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AIRCRAFT SELECTION FOR TTB (TRANSPORT-TANKER-BOMBER)

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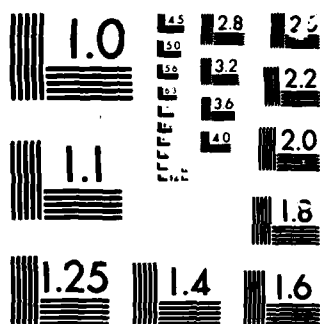
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AIRCRAFT SELECTION FOR TTB AIRCRAFT
LEASE VERSUS BUY DECISION

THESIS

Timothy W. Reid
Major, USAF

AFIT/GOR/ ENS/85D-16

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ABSTRACT

This study was accomplished to determine the best alternative for Air Training Command to pursue for procurement of the Transport-Tanker-Bomber T-37 aircraft. The study focused on the two alternative forms of financing (leasing and buying) and the four aircraft to select from.

The calculations were made through cost-benefit analysis where the determining factor was the net present value of costs.

Current OMB guidance on lease vs. buy analysis was discussed and generally followed. The government perspective (as directed by OMB) was taken through the analysis to ensure proper accounting of tax impact and depreciation allowances. The results of the study indicate that the buy option is always more favorable from the government perspective, and the lease option more favorable when the service perspective is taken. Further study should be accomplished as more information becomes available.

Handwritten notes:
T-37 (buy), T-38 (buy), T-39 (buy), T-40 (buy)
T-37 (lease), T-38 (lease), T-39 (lease), T-40 (lease)

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AIRCRAFT SELECTION FOR TTB AIRCRAFT
LEASE VERSUS BUY DECISION

THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University
in Partial Fulfillment of the
Requirements for the Degree of
Masters of Science

Timothy W. Reid, B.S.

Major USAF

December 1985

Approved for public release; distribution unlimited

Preface

The purpose of this study was to accomplish an economic analysis to determine the best alternative available to Air Training Command for procurement of a TTB trainer aircraft. The study focused on two alternative forms of financing (leasing and buying). The analysis took the government perspective and used net present value of costs calculations for each alternative. Funding is a major problem for ATC, and it is crucial that they obtain the most economically favorable alternative available. Further studies should be accomplished when more information becomes available.

In writing this thesis I have had a great deal of help from others. I am truly indebted to my faculty advisor, Maj Ken Feldman, his guidance and insight have been invaluable. I wish to thank Capt Stuart Williams for his help with the multiplan computer programs. I would certainly like to thank my wife Priscilla for her devotion and understanding during the long days, long nights, and short weekends.

Tim Reid

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TABLE OF CONTENTS

	Page
Preface.....	i
Contents.....	ii
Abstract.....	iii
I. Background.....	1
II. Alternatives.....	10
III. Methodology.....	22
IV. Analysis.....	35
V. Comparison of Study Results with Previous ATC Study.....	57
VI. Conclusions and Recommendations.....	68
Appendix:	74
Bibliography.....	86
Vita.....	88

AIRCRAFT SELECTION FOR TTb AIRCRAFT
LEASE VERSUS BUY DECISIONS

I. BACKGROUND

One of Air Training Command's (ATC) missions is to conduct all fixed wing flying training for the U.S. Air Force. To accomplish this mission ATC uses three types of aircraft: T-37, T-38, and T-43. The T-43 aircraft is only used in Undergraduate Navigator Training (UNT). The T-37 and T-38 aircraft support the remaining ATC flying programs.

The Undergraduate Pilot Training program conducted by ATC provides the fundamental flying skills necessary for the new pilot to enter and successfully complete advanced, specialized aircrew training conducted by the operational commands.

To be eligible for pilot training, a U.S. candidate must meet several requirements. The individual must be less than 27.5 years of age, be a college graduate and a commissioned officer, pass a flight physical, and hold a Federal Aviation Administration (FAA) pilot license or successfully complete a light aircraft screening program.

The three major sources of UPT candidates are the U.S. Air Force Academy, Air Force Reserve Officer Training Corps (AFROTC) and Officer Training School (OTS). Other sources are active duty officers, Air National Guard officers, Air Force Reserve

Officers, and foreign students.

