company and EADS North America were competing in the USAF's KC-X aerial tanker replacement program source selection. Due to the sensitivity of this program, along with the total involvement of key Boeing and EADS personnel in the proposal, source selection and other KC-X pre-contract activity, we determined that they should be excluded from the study, for now.

## **Program Management Inputs**

All of the companies which granted interviews expressed various opinions regarding good and bad management practices on the part of the various Government buying offices. The U.S. Air Force's BIG SAFARI program office was cited by several industry sources as being a model of efficiency and a fine example of Government program management focusing on program essentials, employing commercial practices whenever possible, and not getting caught up in the minutia of less important concerns. Programs begun by BIG SARAFI and later transitioned to other government program management offices have not gone well following the management transfer according to one industry source. Inexperience of the management team in the gaining Government office was the perceived problem. One telling and related comment from a senior industry manager was, "The Government often spends more money on the paper surrounding an airplane purchase than they do on the airplane itself". This criticism is important to consider especially in the area of CDA acquisition wherein commercial practices would seem to be most applicable due to the commercial nature of the basic product being acquired.

CDA assets are often selected to meet the needs of a rapidly evolving military requirement so that the needed capability can be fielded as quickly as possible. While this strategy serves the Government's need quite well it can be harmful to the CDA contractor community for several reasons. First, the CDA contractor has little or no time to plan internally, or to schedule personnel and other resources. This drives inefficiencies and can result in major plant disruptions. Further, assets that were being produced and programmed for commercial customers are often redirected to the Government customer due to the urgency of the Government requirement. This practice has the effect of harming the commercial customer(s) and often causes the CDA contractor to lose future commercial business due to having failed to deliver as the commercial customers anticipated.

Another downside of Government haste to field CDA products or capabilities is requirements definition. Often cited as an acquisition program risk in all major system acquisitions as well as complicated services acquisitions, requirements definition is rarely complete or even done well on rapid response CDA programs. CDA contractors usually must go through numerous changes and additions to initial requirements baselines which of course extend schedules and drive up costs. Often, the cost and schedule advantages

associated with selecting CDA products to meet military capabilities needs is lost due to poor requirements definition and the attendant consequences.

Several industry sources noted that Government data requirements are far more excessive than those of commercial customers. And within Government, some uniformed services and individual uniformed service commands seem to have greatly different data requirements for similar CDA programs. The USAF was generally criticized for asking for technical data in apparent excess of their needs compared to Army, Navy and Marine programs. One industry executive observed, “The Air Force doesn’t seem to know for sure what they need so they ask for everything”. He also observed that one major USAF CDA program asked for the same technical data numerous times because they repeatedly misfiled/lost it.

One of the interesting situations we observed during our research and interviews for this study is that the USAF’s Oklahoma City Air Logistics Center (OC-ALC) manages all contractor logistics support (CLS) programs and contracting operations for all four military services. CLS is often a major feature of CDA programs, following the proven commercial support model. Though it is a generalization drawn from several industry sources it is worth noting that, in their view, the USAF is harder to please and work with than the other services. This fact, accepted to be accurate based on our research, is at the same time both complimentary and critical of USAF practices. Government program managers should certainly keep it in mind as they plan CDA program activities and consider lessons learned on prior programs.

In some instances the Government has purchased certain CDA assets in very limited quantities, often including as few as one aircraft of a type per year. This practice, though sometimes necessary due to congressional appropriation constraints, results in higher costs for each individual CDA purchase and the creation of what the CDA industry terms “partial orphan aircraft”. That is, the configuration of most CDA systems in continuous production evolves on an annual or even more frequent basis, and this causes the Government’s “one-at-a-time” purchasing practice of CDA systems over many years to put aircraft in the military service’s fleets that are slightly or even significantly different in configuration. These configuration differences drive additional costs for support and modification. The lesson in this case is obvious: to save money, always buy in the largest quantity feasible and maintain CDA system fleet configuration as uniformly as possible.

An interesting and important sub-set of products in CDA acquisitions are aircraft engines. Often, CDA aircraft can be delivered with different engines or engine configurations. The question to be considered in all CDA purchases is whether the Government is best served by selecting and buying the engines directly from the engine OEM or by having the CDA manufacturer select and provide the engines. As one engine OEM noted, it is always less expensive to purchase engines directly from the OEM, when engine integration on the CDA has been completed and certified, and to provide the engines as GFE to the CDA manufacturer. Similarly, support costs for engines can be lessened by going directly to the engine OEM and avoiding the “middleman” or CDA manufacturer’s associated costs.

One industry source, which does a great amount of aircraft modification work, noted that some CDA industry sources maintain much closer ties to Government program offices than others by virtue of both geography and long-standing contract relationships. They noted that a major CDA manufacturer occupies offices on a military installation and appears, in their view, to have an “inside track” on the origination of CDA requirements definition and other new work at that location. In fact, when this source meets with the Government program office staff on potential new work, some of their competitor’s employees may be present supporting the Government management team. Given the current sensitivity to potential organizational conflict of interest violations, the Government CDA program manager must be certain that a condition such as this is absolutely avoided.

We found agreement among industry sources on one overarching principle. Since CDAs usually involve multiple parties working together to create a military capability (aircraft manufacturer, engine manufacturer, on-board mission equipment manufacturers, integration or installation contractors, and perhaps others), the key to CDA program success is always competent and strong Government team leadership. The Government team leader must obtain the agreement of all parties on program goals, priorities and the metrics to be used for measuring progress toward those goals. If any major team member fails to devote their best efforts to meeting overall goals, and instead pursues self-interest ends, then the CDA program will undoubtedly be less effective than it could be otherwise. This issue is also at the heart of the question, “Who is best qualified to serve as the system integrator?” In the CDA world, as opposed to the major systems development world, the “integrator” role must often default to the Government because many of the commercial suppliers of aircraft and equipment do not specialize or excel in system integration nor do they readily accept that responsibility.

