ADAPTING COMMERCIAL AIRCRAFT DESIGNS TO MEET EXISTING AND FUTURE MILITARY AIRCRAFT REQUIREMENTS

A COST-EFFECTIVE DESIGN APPROACH TO MEET MILITARY AIRCRAFT REQUIREMENTS IN AN AUSTERE FISCAL ENVIRONMENT

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ABSTRACT

In an austere fiscal environment, such as many national defense ministries are currently facing, it may be imperative to achieve a more cost-effective design solution for military combat support and transport/logistics-type aircraft. For these specific military operational requirements, it may be entirely suitable to procure and/or modify existing commercial aircraft specifically tailored to meet such requirements. This paper discusses the decision process relating to and impacts of military jet aircraft design and development versus procurement and modification of existing commercial jet aircraft. The military acquisition process and approach to aircraft design requirements, modifications, mission system integration, and certification and testing are addressed. Considerable attention is directed toward compliance with specifications and federal regulations to achieve successful aircraft design, modifications, and flight certification through either the military or civil aircraft certification process. Examples are provided of successful military jet aircraft programs which have adapted commercial aircraft designs to meet military aircraft requirements. A listing of current or future medium- and long-range commercial jet aircraft which offer potential for military mission application is also provided.

I. INTRODUCTION

Over the past twenty years the cost and sophistication of military aircraft weapons systems development and production have increased manyfold. Today, a complex military fighter aircraft, such as the F/A-18 Hornet, developed by McDonnell Douglas, or the Tornado, developed by Panavia, a NATO consortium, can literally cost billions of dollars to develop and manufacture. It is recognized that front-line combat aircraft require specific design characteristics that make these weapons systems fully capable and survivable in a combat environment. These specific military design requirements often result in detailed military specifications (commonly called MIL-SPECs) which significantly increase the scope, cost and complexity of aircraft systems design.

Many military aircraft operational mission requirements, however, do not mandate complete use of MIL-SPEC design methods; hence, less rigid, less costly commercial equivalent or similar design specifications may be entirely suitable to satisfy these mission requirements. Examples of such military aircraft missions could include transport and logistics support, aerial refueling, and other combat support missions such as airborne early warning, command and control, battlefield surveillance and electronic warfare.

To meet these operational mission requirements, it may be entirely suitable, and certainly cost-effective, to adapt existing commercial aircraft and avionics system designs to the maximum extent possible; and in some cases, even tailor or modify military specification requirements to meet similar, existing commercial specifications. In those critical areas such as safety-of-flight, aircraft combat survivability, or critical mission system design, it may be necessary to retain full military specifications; but, in many other areas, including overall aircraft structural design, it may be possible to use existing commercial aircraft and their associated subsystems at a substantial cost savings over the design and development of an entirely new aircraft weapons system to full military specifications.

Over the past ten years, several U.S. military aircraft programs have successfully adapted existing commercial aircraft to meet specific military operational mission requirements. Examples include military derivatives of the Boeing 707 transport aircraft, such as the E-3 AWACS, the E-6 TACAMO, and the E-8 JSTARS. Other examples of adapted McDonnell Douglas commercial aircraft include the DC-10 to U.S. Air Force KC-10 tanker conversion, the U.S. Navy C-9B transport and logistics support version of the DC-9, and the EC-24 electronic warfare conversion of the DC-8. Each of these programs has achieved considerable cost savings by adapting an existing commercial aircraft design in lieu of designing and developing a new aircraft.

II. AIRCRAFT DESIGN REQUIREMENTS

The aircraft design and development process is lengthy and expensive, often taking 10-15 years to develop and successfully test an aircraft design at costs involving hundreds of millions of dollars. To avoid these extensive research, development, test, and evaluation (RDT&E) costs, it is much more cost effective to adapt existing aircraft designs or even to directly procure existing aircraft with few or no modifications to meet military operational requirements. The direct procurement versus design and development decision is made by government acquisition agencies based on many factors--but most importantly, the military operational suitability and, of course, affordability.