The UPT program includes ground training, flying training, and professional officer development. The course is currently 49 weeks long and includes 175.4 flying hours and is divided into three phases: preflight (ground training), primary (T-37), and basic (T-38).

Preflight consists of 17 training days of ground training to prepare the student for flying in general and the T-37 in particular. Training devices such as the altitude chamber, ejection seat trainer, swing landing trainer, and parasail equipment are used to demonstrate and reinforce important aspects of aerospace physiology.

Primary flight training is conducted in the T-37, a sub-sonic, side-by-side seat, jet trainer aircraft. The program contains 74.4 hours of flight instruction of which 12 hours are devoted to solo flying. Instruction is provided in six categories of training with Visual Flight Rules (VFR) or contact, instruments, formation, and navigation receiving the most emphasis. Procedures and basic training complete the six categories. A modern flight simulator is used to provide procedural, instrument, and some navigation training.

The emphasis in the primary phase of training is fundamental contact and instrument skills. While continuing to develop these skills in the basic phase, the major emphasis shifts to formation and navigation conducted in the T-38. The T-38 is a high

performance, supersonic jet trainer. It has many of the handling characteristics of modern fighter aircraft. The basic phase contains 101 hours of flight training including approximately 71 hours of dual instruction and 30 hours of solo time. In addition, the students receive 34 hours of instruction in a flight simulator. When a student successfully completes the basic phase, he is awarded USAF pilot wings.

Although UPT is the major program, ATC also supports several other flying programs. These programs are shown in Table I-1.

Table I-1
ATC FLYING TRAINING PROGRAMS

Program	Type Aircraft Used
Undergraduate Pilot Training (UPT)	T-37, T-38
Pilot Instructor Training (PIT)	T-37, T-38
EURO-NATO Joint Jet Pilot Training (ENJJPT)	T-37, T-38
ENJJPT PIT	T-37, T-38
Accelerated Co-Pilot Enrichment (ACE)	T-37, T-38
Fixed Wing Qualification (FWQ)	T-37, T-38
Undergraduate Navigator Training (UNT)	T-37, T-43
Tactical Navigator Training (TNT)	T-37
Pilot Instructor Training (at Mather)	T-37
Medical Officer Flight Indoctrination	T-37
Formation Lead-In Training (FB-111)	T-38

The UPT program is conducted at five ATC bases located in Texas, Oklahoma, Mississippi, and Arizona. The primary mission of these bases is pilot training. The PIT program for UPT is conducted at Randolph AFB, TX. The ENJJPT program is accomplished at Sheppard AFB, TX. All navigator training is located at Mather AFB, CA. The ACE program was developed to give additional flying experience to Strategic Air Command (SAC) B-52 and KC-135 co-pilots. This mission is accomplished by locating three to five T-37 or T-38 aircraft at SAC bases. The aircraft are provided maintenance support by one of the UPT bases.

There are three major operational changes that are programmed with the first to occur in FY 86. These are a syllabus increase for UPT, T-37 replacement, and Specialized UPT (SUPT).

Beginning in FY 86 the UPT syllabus will be increased 3.9 flying hours in the primary phase and 5.2 flying hours in the basic phase. This increase will be used to increase the graduate's proficiency in instruments and navigation.

The T-37 aircraft used in UPT and PIT will be replaced with the T-46A trainers starting in FY 87. The final decision to replace the T-37 in the remaining programs has not been made yet. The phase-in of the T-46A in UPT will require about five years. Current projections indicate that 676 T-46A trainer aircraft will be procured if all T-37s are replaced.

The SUPT concept, approved by the Secretary of the Air Force in 1980, differs from the current program by splitting the entire

basic phase of pilot training into two tracks. One track would be designed to train pilots selected to fly fighter-attack-reconnaissance (FAR) type aircraft. The other track would train pilots for tanker-transport-bomber (TTB) type aircraft. The FAR track pilots would train in the T-38 aircraft since it exhibits fighter aircraft performance characteristics. A business jet type aircraft would be required to train TTB track pilots. The primary phase remains basically unchanged. Selecting pilots for the basic phase tracks would occur near the end of the primary phase as each student pilot meets an Advanced Training Recommendation Board (ATRB). Table I-2 on the following page, shows how Specialized UPT will differ from Generalized UPT.