Perhaps a corollary to the leadership suggestion is the suggestion heard from several sources regarding concentration of CDA program expertise. Managing all CDA programs, regardless of end user or specific mission, out of a single government program management office organization is viewed by industry as a very positive management approach. Concentrating CDA technical and business expertise in one office can lead to management efficiencies and avoid the constant retraining of “new” government employees, or, the retraining of those assigned to their first CDA program. A problem cited on some CDA programs involves the operational “user” of the system being produced receiving criticism for “trying to run the program”. If the Government CDA program office is viewed by the “user” as being inept or inexperienced then it is understandable why the “user” often intervenes. But, if the Government program office is staffed with highly experienced and competent personnel who have “been around the block on CDA programs” the likelihood of “user” discontent will be greatly lessened. This is another argument for managing CDA programs centrally in Government acquisition offices.

We asked the “purely commercial” CDA companies why they participate in CDA programs since they often are disappointed in the Government’s acquisition strategy and contracting approach (FAR 15 vice FAR 12) and these programs account for a very small portion of their total corporate revenue. The answers were two-fold. First, they stay in

the game for purely patriotic reasons and, second, they want their aircraft to be seen around the world being used by U.S. Government personnel, which, they believe, fosters additional commercial sales opportunities for them. Incidentally, one of these commercial contractors cited a 4 for 1 reduction in financial management and contracting employees when they stopped doing FAR Part 15 contracts and programs many years ago.

We spoke with one company that has just successfully won their first government contract on a small \$20M program. They were surprised at the complex proposal process (compared to their commercial experience) and the standoff nature of the government acquisition officers. In the commercial world, customers are eager to explain and help you put together a compliant proposal. In this case, they felt the government tended to be aloof and erred on the side of not helping small companies. To add to their enjoyment, the loser protested and delayed the award, with little explanation of the process from the government.

One primarily commercial industry source made two suggestions worthy of careful consideration for CDA programs. First, the Government would benefit if they created and maintained an encompassing market research data base for all potential CDA platforms so that each new program could avoid doing fresh market research each time they begin what will become a CDA program. This data base should include catalog pricing information as well as well as technical information on CDA platforms. Secondly, the FAR should be amended to more frequently permit selection of the best CDA platform for a given mission, based on thorough market research, followed by sole source negotiation for that platform (the BIG SAFARI model as well as a standard commercial practice) and the necessary modifications. Time wasted in the proposal/source selection cycle could be minimized in their view with this acquisition strategy.

## **Technical Inputs**

CDA programs can greatly benefit from utilizing FAA airworthiness certifications, previously granted, or granted in-process as the CDA is being modified for military use. One industry source noted that Government buying office use of FAA resources and certifications has been an evolving process but that some Government buying offices apparently do not fully understand FAA procedures and services. For instance, he noted that there continues to be a high level of reliance on in-house engineering resources by some government offices. This practice, though workable, is often far less efficient than relying on FAA procedures and personnel because the FAA relies on highly repeatable processes and employs very experienced personnel. This same source opined that some Government engineering personnel may not trust the FAA's procedures and people because the FAA works so much more closely with the CDA manufacturer (even utilizes the CDA's engineering resources) than a Government buying office is permitted due to the "arms-length" working relationship the Government culture dictates. An example of the differences between FAA and in-house Government engineering requirements is "g-loading"; the Government is always much more stringent

in this area and, in industry's view, over-specifies its needs in this, and many other areas, and thereby contributes to unnecessary costs.

Another CDA contractor stated that their work with the FAA offices has been excellent except in one regard. This CDA contractor is ISO 9000 certified throughout their entire company and in multiple locations around the world for both production and repair operations. The FAA however develops and maintains its own standards and does not acknowledge ISO 9000 standards. Although this CDA contractor complies with the FAA's standards as required, they assert that compliance with FAA standards is far more costly and time consuming than compliance with ISO 9000 standards.

With no exceptions, all CDA companies stated that the FAA is very slow to act in numerous certification activities, regardless of industry and Government production or test schedules. One program we reviewed began with FAA airworthiness certification procedures in use but extensive FAA delays caused the Government to take this responsibility back in-house to maintain schedule commitments to the "user". The FAA reply to this sort of charge though is consistent and understandable: the only goal the FAA has in this arena is aircraft safety and they are intentionally insensitive to industry or Government schedules if safety is not first served. While these FAA priorities are unquestionably correct they also contribute to CDA program cost increases due to schedule extensions. Since invoking safety considerations is tantamount to invoking patriotism or Motherhood and is often unquestioned, all parties in CDA programs must be vigilant to the possible misuse of safety concerns as an excuse for covering up inefficient operations and time wasted.

The USAF is apparently the most rigorous of the military services with regard to reviewing technical documentation one industry source asserted. This source also noted however that the diligence of the USAF does not seem to have any effect on the delivered products when comparing USAF CDAs to other services' CDAs (several examples of the same CDA product in two or more military services).

Independent Research and Development (IR&D) decisions regarding spending corporate resources in the CDA industry sector are usually focused on commercial business gains rather than on CDA program opportunities. Most of the CDA sources interviewed for this study do far more pure commercial business than CDA business, which helps explain the propensity to devote their IR&D resources almost exclusively to commercial opportunities. CDA programs can be the benefactor of previous IR&D work done for commercial purposes. One exception to this practice occurs when the Government buying office announces its intent to purchase a specific CDA product. In this case, the CDA manufacturer can be influenced to devote IR&D effort directly in favor of the CDA program.