Military Operational Requirements. Military operational requirements may dictate a unique mission performance capability or operational mission scenario that no aircraft can currently achieve, so a new aircraft must be designed and developed to meet this operational requirement. For example,

a unique mission might require a jet fighter aircraft to launch from Great Britain, fly a 2000 nmi mission into the Norwegian Sea, make a supersonic dash intercept at Mach 2.5-3.0, fire air-to-air weapons at an aerial target, and return to home base. Without several refuelings no existing free-world fighter aircraft could meet this demanding requirement, and most could not conduct a supersonic intercept at speeds greater than Mach 2.5.

Hence, a new fighter aircraft would have to be developed, with high-performance, fuel-efficient engines, and designed with aerial refueling capability or built large enough to carry sufficient internal fuel for a 2000 nmi range mission capability. These operational requirements become design constraints and literally "size" the aircraft design. When the Ministry of Defense (MoD) scopes the cost of this development program to perhaps 750 million dollars for aircraft RDT&E, 400 million dollars for engine RDT&E, and 5,500 million dollars for production of 100 of such fighter aircraft, the MoD may, after considerable study, analysis, and deliberation, decide to reduce the supersonic intercept speed requirement to Mach 2.0 or less, accept aerial refueling in lieu of a larger, new aircraft, or even reduce the range requirement to one that existing fighter aircraft could meet to save over one billion dollars in development costs.

This portrays an extreme example for a high performance aircraft to meet a demanding operational mission requirement. Yet, less demanding operational requirements for transport, utility, or combat support aircraft can often be nearly or totally met by existing commercial aircraft designs, offering the potential for savings of hundreds of millions of dollars in RDT&E costs.

Develop vs Buy Decision Factors. The government decision to procure existing military or commercial aircraft "off-the-shelf", modify existing commercial aircraft to meet military requirements, or to design and develop a new aircraft to meet demanding or unique mission requirements is a complex one and will be based on a variety of factors including:

- Affordability
  - -RDT&E costs
  - -Procurement costs
  - -Life cycle operations and maintenance (O&M) costs to include all logistic support costs
- Operational requirements
- Military suitability (ability of design to meet requirements)
- Military vs civil design standards
- Military vs civil flight demonstration and test
- Military vs civil flight certification
- Military standardization and interoperability
- Procurement quantity of buy
- Supportability and logistics
- Reliability and maintainability

These factors must be prioritized by MoD procurement officers and develop vs buy decisions made will be weighted based on these priorities--with affordability based on cost often being the dominant consideration, especially in periods of austere military budgets. Note that as these factors are prioritized, affordability and cost are likely to outweigh other criteria. However, military vs civil design standards, certification and testing decisions, standardization, and interoperability must also weigh heavily in the decision process because they strongly influence the develop vs buy decision as well as cost.

Military Specifications. Military air operations are unique and sufficiently demanding that military aircraft require specific or unique requirements be imposed on the design. For example, military aircraft that take-off and land on aircraft carriers (other than vertically) must have specially designed structure, increased structural strength to accommodate these demanding and recurring take-off/landing loads. Such demanding design requirements result in the imposition of specific and detailed military design specifications (commonly called MIL-SPECs), which may significantly increase the scope, complexity, testing requirements, and cost of a military aircraft system design. These MIL-SPECs include design methods, standards, data and procedural requirements, and specific compliance instructions.

Many military aircraft operational and mission requirements, however, do not mandate complete use of MIL-SPEC design methods. It may be entirely suitable and acceptable that certain MIL-SPEC design methods or standards be relaxed or deleted altogether, especially if their purpose is not required in the design to achieve an added level of performance or capability. Many words have been written, lectures given, and government procurement officers reprimanded on the subjects of over-specification and over-design, with attendant cost and schedule overruns. But the root cause can usually be traced to the original requirements for design specification and the degree to which the specifications were tailored to meet or allow for specific operational and mission requirements.