This change to the pilot training format should produce several advantages. First, the training can be designed to more closely meet the needs of the follow-on assignments of the graduates. "Our SUPT graduates will be more proficient in instrument procedures, low level navigation, formation, and crew coordination. We also determined that we can produce 139 more graduates per year in SUPT due to more frequent class entry dates and different syllabus constraints." These views were expressed by the Vice Commander of ATC. He went on to say, "Our ability to graduate a quality pilot familiar with the basic flying concepts of all the MAJCOMs is the most significant aspect of SUPT and the acquisition of the TTB Training System (TTBTS). These pilots will be better prepared to immediately apply their talents and

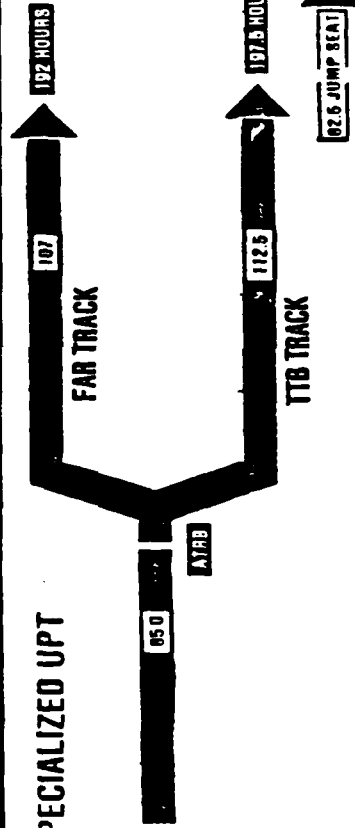
TABLE I-2

SUPT VS SUPT

GENERALIZED UPT



SPECIALIZED UPT



from our investment in the TTB Training System will be realized for years to come." Secondly, future savings can be realized by acquiring the TTB Training System now. As ATC implements SUPT and trains 40 percent of the student pilots in the Fighter-Attack-Reconnaissance (FAR) track of training, the total ATC requirement for T-38s will drop from approximately 650 aircraft to 450 aircraft if the current T-38 utilization rate is maintained. This is highly significant because ATC can reduce the utilization rate of the fleet and postpone replacement of the T-38 beyond the year 2000. The buy at that time would be for approximately 200 aircraft less than the number required for generalized UPT. A recent Air Force study showed that the savings realized would be over \$1.3 billion (FY 85), based on a replacement cost of \$6.5 million per aircraft. (Ref 1)

A third advantage of SUPT is the projected Operating and Support (O&S) cost savings. A recent Air Force study showed that the acquisition of a TTB aircraft and SUPT will generate an annual O&S cost savings of \$80 million (FY 85 \$) between UPT and SUPT when equal numbers of graduates are considered. The recurring annual O&S costs per SUPT graduate is approximately \$213,800. The recurring annual O&S costs per UPT graduate is approximately \$251,500. (Ref 1)

UPT \$251,500 X 2122 graduates	=	\$533.7 M Annual Cost
SUPT \$213,800 X 2122 graduates	=	\$453.7 M Annual Cost

SUPT saves		80.0 M Annually

The main factors that account for this savings are:

	T-38 -----	TTB -----
Maintenance Manhours Per Flying Hour	12.3	6.5
Fuel Cost Per Hour	\$396	\$210
Total Cost Per Flying Hour	\$1269	\$700

Additionally, an uncounted benefit of the TTB track is the 82.5 additional hours of jump seat training. These are hours in which the student sits in the jumpseat and is able to observe the instructor pilot and the second student on the aircraft. Air Training Command believes this observer time to be extremely valuable because it provides another level of learning transfer for the students and permits them to watch contemporaries and instructors which will reinforce positive learning skills.

The major obstacle for the Air Force is obtaining funds for two trainer aircraft simultaneously, the T-46A for primary training and the TTB for basic training. The current plan is to purchase the TTB trainers in FY 88, one year after the initial T-46A purchases.

With funding the big problem that it is, it becomes increasingly more important that the Air Force seek the most economically attractive procurement package available. Historically, the Air Force has purchased new aircraft, which

were initially designed and produced to meet specific military requirements. The TTB program, in an attempt to find the best economic option available, is examining the acquisition of an off-the-shelf Federal Aviation Administration certified aircraft modified to meet training requirements. Therefore, leasing is being looked at as a very viable option.