CDA programs often experience difficulties when compliance with special government requirements is forced on to what are otherwise commercial products. Examples of this sort of dilemma are the Government's requirements for specialty metals (must be melted in the U.S. vice foreign sourced) and Unique Item Identification (UID) of all parts. These requirements are not part of the commercial world and cause CDA suppliers to incur additional costs if they are unable to obtain waivers. Additionally, some small/small disadvantaged businesses which supply parts to CDA manufacturers for

commercial products are completely unable to cope with CDA specialty metal requirements and therefore, are unable to participate in certain CDA programs. Each of these requirements can also have a negative effect on CDA system support in that commercial and CDA specialty metal parts cannot be comingled in the Government supply system and must be tracked separately. A similar problem occurs with UID and non-UID parts which require separate tracking systems.

When specific technical requirements are not clearly established in statement of work (SOW) or similar document language, a great potential for disagreement and conflict is usually created. Several sources cited the difficulty of working with DCMA inspectors in these circumstances. Some DCMA inspectors demand standards of manufacturing performance well beyond commercial practices when no clear standard is specified in the SOW and the CDA contractor has little choice but to comply, even though such practices drive higher costs and extend schedules. Thoroughness in the preparation of SOWs and similar documents prevents later disagreements in the CDA world and permits more precise pricing of work packages up front.

## **Contracting and Financial Inputs**

Perhaps the most often heard contracting complaint from industry centered on the Government's frequent assertion that it is conducting commercial competitions or commercial, sole source CDA purchases, but the Government solicitations used in these cases have been filled with terms and conditions that were clearly not commercial in nature. Several of the companies which participated in this research describe themselves as "purely commercial" and they, by choice, do not maintain accounting, purchasing, quality, or material management systems which comply with Government contracting requirements. These companies will accept FAR Part 12, firm-fixed-price, commercial contracts but they refuse to bid on solicitations which contain FAR Part 15 clauses or requirements. The Government's practice of blending FAR 12 and FAR 15 clauses and requirements in the same solicitation, and ultimate contract, has precluded competition from these "purely commercial" sources in numerous programs. One industry financial manager, whose company does both FAR 12 and FAR 15 contracts, noted that a FAR 15 proposal takes, on average, three to six months longer to produce than a comparable FAR 12 proposal and costs two to four times as much. He also noted in passing that the Defense Contract Audit Agency (DCAA) is unable to keep up with multiple proposal audits regardless of whether they are for CDA proposals or other type proposals. Along this same line of thought is the difference in DCMA oversight on FAR 12 versus FAR 15 contracts. One industry source estimated it takes 25% or more time to complete individual tasks on a FAR 15 contract than a FAR 12 simply due to the "waiting periods" for DCMA to inspect work progress and quality procedures (cited NASA and Navy contracts for the same products/services). This same contractor also noted that their USAF customer asks DCMA to do a GFR audit annually while the same Navy workload gets this audit only every three years. The lesson learned here is one of utilizing DCMA support in as efficient manner as possible.

In the commercial world it is imperative for companies in competitive markets to keep their product costs private since price competition is the primary key to long-term success. This principle is one of the major factors influencing a company's decision to forego certain CDA programs because they fear their internal product cost elements might be discovered by their competitors on the CDA contracts, copies of which can be obtained through the Freedom of Information Act. This situation could cause them to lose competitive advantage and market share they fear. Cost privacy is another reason that some CDA companies choose to pursue only commercial, FAR 12 type business. Several CDA manufacturers stated bluntly that FAR 12 business practices encourage internal cost frugality while FAR 15 practices encourage unnecessary cost increases.

Commercial pricing is often "market based"; that is, prices are based on business case analysis focused on achieving a profit objective for a projected level of sales coupled with projected sustainment revenue streams. Business case analyses always consider competitor's products and prices as well. One manufacturer noted that they sell a certain model of aircraft "at cost" just to undercut their competitors and/or to establish business relationships with certain buyers. If they ever make any profit on this particular product line it is in the sustainment phase only.

In the commercial market, customers make large down payments or significant front loaded progress payments to cover long lead items, materials, etc. The government desires to delay payments if not the entire price until aircraft delivery—all while not wanting to pay for financing of the program. As mentioned above, the government then wants to pay the same price as offered in the commercial market after increasing the manufacturers cost of production.

The use of Unpriced Change Orders, Letter Contracts, Provisioning Item Orders, etc) is a major source of irritation to industry sources. CDA programs are never funded with advance buy or long lead monies in congressional appropriations and Government buying offices often resort to using UCAs to save upfront time for getting contracts established on CDA programs. This practice drives industry to extra proposal costs and administrative efforts and often comes back to penalize industry's opportunity to earn profit when UCA costs have been mostly booked and recognized by the time negotiations occur, and they comprise much of the total program's costs.

One industry source provided an excellent example of the Government's inadvertent restriction of competition. The CDA source produced and sold CDA platforms to the Government on a commercial, fixed price basis. The Government then solicited bids under full and open competition rules for installation of additional, military unique equipment on these CDA platforms. Even after much discussion and disagreement the Government insisted on doing the installation work using a FAR Part 15 competition vice a FAR Part 12 contract competition. This decision caused the CDA OEM to forego the competition for the installation of additional equipment due to their inability to perform FAR 15 cost accounting and other mandated management practices. The CDA contractor in this example is convinced that the work could have been done as a fixed price, commercial effort but the Government office claimed to have been directed by "the Pentagon" to use FAR 15 procedures and rules for the installation program. This



same CDA contractor also asserts that they have refused to bid on other Government CDA programs utilizing FAR 15 rules even when they have been convinced that they have a CDA product superior to all others for a given requirement.

Another irritant to industry caused by the use of FAR 15 procedures for CDA products is the necessity to incur internal costs not normally incurred on a FAR 12 contract. For instance, costs associated with IR&D, B&P, UID, specialty metals, and socio-economic programs, plus profit on these costs, must be added to the price of a CDA sold under FAR 15 rules in most DCMA approved accounting systems. Additional contracting and financial employees, sometimes over twice as many for FAR 15 as for FAR 12, was cited by one source. These costs are usually not added to the cost of the same product sold under commercial rules.