Specification Tailoring. Specification tailoring is a laborious process in most government procurement agencies because a complete (standard) type aircraft specification is initially imposed as a comprehensive set of MIL-SPECs and design standards, and only through many deliberations and meetings can agreement be reached on what degree of modification, tailoring, or deletion of these design standards can be allowed. A different approach is to start with a lesser group of safety critical and mission performance specifications and add only those additional specifications to meet special or unique operational requirements. This latter approach has met with some level of success in development and procurement of military electronics and computer equipment; but where personnel lives are at risk in military aircraft, conservative designers, engineers, and procurement managers have always decided in favor of excessive specification when necessary to achieve performance, reliability, and ultimately--safety.

As defense costs continue to skyrocket and fewer defense weapons systems are developed and procured, with declining defense budgets, each procurement agency must make hard decisions about the issue of specifications--and the degree to which demanding and costly MIL-SPECs will be imposed.

One obvious place to start in the aircraft design field is with unmanned air vehicles (UAVs). Here the operational and mission requirements may not be as severe as for a manned aircraft, and high levels of survivability are not expected. In

fact, in some cases, UAVs are designed to be expendable, so imposition of a comprehensive set of MIL-SPECs is unwarranted. The best UAV designers are often model airplane hobbyists who have experience working with simple, lightweight materials and know how to effectively utilize off-the-shelf commercial designs to minimize costs. Here is a simple example of employing existing designs with minimum or no requirement for MIL-SPECs while still achieving military requirements.

Commercial Aircraft Suitability. In the area of manned military aircraft, it may be entirely suitable to employ existing commercial aircraft or modify them for such military mission roles as: transport and logistics support, training, utility, and combat support roles such as airborne early warning; command, control, and communications (C^3); battlefield surveillance; electronic warfare (EW); and aerial refueling. In most of these mission roles, aircraft performance requirements are often based on cargo- or passenger-carrying capacity, long range and endurance, high subsonic speeds, reliability and ease of maintenance. In each of these cases, large commercial cargo or transport aircraft such as the Boeing 707 or McDonnell Douglas DC-8 have been proven entirely suitable for such mission roles.

The classic case involves the Boeing 707. It's prototype, Boeing designation 367-80, was designed and developed in the early 1950s to meet both commercial and military operational requirements for a new generation, transcontinental "jet stratoliner." Boeing built the first prototype aircraft on 16 million dollars of company funds because no commercial or military orders for such an aircraft had been received. Shortly after the 367-80 first flew successfully in July 1954, the U.S. Air Force placed the first order for KC-135 Stratotankers, an aerial refueling version of the 367-80 designated as the Boeing 717, and the jet age of military and commercial air transport was underway.[1] Since then, the Boeing 707/717/720 jet aircraft family has been the most successful and highly modified commercial aircraft design to be adapted for military use. A larger, stretched version of the B707 family, with newer engines, was designated the B707-320 series intercontinental aircraft, which was able to achieve over 5000 nmi range, unrefueled with a full payload.[2] This version was chosen by the military for VIP transport and as the baseline design for military aircraft such as the E-3, E-6, and E-8 which will be described in more detail later. The McDonnell Douglas DC-8 aircraft was developed shortly thereafter and also became very successful as a commercial passenger and cargo aircraft, but with less interest for military use. One successful example is the DC-8/54 conversion to an U.S. Navy EC-24 electronic warfare aircraft, modified by Chrysler Technologies Airborne Systems, previously known as Electrospace Systems Inc. (ESI).

Military vs Civil Design Philosophy. There is a basic difference in approach to aircraft design between military specifications and civil aircraft federal regulations, although the end product--the aircraft design and system engineering development process--are similar from the aircraft manufacturer's perspective. Fundamentally, military aircraft design specifications evolved over the years from experimental flight testing and flight mishaps (with a high mortality rate) to achieve a level of detailed specification of every aspect of the design, as found on current high performance military aircraft. Initially, a conceptual fighter aircraft preliminary design may be based on a loosely structured performance specification with little detail, but as the aircraft developmental design matures and is refined, draft design specifications are produced by the designer and provided to the procurement agency as contract deliverables for validation and testing of the aircraft. As a result of testing and modifications, these design specifications are refined and used to develop detailed design specifications from which a full-scale development flight model will be fabricated, assembled, and tested. Even with computer aided design/computer aided manufacturing (CAD/CAM), the design and development is still very much an iterative process between the developer and the military customer; and the design is continually refined until the customer is satisfied that the design will meet his requirements within the constraints of literally hundreds of imposed MIL-SPECs.

In contrast, the civil design approach is based on federal regulations, standards, and general design criteria, which guide the aircraft manufacturer, but do not impose the myriad of detailed design specifications that the military design process does. The commercial design approach allows the developer and manufacturer more flexibility in the design process. In the U.S.A. (as in other countries), the Federal Aviation Administration (FAA) monitors the design process and ensures compliance with Federal Aviation Regulations (FARs), type specifications, and other published design criteria, just as the military procurement agency would do utilizing military type specifications and MIL-SPECs. Despite these differences, military certification authorities may accept civil certification on commercial aircraft or give waivers or exceptions for areas not covered by civil regulations; conversely, civil certification authorities will not certify military aircraft unless they were originally designed to civil FAR standards and had obtained a civil airworthiness type certificate.

Most civil aviation authorities (such as the CAA, FAA, etc.) work closely with their national MoD aircraft design and certification authorities. In the U.S.A. the military services certification authorities have formal agreements with the FAA for military certification and acceptance of commercial transport aircraft and their associated design standards. The U.S. Air Force (USAF) has used and/or adapted commercial transport aircraft to meet military requirements for many years and has a standing USAF Regulation 80-36 which sets policy and responsibility for civil airworthiness standards for USAF transport aircraft. In this regulation, under general airworthiness standards, the USAF "conducts a continuing program toward a goal of common basic airworthiness standards for both civil and military transport aircraft." The USAF policy on transport design states that "transport aircraft that the USAF procures or develops must be designed to comply with civil airworthiness standards when their intended use is generally consistent with civil operations. This does not preclude using military specifications and standards in designing an aircraft when necessary to make sure that the aircraft performs its military role under intended operating conditions." This policy enables the USAF to: take advantage of lower development, production, and operating costs when using an existing civil aircraft design for military use; facilitate greater interchangeability of USAF and civil transport aircraft for maximum airlift capacity and flexibility in emergencies; and

improve USAF ability to dispose of surplus transport aircraft in the civil transport marketplace.[3] Similar agreements and national regulations exist for military coordination with civil aviation authorities in most nations with military air forces and commercial aircraft industries.

III. AIRCRAFT MODIFICATIONS

Modification Requirements. If civil transport aircraft are selected for military use, it is likely that some modifications will be necessary to meet all military requirements for the mission intended. Typical missions could include transport, logistics support, or training, as well as combat support roles, including airborne warning and control (AWACS), C^3, electronic warfare, and aerial refueling. In the first two cases, transport and logistics support, minimum modifications would likely be required, since the aircraft have already been designed for similar missions. The modifications could be as simple as refitting military radio communications or navigational equipment. In the case of training aircraft, the modification requirements would be based on the type of training to be conducted and the training environment to be duplicated. For a pilot flight training system, an entire cockpit redesign with new controls and displays could be required. In the final case of combat support aircraft, the addition of special mission equipment and extensive fuselage internal reconfiguration may be required. These detailed modifications must be specified by the procuring authority, and either military aviation depots or commercial overhaul/repair facilities will be selected to design and perform the aircraft modifications. The choice of civil versus military modification facility will also likely influence whether the aircraft retains civil certification or undergoes additional demonstrations and flight tests to meet military certification requirements.

Modification Procedures. The key decision in the modification process is to resolve whether the extent of design modification will result in a truly unique, military design which will require military certification or the modification is straightforward and can be conducted under civil design standards and certification.

If the civil design certification approach is taken, then liaison with the civil certification authority is required to verify that civil certification can be achieved. A commercial aircraft manufacturing or overhaul/repair facility will likely conduct the design and modification effort employing supplemental type certification (STC) procedures to maintain aircraft civil certification standards. One STC is normally submitted for each specific aircraft modification, so a significant set of modifications to an aircraft may require several STCs.