Balancing this concern, for at least one industry source, is the notion that being equipped to operate under either FAR 15 or FAR 12 rules enables a CDA contractor to better gauge the risks associated with any individual transaction. That is, under a FAR 12 contract the CDA contractor assumes 100% of the cost and performance risk but under a FAR 15 contract the Government usually shares a portion of the risk for cost, schedule and performance. Being experienced in both arenas creates a business maturity that is valuable to both the contractor and its Government customer, at least in one vendor's view.

U.S. laws governing the export of products to foreign countries can have a very serious and negative impact on CDA products when "technology transfer" issues may apply. For instance, a U.S. manufacturer can sell its commercial products internationally complying with one set of rules but if the same product is sold as a CDA, with military applications, a different set of rules applies. In essence, the Department of Commerce governs commercial transactions and the Department of State governs CDA and military transactions with foreign countries. In the worst case, these differences in U.S. legal restrictions can drive the necessity for separate production lines and separate product management systems for essentially the same product. This condition obviously causes higher costs for both the purely commercial product as well as the CDA product and is a source of concern for CDA companies.

## **Logistics and Sustainment Inputs**

The decision to support and sustain any military system via either commercial practices or in-house depot capabilities, or some combination of the two, is always a major acquisition program issue. This decision process applies to CDA programs of course, but the facts underlying and influencing this decision are, or should be, very different for CDA programs. First of all, CDA products by definition have an existing logistics support structure serving the commercial customer base. The commercial production line guarantees parts availability to commercial and CDA customers alike and greatly simplifies the CDA user's logistics planning. All industry participants in this study agreed that utilization of existing commercial supply and maintenance infrastructures is far more responsive and far less costly than trying to support a CDA system within the government depot infrastructure. This opinion was consistent

regardless of whether the CDA contractors provide support services or not. Some CDA manufacturers have established hundreds of certified supply points and maintenance hubs around the world in response to huge international business base demands and parts and services are available within hours at nearly any location world-wide. Commercial parts certification and tracking systems are an additional benefit received from the CDA supplier(s).

All of the CDA suppliers we interviewed for this study have a consistent approach to release of their technical data. That is, they provide commercial manuals for operations and maintenance of their products to all customers but are always extremely reluctant to provide product specifications and drawings of their products, which they deem to be commercially developed and produced. This is the commercial “standard practice”. However, some Government offices demand specifications and drawings for CDA systems and this practice almost always creates disagreement and conflict. CDA suppliers understandably want to be assured of future business in the sale of their proprietary products and can be counted upon to rebel against surrendering their technical data in the fear that their competitors might be enabled to produce the same products. The Government wants to expand competition in all cases and attempts to obtain rights to CDA contractor technical data as a means to create follow-on competition and avoid “sole source” buying situations. Case by case resolution of this recurring dilemma is always necessary. Most industry sources we interviewed believe the Government wastes lots of money and time buying technical data they think they need to do organic support and never use most of it beyond the commercial manual level.

Commercial industry, along with their historic commercial customers (airlines and others), has pioneered many of the support techniques the Government has come to label “Performance Based Logistics” or PBL. Power-by-the-hour charging for aircraft and engine support of all types is one of many commercial industry inventions adopted by Government PBL advocates. Once a commercial platform achieves a certain level of service in the field, a support provider can calculate and continually refine the optimal maintenance scheduling and parts replacement program necessary for a specified level of operations. Commercial maintenance tracking systems are a key factor in this process. The U.S. Army, on several of their CDA platforms, relies on the CDA contractor’s maintenance tracking and parts tracking systems to achieve optimal logistics support. New CDA programs should carefully plan for the most efficient logistics support obtainable and that planning must address the proven capabilities industry provides.

## **Industry Recap**

CDA programs will very likely outnumber new development aircraft programs by a large margin for the foreseeable future just as they have in the past. They have proven to be less costly and much more rapidly fielded than new aircraft development programs. The CDA industry, though smaller than in previous decades, remains robust and able to generate true competition for most CDA program initiatives. In fact, the CDA industry is simply a reflection of the overall U.S. commercial aircraft industry, one of the few sectors of the U.S. economy which annually reports a positive balance of trade position.

Because CDAs are founded on commercial platforms they come with a supporting infrastructure which, one must remember, includes the FAA's capabilities and services, in addition to each company's supply and support systems. Government program managers should always attempt to be aware of, and utilize, existing commercial capabilities in their planning and execution of CDA programs. Additionally, when competition is strong, Government CDA programs should rely on commercial contracting methods and procedures. This practice, in industry's view, not only saves time and money but it enables broader levels of industry participation in CDA programs.

Government CDA programs should be staffed with experienced and highly qualified managers and technical specialists. Industry observes that, in many cases, the best and brightest of the Government's acquisition and technical personnel resources are not assigned to CDA programs and this has often led to myriad difficulties in communication, requirements definition, responsiveness, day-to-day management interface and trust. Knowing the "realm of the doable" and the "differences" in CDA programs, and managing confidently, form the hallmark of strong Government management and leadership, a condition the CDA industry always hopes for but finds only infrequently.