If military design certification is the approach selected, then a miliary aircraft depot or commercial aircraft manufacturing or overhaul/repair facility will undertake the design and modification effort. All subsequent responsibility for aircraft certification will rest with that military certification authority, especially if the aerodynamic flight characteristics or shape/structure are altered sufficiently to void the civil type certificates. In this case, the military certification authority must also determine necessary and sufficient flight demonstration and testing requirements to allow flight certification in accordance with military airworthiness and flight certification procedures. This will likely be more complex, time-consuming and costly than maintaining the aircraft under civil certification standards. However, since civil aviation authorities are normally unwilling to certify unique military designs that change the aerodynamic shape or flight characteristics, complex modifications such as adding an AWACS radar electronics system and external radome to a B707 to meet unique military mission requirements will usually result in a requirement for military flight testing and certification. Cases such as this involving extensive modifications to the basic aircraft are usually undertaken by the original aircraft manufacturer. In any case, close coordination with both military and civil certification authorities is required until a decision is made concerning the final certification authority.

Modification Costs. Within the constraints of adapting existing commercial aircraft to meet military operational mission requirements, the program acquisition strategy should evaluate not only procurement and aircraft modification costs, but also overall system life cycle costs. If the life cycle aircraft performance requirements are not overly demanding, it may even be suitable to consider procurement, refurbishment, and modification of used commercial aircraft to further reduce initial acquisition costs. Cost trade-off analyses must be conducted, however, to ensure that used aircraft higher O&M costs over the intended aircraft life cycle do not overrun lower initial used aircraft acquisition and modification costs. Based on the extent of design work, structural repair, reconfiguration, and modification required for system installation, the modification costs may be significant; but, compared to the cost of designing and developing a new aircraft to conduct this military mission requirement, the cost to adapt and modify an existing commercial aircraft should be less than 10-20% of the design and development costs for an entirely new aircraft mission system. In some cases, for straightforward modifications, the cost to adapt and modify an existing aircraft may be less than 1% of the new aircraft development costs.

IV. AIRCRAFT/MISSION SYSTEM INTEGRATION

Mission System Design. Mission system design will be specified by the military procurement authority based on the operational mission requirements. The mission system design must be optimized in weight, volume, power, and performance characteristics to the aircraft platform selected, and system integration concerns must be resolved prior to finalizing the design. Significant aircraft modifications or design changes to achieve mission system integration will require recertification and necessary demonstration and testing to revalidate the airworthiness of the aircraft to either civil or military standards. The decision process concerning civil vs military recertification was discussed in Section III, but it influences the design approach for system integration as well.

If civil certification is required, then all aircraft modification and redesign work must be accomplished by a certified aircraft manufacturer or overhaul/repair facility utilizing designated engineering representatives (DERs) or FAA personnel to oversee and approve the modifications. This is normally accomplished through the STC process discussed earlier. If military certification is required, then military specifications, design drawings, and interface control documents (ICDs) will be developed and approved by the

military design authority, as well as an overall demonstration and test plan for the modified aircraft. The modifications and mission system integration will be based on these approved designs and test procedures. In either case, the modified aircraft will require system demonstrations and testing and may require aerodynamic flight testing if weight and balance, flight control, propulsion, or other flight critical subsystems have been altered by the modifications.

Examples of successful major mission systems integration programs are shown in Table 1 in Section VI and include the Boeing/USAF E-3 AWACS, E-4 ABCP, E-8 JSTARS; the Boeing/USN E-6 TACAMO; and the ESI/USN EC-24 EW aircraft. Each of these programs has achieved considerable cost savings by adapting an existing commercial aircraft design in lieu of designing and developing a new military aircraft.

V. AIRCRAFT CERTIFICATION AND TESTING

Aircraft demonstration and test requirements to achieve flight airworthiness certification are also considerably different between the civil and military regulations, although there is considerable variance based on type aircraft and across individual national regulations as well. Therefore, the specific operational requirements must be carefully reviewed, the certification regulations followed, and the demonstration and test procedures complied with for each particular aircraft modification program.