## Industry Questionnaire

1. In which CDA programs have you participated with the Department of Defense? Note whether each was competitive or non-competitive and the approximate time frame.
2. Describe your ‘Bottom Line’ experiences with CDA programs to meet military mission requirements (i.e., good, bad, ugly). Why does your company choose to participate in this business sector?
3. What things could the Government Buying Offices have done that they failed to do which would have aided your participation in military CDA programs?
4. What things did the Government Buying Offices do that were beneficial to your participation? Harmful to your participation?
5. Which military services and or commands are the easiest to work with? Why?
6. What FAA involvement has been part of your military CDA program experiences? Describe FAA interfaces and any noteworthy problems or successes?
7. Was CDA system sustainment in any way a part of the basic CDA program? What were the sustainment features: government organic, contractor support, other?
8. What military CDA sustainment program lessons learned have you developed?
9. What is your company’s policy on the granting (or not) of rights in technical data and computer software documentation to government customers? Provide examples if possible.
10. In your experience, did the military CDA program’s requirements remain stable? Describe any facts bearing on requirements changes.
11. What entity or participant is best qualified to perform system integration on military CDA platforms? Why?
12. What are the true advantages to proposing and contracting via commercial rules (FAR 12) vice Competitive Negotiated Rules (FAR 15)? Where are the cost savings, performance and schedule advantage.
13. Do you spend IR&D money to develop capabilities pertaining to military CDA programs? Why? Any examples?
14. Do you have an estimate of how many additional resources (\$\$, manpower, etc) are needed to execute a military program vice a commercial program—or is this a myth?
15. As best you can determine, what is your forecast for the commercial, military and CDA markets over the next ten years?

## Part Five

# Did We Pay Attention and Learn Something?





## Chapter Twelve

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### Lesson Learned

*“An accident investigation hearing is conducted by non-flying experts who need six months to itemize all the mistakes made by a crew in the six minutes it has to do anything.”*

— Anonymous

**One of the best kept secrets in the Department of Defense** is that we already have all the acquisition answers hidden away—in something similar to Vice President Al Gore’s lock box.<sup>129</sup> It must be true since we have been doing annual acquisition studies, blue ribbon panels, reviews, GAO investigations, CBO studies, RAND studies and dozens of others over the past forty years. Each comes out with a lengthy list of lessons learned and recommendations. More surprising is that you can take studies from each decade and compare them; they all seem to offer the same recommendations and lessons learned. And what do they tell us? Pretty much programs get in to trouble when they push technology, have requirements instability and suffer program instability (normally seen as funding instability).

Armed with this information and insight, we charged into our literature search and interviews expecting to find virgin territory, fresh solutions and new insights. What we found were thirty years worth of studies with lengthy lists of lessons learned along with a current list of active CDA programs with some in deep trouble. Obviously these program managers missed the memo to read the lessons learned or to take the acquisition training! Actually, that’s not true. These program managers and senior leaders are some of the brightest, best educated members of the DOD and contractor workforce. We expect they can quote the lessons learned by verse and chapter.

So how come we still get bad outcomes with all of this great advice showing us the way? In this case CDA programs are no different than their traditional acquisition cousins—we get distracted and compromised and don’t follow the overwhelming mountain of lessons learned. We are distracted by the contradictory incentive structures within the CDA playing field. The lessons learned provide a basic structure and sequence for developing CDA programs that if followed produce a low risk program. Yet, every program manager believes that they don’t apply to them in all cases and that their program is “special.” So why do we not follow the rules?

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<sup>129</sup> In the 2000 presidential debates, Vice President Al Gore commented that he would put “Social Security in a lock box” to secure its future.

- The user community sees requirements as dynamic and constantly changing, so why shouldn't the weapon system that they are buying be appropriately flexible? The requirements end of the acquisition cycle is not connected to the development/production end.
- Congress exists to satisfy its constituents and does so through wealth transfers in a variety of forms—one of which is to buy products from congressional districts. As the makeup of Congress changes and politics change, the popularity and desire for specific weapons also change. The net result is a constant dynamic of funding instability.
- The contractors are forced to compete in a dynamic defense market with decreasing budgets and decreasing opportunities to compete. This encourages them to propose unrealistic costs and schedules.
- The program manager is not always fully in charge. Much like a toddler in a car seat with a fake steering wheel, he/she may turn it in the right direction, but the system has often disconnected the wheel.
- Last but not least, the DOD bureaucracy imposes additional burdens and hurdles that usually add little value to the process.

Thus, you can't really fix CDA or normal acquisition until you force all participants to play by the rules. This won't likely happen since all have very different incentive structures and functions that they all are attempting to optimize. From a math viewpoint, we are trying to optimize across a large number of local maximums, but essentially eliminating the possibility of a global maximum due to multiple, crushing constraints. This begs the final question—if we follow the lessons learned and produce a CDA on schedule and cost with fixed requirements—would anyone be happy?

## **The Lessons Learned**

We have gathered a long list of lessons learned from our interviews and extensive literature search. We have summarized the most important and focused primarily on those that address commercial derivative aircraft. We have kept to our previous functional approach and will list them accordingly.

### **Program Initiation Lessons Learned**

*(Statutes and regulations, user requirements, market research, acquisition strategy, analysis of alternatives, concept development, risk management)*

- Commercial aircraft (especially large aircraft) are optimized for a single mission to produce revenue at the lowest possible cost—so they have little excess performance margins. This means they do not have excess structure, redundancy or capability beyond that needed for their mission—they are not overbuilt. Military requirements may be quite different and broad, thus requiring extensive modifications. The program needs to do extensive analysis of the total military



requirements prior to choosing a commercial airframe. Requirements are often compromised to meet budget and schedule, so you can rarely have everything you want.<sup>130</sup>

- CDA's are attractive because of the promise of short schedules and lower cost—extensive program management resources, time, and experience will be needed to maintain both. You can't make cost and schedule if you don't build what you originally bought.<sup>131</sup>
- Successful program managers use their knowledge of the commercial marketplace to structure operational requirements so that commercial items can meet military needs.
- The buying organization must perform risk analyses to ensure that the DOD has accounted for all possible risks in the acquisition, support, and life-cycle management of the commercial system.
- While many CDAs involve post-production modification, it should not be assumed that these programs should always be managed out of the DOD depots. Most programs (even simple-sounding VIP aircraft) require extensive interaction with Congress, higher headquarters, corporate lawyers, and corporate sales as well complex acquisition strategies. The staffs at DOD acquisition centers are far more qualified and experienced in these types of programs.<sup>132</sup> At the same time, the acquisition center staffs may not have the training or experience to handle all of the product support implications. The decision on where to manage the program must be an integrated decision. Based on our interviews, neither staffs have the proper training in CDA acquisition and sustainment support.
- The program manager must do market research to determine total system operation and system supports costs and effectiveness. They need to determine compliance with open system architecture standards and support in the commercial maintenance system. A key consideration is if the hardware/system will be able to participate in future system modifications and if the system suppliers will be able to provide long term support.
- Where possible, candidate systems should be tested in the environment in which they will operate. Any performance claims for a system based on future modifications should be heavily discounted for risk.
- Program management must seriously consider the long term impacts of not having full access to system data (design, production or test) as it will impact maintenance, modification and operational costs.