Civil Inspection, Demonstration, and Testing. In the U.S.A. civil certification procedures are delineated in FAR, Part 21, which discusses type certificates, inspection and test requirements, production certificates, and issuance requirements for standard airworthiness certificates. FAR, Part 25, provides airworthiness standards for transport category aircraft and delineates flight performance requirements, controllability and maneuverability characteristics, flight maneuvers and gust loading conditions, equipment and subsystem requirements, and operating limitations.[4] These flight requirements, characteristics, and limitations define the operating limits which are then verified by analysis, comparison, demonstration, or test. FAA inspectors and DERs work closely with the aircraft design authority and manufacturer to determine necessary demonstration and test profiles for the type aircraft redesign or modification involved. These test profiles and procedures then form the basis for the aircraft inspection, demonstration, and flight test program.

Now that FAR, Part 36, has invoked noise control regulations, an airworthiness certificate will not be issued until compliance with applicable noise regulations has been shown. Currently, military certified aircraft are not required to comply with FAR, Part 36, procedures since the FARs are not binding regulations for military certification; however, military large transport and high performance jet aircraft are attempting to comply with local and national noise abatement procedures whenever possible to avoid public outcry and criticism.

Military Inspection, Demonstration, and Testing. In contrast, military aircraft system demonstration, test, and evaluation leading to military certification begins early in the aircraft system design process with the development and approval of a test and evaluation master plan (TEMP), which provides a master plan and schedule for all inspection, demonstration, and testing requirements based on system mission performance goals and design capabilities. As the design is refined or the performance goals are modified, the TEMP is updated to reflect the latest performance characteristics required from the aircraft. After the aircraft design is completed and a flight prototype built, the aircraft is thoroughly demonstrated and tested against these design goals and performance characteristics to verify the aircraft airworthiness, system capability, and mission utility.

When an existing aircraft is modified, a TEMP is still used as the governing document by the military design authority to verify design goals and performance characteristics through inspection, demonstration, and test. If the modifications have no impact on aerodynamic shape, aircraft performance, or handling characteristics, then the demonstrations and testing may be reduced in scope to verification of changes in mission system performance or capability. To achieve this, the military design authority or procurement agent will include data and demonstration specifications (MIL-D-8706/8708) in the overall design contract for aircraft modification. The prime contractor will perform necessary tests and demonstrations in compliance with the contract and these MIL-SPECs. Upon successful completion of these contractor tests, the military procurement agent will then conduct independent tests and demonstrations to validate and confirm the contractor's test results. These tests are conducted against the ultimate aircraft performance envelope, and aircraft fatigue life estimates for operations over the forecast life of the aircraft are developed. After government testing is completed and data analyzed and evaluated, a final test report is submitted to the military certification authority for flight certification approval.

This military approach to inspection, demonstration, and testing is thorough, rigorous, and comprehensive. Consequently, it is often more costly and time-consuming, especially for significant modification programs such as the Boeing E-3 AWACS or E-6 TACAMO programs. Because these programs involved external and internal modifications to the aircraft, in each case, the military design agent contracted directly with Boeing to modify the B707 aircraft, including equipment installation, system integration, test and demonstration to provide a modified aircraft system design to meet military certification requirements. Final military flight testing of these aircraft is conducted by the military service flight test agent.

VI. EXAMPLES OF SUCCESSFUL PROGRAMS

Many examples of successful programs that have adapted existing long-range, commercial jet aircraft designs to meet specific military aircraft requirements have already been mentioned and are summarized in Table 1 below.

Future Potential Military Applications. Military aircraft design planners should carefully evaluate current and future military operational mission requirements against the large volume and variety of commercial jet aircraft designs that are currently being developed or are in production. After evaluating unique military RDT&E and production costs for programs such as the C-5, C-17, and the NATO Future International Military Airlifter (FIMA), future national budget constraints may force increased utilization and adaptation of existing or future commercial aircraft to meet these future military operational and support mission roles. Commercial aircraft marketing managers must also be vigilant for every opportunity to enter the military aircraft marketplace when a commercial aircraft design appears suitable to meet a military operational requirement.