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<sup>130</sup> Former USAF PEO

<sup>131</sup> Former USAF PEO

<sup>132</sup> Several suggested that CDAs start at the product centers and then move to the depots once attaining IOC.

- Program management must appreciate that CDA source selections can be fundamentally different and much more difficult than traditional clean-sheet development program source selections. Program management must fully understand the competitors prior to developing a detailed evaluation model, data call and evaluation plan which will become Sections L&M. These should be thoroughly vetted, dry run and then shared with the offerors.
- Different source selection criteria are needed for CDAs candidates vice traditional government developed aircraft. CDA programs should be heavily weighted toward operational demonstrations to verify system achievement of requirements.<sup>133</sup>
- Program teams should reevaluate government requirements if they limit competition to only one or two competitors or drive competition away.
- Government program managers and staff must understand that profit is the reason that companies make large investments in research and development which create the commercial aircraft in the first place. These profits reimburse the companies for their research and development programs and encourage them to make future investments. As long as the government gets the best market price in a competitive environment, then the profit should be of lesser interest to the government. The key point is the government should maximize competition and minimize government interference and oversight.

## **Programmatic Lessons Learned**

*(Program organization, personnel qualifications, acquisition planning and scheduling, LCC, funding, source selection, contracting, oversight [governance])*

- CDA program offices in the Air Force tend to be lightly manned, so it is critical to staff them with experience acquisition personnel. The team needs experience in development of major programs plus insight and experience into the commercial industry practices.
- The need to understand commercial practices and manufacturing is key to CDA success. DOD functional managers and leadership must learn to act commercially and improve their understanding of commercial practices. This is prime example of where EWI programs would be incredibly valuable.
- DOD organizations must understand that CDAs are different and require a different skill set than normal acquisition programs.
- Program offices need to invest in training/education for their teams for upcoming CDA source selections and reviews as well as the day to day operations. CDA

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<sup>133</sup> “Lessons Learned Applying Commercial Off the Shelf Products,” by Lisa Brownsword and Patrick Place, COTS-Based Systems Initiative, CMU/SEI-99-TN-015, June 2000.

- experience is rare in DOD, so training is a must. DoD needs to develop a rigorous airworthiness training program.
- The program office should require full reliability and maintainability of the commercial fleet as part of the source selection evaluation.
  - Data Rights is a very touchy issue for OEMs which makes them cautious about sharing proprietary data with their customers—especially the military. The OEMs normally only provide sufficient data to operate and maintain the system safely—not to replicate the systems (second sourcing) or to support heavy maintenance. Thus the commercial documentation may not be as complete as required for standard military technical orders or documentation. Whenever possible, the DOD should use the commercial documentation for training and maintenance. However, the government does need to purchase all data necessary to support their unique modifications and to make future modifications in these areas.
  - The acquisition of the green aircraft should be done under FAR 12 using commercial practices to the maximum extent.

## **Development Lessons Learned**

*(Technical requirements, specifications and standards, SE&I, test, airworthiness certification, configuration management, data rights)*

- Most commercial aircraft are updated on a regular basis employing open architecture designs. DOD needs to consider how their modifications and use impact DOD's ability to take advantage of these upgrades.
- Don't believe that the military modifications of a CDA will be easier than a full up development program. Early on, a clean sheet aircraft's design can be adjusted to meet mission or mission equipment requirements. With a CDA, one is always constrained by the green aircraft configuration.
- Users should develop requirements that take maximum advantage of commercial items with previous commercial and FAA testing. The program office and selection team must understand the commercial test environment.
- The RFP should require the offers to explain how their past test plan supports the new program and what additional testing would be required. The government must share their test requirements and plan with the commercial offerors.
- Carefully chosen CDA aircraft can take advantage of FAA systems for design approval (type certification), production approvals, maintenance, and operational aspects.
- The acquisition strategy plan should consider testing of the green aircraft (or major subsystem) as part of the source selection evaluation. As a minimum, OEMs should be required to demonstrate/test their green aircraft to published operational performance.

## **Production Lessons Learned**

*(Facilities, quality, subcontractors)*

- Program offices and users need to consider how their changes will impact the cost, schedule and risk of problems as changes are made to the green aircraft while in the commercial facility (or post delivery). The government must provide detailed requirements and allow the offerors to study, analyze, engineer and propose optimal solutions that will minimize schedule and costs. This would include doing modification on the commercial provider's line or performing them post production.
- Generally, commercial equipment used in military aircraft exhibits a significantly lower Mean-Time-Between-Failure (MTBF) in military service when compared to the MTBF in commercial airline service.<sup>134</sup>

## **Performance and Testing Lessons Learned**

- Commercial systems are only tested to meet FAA requirements which may be narrowly focused areas of performance. While commercial systems may exceed FAA standards or commercial requirements, they may also have been optimized to only meet a very narrow performance band.
- Commercial systems must be test to validate contractor claims.
- After production and/or modification, it is very expensive and time consuming to modify the systems to provide additional capability.