Table 2 below provides a listing of current or future medium- and long-range commercial aircraft which offer potential for military mission application. The listing is by no means complete, but may offer a perspective on the spectrum of commercial jet aircraft designs that are potentially suitable for a wide variety of military mission applications. Many of these modern commercial jet aircraft, such as the Boeing 757/767, McDonnell Douglas MD-80 and MD-11, and Airbus 300 Series, with state-of-the-art avionics and fuel-efficient fanjet engines, should be closely examined and seriously considered for military support mission roles in the future. When long, intercontinental range is not a requirement, military aircraft procurement agencies should also consider the large international stable of smaller, cost-effective, twin-engined business jet aircraft to meet short- and medium-range military support mission requirements.

Table 1
SUCCESSFUL AIRCRAFT PROGRAM EXAMPLES FOR ADAPTING COMMERCIAL AIRCRAFT DESIGNS TO MEET EXISTING MILITARY AIRCRAFT REQUIREMENTS

COMMERCIAL AIRCRAFT DESIGNATION	MILITARY AIRCRAFT DESIGNATION	SPECIFIC MILITARY APPLICATION
Boeing		
B707	VC-137	•VIP Transport
	E-3	•Airborne Warning and Control (AWACS)
	E-6	•Survivable Airborne Communications (TACAMO)
	E-8	•Joint Surveillance Target Attack Radar System (JSTARS)
B717	KC-135	•Aerial Refueling
	C-135	•Cargo/Troop Transport
	EC-135	•Airborne Command Post (ABCP)
	RC-135	•Photographic/Electronic Reconnaissance
B737	T-43	•Airborne Navigation Trainer
B747	E-4	•Airborne Command Post
	VC-25	•VIP Transport
McDonnell Douglas		
DC-8	EC-24	•Electronic Warfare
DC-9	C-9	•Cargo/Troop Transport •Medical Evacuation (Medevac)
DC-10	KC-10	•Aerial Refueling

Table 2
MODERN COMMERCIAL TRANSPORT AIRCRAFT AVAILABLE TO MEET EXISTING OR FUTURE AIRCRAFT REQUIREMENTS

COMMERCIAL AIRCRAFT DESIGNATION	MILITARY AIRCRAFT DESIGNATION	POTENTIAL MILITARY APPLICATIONS
Boeing		
B757		•Aerial Refueling
B767		•Cargo/Troop Transport
B777		•Open Skies Treaty Verification
		•Surveillance/Reconnaissance
		•Maritime Patrol
		•Electronic Warfare (EW)
		•VIP Transport
		•Medical Evacuation (Medevac)
McDonnell Douglas		
MD-11		•Same as top list
MD-80 Series		•Cargo/Troop Transport
		•VIP Transport
		•Medevac
Airbus Industries		
A300		•Same as top list
A310		•Same as top list
A320		•Same as top list
A330		•Same as top list
A340		•Same as top list
British Aerospace		
BAe146		•Surveillance/Reconnaissance
		•Utility/Training
Canadair		•Cargo/Troop Transport
Challenger 601		•VIP Transport
		•Open Skies Treaty Verification
		•Maritime Patrol/EW
		•Medevac
Falconjet		
Falcon 200		•Same as above list
Falcon 900		•Same as above list
Gulfstream		
G-III/IV	C-20	•Same as above list
SRA-4		•Same as above list

VII. SUMMARY

In summary, the future design and development costs for new military jet aircraft in combat support mission roles may not allow unique designs, such as the USAF C-5, C-17, or NATO FIMA, because of affordability. In fact, the NATO FIMA program was restructured in 1989; and a new consortium, the European Future Large Aircraft Group (Euroflag), was formed to focus the approach to the aircraft requirements and better address the affordability issue. The aim of the new consortium is to satisfy the European requirements for a new military transport aircraft for the 1990s and beyond.

There are a variety of existing, modern commercial aircraft and avionics systems available to be linked to a military requirement at an affordable and cost-effective price when compared to developing a new aircraft and associated systems. It is the responsibility of both government procurement agencies and industry to ensure that such cost-effective procurements are achieved whenever existing commercial aircraft, systems, or standards can be adapted to meet the military requirement.

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