## **Sustainment Lessons Learned**

*(ILS strategy, source of repair, supply chain management, sustainment organization)*

- Since most CDA systems are bought after the commercial aircraft has reached steady state or maturity, the program office should consider life cycle logistical support as a high risk area. The source selection team needs to evaluate and verify that the commercial part suppliers' support is longer than the anticipated life-cycle. This needs to be a major element in the Section M evaluation criteria.
  - There is a higher risk of parts or systems obsolescence on CDAs and COTS parts than on new development. Commercial suppliers with large commercial business bases are more likely to upgrade or redesign their systems—maintaining open architecture with the commercial design in essential.

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<sup>134</sup> "Use of Commercial Off the Shelf Equipment in Military Aircraft," PMC-76, AD-AO33 818, May 1976.

- Commercial Logistics Support is often the cheapest and most efficient way to support a fleet of CDAs that maintain a high degree of commonality with their base commercial fleet.
  - Leverages fleet buys of spare parts and supply chain
  - Allows upgrades to changing commercial standards (reduces or eliminates obsolescence problems).
- The government must consider options to ensure technical data will be available throughout the program life for sustainment. This might take the form of third parties holding the data in escrow.
- DOD needs to educate personnel in advance either through short, long term or just-in-time education program on issues relating to CDA programs.
- When possible use OEM parts since secondary parts will need to be thoroughly tested to validate claims.
- The program office and users must consider the cost of departing from the commercial baseline configuration. The ability to use commercial maintenance facilities, supplies and sources is a major cost savings.
- The program office must consider how they will handle product improvements and upgrades made available to the commercial customers. Failure to participate may leave the government with an orphan system.
- The DOD must consider the full cost of the operations support and sustainment systems especially when replacing traditional military developed system using government sustainment with a CDA.
- There are significant savings through participation in commercial supply chain and major subsystem maintenance using commercial sources. Traditional logistics with the DLA and depots can be significantly more expensive than commercial savings from economy of scope and scale.
  - Potential parts pooling provides a quick turn around and maximizes aircraft availability while minimizing spares investment.
  - Leverages extensive and experienced commercial maintenance facilities that reduce capital investment to DOD.



## Chapter Thirteen

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### What Does the Future Hold?

*“The airplane stays up because it doesn’t have time to fall.”*

*--Orville Wright*

### Successful Integration?

Readers of this book who made it this far are probably a little confused, if not slightly disturbed about the military and CDAs. The book title starts with “Successful” but the track record of late and the acquisition environment appears to suggest otherwise. This book was never intended to be a propaganda piece about preference for CDAs, with rosy stories and examples of all their successes in the military. Rather, it is meant to be a straight-forward presentation of what commercial derivatives can offer the military, guides on how to select, acquire and use CDAs, and a balanced discussion of CDA program successes and failures and the lessons learned along the way.

DOD programs are rarely textbook examples of perfect policy execution where all the facts and data are available at the outset to determine requirements, designs, mission needs and then produce, deploy and operate systems according to some original plan. Instead, programs are a mixture of politics, mission needs, budgetary constraints, timing, and sometimes just good or bad luck. If the depots are full, then a new program may get to go CLS and leverage the CDA commercial market. If the depots have excess capacity and a strong congressional caucus interest, then CDAs are likely to go organic and miss out on some potential savings.

As mentioned in the previous chapter on lessons learned, the biggest problem we have encountered in the past is that we don’t follow the rules. Whether for good or bad reasons, we ignore the basic rules of CDAs, which are repeated here:<sup>135</sup>

- Pick a commercial system that meets the military requirements.
- Understand that the commercial systems may have been built to operate in a totally different environment than that envisioned by the military operators.
- If there is a mismatch between the military requirements and the commercial capability, change the requirement whenever possible.
- Understand at what point of the commercial product lifecycle the procurement will occur and what benefits or challenges will be encountered during the product support phase

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<sup>135</sup> To the technical writers and English majors, the repetition of these rule is intentional.

- Only minor changes should be allowed, since cost, risk and schedule delays increase exponentially with changes.
- All of the same lessons learned for traditional DoD acquisition programs apply—funding stability, no requirements creep, and requiring high technology readiness levels.

## **Future Programs and the Challenge to DoD**

As of this writing, the USAF has just awarded one of its largest contracts in history for a commercial derivative aircraft—the Boeing KC-46 tanker—a modified version of the Boeing 767 that is at the end of its commercial production run. This program will likely have a total lifetime acquisition value in excess of \$100B. The USAF is also planning on replacing the 1960's era T-38 advanced trainer with a new, off the shelf trainer during this decade—a yet to be proposed version of a military derivative aircraft will be the ultimate winner. The Navy and USAF are both getting ready to begin major competitions to buy CDA helicopters for the Presidential, rescue, and missile surveillance missions—all together totaling many billions in LCC. All totaled, these programs represent up to a trillion dollars in life cycle costs over the next half century. All are expected to be CDA purchases and all have the opportunity upfront to leverage CDA LCC savings if the services choose to go that route and do it efficiently.

So what does the future hold? While there is a detailed business case analysis (BCA) process required to be performed for these future programs, it seems unlikely that these BCAs will provide the key evidence that will allow these future programs to leverage CDA cost savings and efficiencies due to political pressures and reliance on business-as-usual practices. The DoD workforce is not trained in, or possibly not cognizant of, all CDA issues that should be vetted in these required BCAs. Rather, since life cycle costs and performance are often only minor elements in the real life program decisions, and since past is often prologue, CDA opportunities will usually take a back seat to politics, industrial base issues and business-as-usual strategies.

We believe that progress can be made but it will require several changes to the DoD CDA mindset and approach:

1. When vetting acquisition strategies, the use or exclusion decision regarding CDAs must include all life cycle costs and benefits.
2. BCAs for CDA programs must consider full CLS options regardless of the politics of depot core capabilities and 50:50.
3. DoD must invest in CDA acquisition education and training as well as identification and tracking of qualified CDA acquisition and sustainment personnel that are needed to plan, strategize, manage and execute these programs.







## Appendix A: Glossary

<b>ACAT</b>	Acquisition Categories
<b>AD</b>	Airworthiness Directive
<b>AETC</b>	Air Education Training Command
<b>AFIT</b>	Air Force Institute of Technology
<b>AFMC</b>	Air Force Material Command
<b>AFOTEC</b>	Air Force Operational Test & Evaluation Center
<b>AFSC</b>	Air Force Systems Command
<b>ALC</b>	Air Logistics Center
<b>ASC</b>	Aeronautical Systems Command
<b>ATC</b>	Air Training Command
<b>AWACS</b>	Airborne Warning and Control System
<b>BAR</b>	Broad Area Review
<b>BASA</b>	Bilateral Aviation Safety Agreements
<b>C/SCSC</b>	Cost and Schedule Control Systems Concepts
<b>CAA</b>	Civil Aeronautics Authority
<b>CAIG</b>	Cost Analysis Improvement Group
<b>CAS</b>	Cost Accounting Standards
<b>CDA</b>	Commercial Derivative Aircraft
<b>CIP</b>	Component Improvement Program
<b>CLS</b>	Commercial Logistics Support
<b>COI</b>	Critical Operational Issue
<b>COTS</b>	Commercial off the shelf
<b>CRAF</b>	Civil Reserve Air Fleet
<b>DAPP</b>	Defense Acquisition Pilot Program
<b>DOD</b>	Department of Defense
<b>DSB</b>	Defense Science Board
<b>EASA</b>	European Aviation Safety Agency
<b>EFS</b>	Enhanced Flight Screener
<b>EVMS</b>	Earned Value Management System
<b>EWI</b>	Education With Industry
<b>FAA</b>	Federal Aviation Administration
<b>FAR</b>	Federal Acquisition Regulations
<b>FASA</b>	Federal Acquisition Streamlining Act
<b>FMS</b>	Foreign Military Sales
<b>FOC</b>	Full Operational Capability
<b>FOT&amp;E</b>	Follow-On Test and Evaluation
<b>GAO</b>	General Accounting Office
<b>GFE</b>	Government Furnished Equipment
<b>HQ</b>	Headquarters
<b>ICS</b>	Initial Contractor Support
<b>IG</b>	Inspector General
<b>IOC</b>	Initial Operating Capability
<b>IP</b>	Instructor Pilot
<b>IW</b>	Irregular Warfare
<b>JCA</b>	Joint Cargo Aircraft
<b>JPATS</b>	Joint Primary Aircraft Training System
<b>JROC</b>	Joint Requirements Oversight Council
<b>JSTARS</b>	Joint Surveillance and Target Attack Radar System

<b>LM</b>	Lockheed Martin
<b>LUH</b>	Light Utility Helicopter
<b>MCA</b>	Military Certificate of Airworthiness
<b>MCO</b>	Military Certification Office
<b>mph</b>	miles per hour
<b>MTBF</b>	Mean Time Between Failure
<b>MTC</b>	Military Type Certificate
<b>NCA</b>	National Command Authority
<b>O&amp;S</b>	Operations and Support
<b>OEM</b>	Original Equipment Manufacturer
<b>ORD</b>	Operational Requirements Document
<b>OSD</b>	Office of the Secretary of Defense
<b>PM</b>	Program Manager
<b>PPCG</b>	Pilot Program Consulting Group
<b>PSM</b>	Program Support Manager
<b>PSSA</b>	Project Specific Service Agreement
<b>QOT&amp;E</b>	Qualification Operational Test & Evaluation
<b>QT&amp;E</b>	Qualification Test and Evaluation
<b>R&amp;D</b>	Research and Development
<b>RET</b>	Retired
<b>RFI</b>	Request for Information
<b>RFP</b>	Request for Proposal
<b>RMA</b>	Reliability, Maintainability and Availability
<b>ROC</b>	Required Operational Capability
<b>SAASM</b>	Selective Availability Anti-Spoofing Module
<b>SAC</b>	Strategic Air Command
<b>SAIC</b>	Scientific Applications International Corporation
<b>SAMP</b>	Single Acquisition Management Plan
<b>SHP</b>	Shaft Horsepower
<b>SSA</b>	Source Selection Authority
<b>STC</b>	Supplemental Type Certificate
<b>SUPT</b>	Specialized Undergraduate Pilot Training
<b>TACAMO</b>	Take Charge and Move Out
<b>TEP</b>	Total Evaluated Price
<b>TIMS</b>	Training Integrated Management System
<b>TINA</b>	Truth In Negotiations Act
<b>TLCC</b>	Total Life Cycle Cost
<b>TRL</b>	Technology Readiness Level
<b>TSO</b>	Technical Standard Order
<b>UPT</b>	Undergraduate Pilot Training
<b>US</b>	United States
<b>USAF</b>	United States Air Force
<b>USAFA</b>	United States Air Force Academy
<b>USC</b>	United States Code
<b>USN</b>	United States Navy
<b>VIP</b>	Very Important Person
<b>WPAFB</b>	Wright Patterson Air Force Base
<b>WWII</b>	World War II



# ACQUISITION EXCELLENCE

## **SUCCESSFUL INTEGRATION OF COMMERCIAL SYSTEMS**



The **Successful Integration of Commercial Systems** is based on the study of Commercial Derivative Weapon Systems that was produced by PE Systems and Dayton Aerospace, Inc. This study looks at the historical record of how DOD tries to meet its warfighter requirements with off the shelf systems. The team interviewed over fifty leading experts in this field to come up with best lessons learned and recommendations to guide future DOD program managers of **Commercial System Integration**.

*Based On  
The USAF Study of  
Commercial Derivative Weapon Systems*

Stockman, Ross, Bongiovi and Sparks