This study will examine and compare the alternatives available to Air Training Command for the acquisition of a TTB aircraft, necessary to implement Specalized Undergraduate Pilot Training. Several different aircraft are candidates for the TTB and most can be acquired using two different procurement strategies: lease or buy. These alternatives will be compared using the net present value of twenty year life-cycle-costs as the measure of effectiveness of each alternative.

II. ALTERNATIVES

When faced with the question of how to acquire an asset, the decision-maker can make one of two basic choices: buy the asset or lease it. To make that decision, several factors must be considered, the most important of which include: (Ref 2)

(1) The ability of the entity to raise funds to buy the asset. Entities in the private sector must consider the availability of equity and debt capacity. Public sector entities must assess their ability to obtain procurement appropriations from the authorizing body.

(2) The total relative costs of buying versus leasing must be compared. Since there are different cash flows associated with each alternative, some meaningful method of comparison must be used.

(3) The risks and costs inherent in the buy and lease alternatives. Obsolescence, for instance, may be a major concern which makes the lease alternative more attractive than a purchase.

(4) The availability of tax benefits is usually a major advantage to buying. Should the tax benefits also be available for leasing, then the lease option could become much more attractive.

(5) The selection of an appropriate benefit-cost comparison methodology. This methodology must take into account all of the pertinent elements, in addition to those listed above, involved in the lease versus buy decision.

The process of selecting the financing strategy to acquire the TTB encompasses several criteria which require managerial judgement as well as quantitative analysis. The lease and buy alternatives are, in themselves, a system of complex decisions.

Leasing has offered the private sector an attractive source of capital for financing the acquisition of assets for a number of years. Not until the passage of the Economic Recovery Tax Act (ERTA) of 1981, however, did leasing offer the public sector an equally attractive financing alternative. Prior to ERTA, tax-exempt entities used their superior credit or tax-exempt status to raise funds through conventional means at a lower cost than was available through leasing. The greatly liberalized leasing rules under ERTA, however, enabled private sector entities to use previously unavailable ownership tax benefits to partially subsidize their acquisitions, and lower government lease payments. However, all leases to government entities do not qualify for tax benefits. A short review of the general nature of leasing and the rules and regulations which govern the financial and tax accounting for leases will follow.

A lease is an agreement between two parties: a lessor who owns and asset and a lessee who uses the asset. The lease

agreement conveys to the lessee the right to use an asset owned by the lessor for a specific period of time in return for a stipulated series of cash payments. This series of cash payments is set to enable the lessor to recover the cost incurred to procure the asset, arrange the lease, and provide a satisfactory rate of return on the investment in the asset over the life of the lease. Title to the leased asset is retained by the lessor. At the end of the lease term, the lessee usually has three options: (1) renew the lease, (2) buy the asset, or (3) terminate the lease and return the asset to the lessor. The terms under which the lessee can exercise any of the three options determine the classification of the lease for tax purposes as well as for financial accounting purposes. (Ref 2)

A lease is a highly complex financial instrument in two respects: First, it is legally complex in that it depends on tax laws, specific tax rulings and complicated trust and security agreements. Second, a lease is computationally complex in that the dollar amounts of the lease payments are dependent upon several factors.

The most important tax issue inherent in a lease is whether the Internal Revenue Service will rule that the lease qualifies as a true lease and is eligible to provide the lessor with the anticipated tax benefits. If the IRS rules that the lease does not qualify as a true lease, but is instead a "conditional sales"

agreement, then the lessor will lose the tax benefits to the lessee. In such cases, the lease agreement will usually require the lessee to pay a higher periodic lease payment to compensate the lessor for the loss of the anticipated tax benefits in order to maintain the lessor's required rate of return.

In 1981, the Economic Recovery Tax Act (ERTA) significantly relaxed the conditions under which a lease agreement would be considered a "true" lease by the IRS. Prior to ERTA, the major consideration in determining whether a lease qualified as a true lease was whether it has nontax economic substance. Toward that end, two specific requirements were imposed:

- a. The lessor was required to make and maintain a minimum unconditional equity investment of at least 20 percent of the cost of the asset.
- b. There must exist a reasonable expectation of profit from the transaction, independent of the tax benefits. (Ref 4)

The passage of ERTA in 1981 essentially repealed the requirements that leases must have nontax economic substance in an attempt to increase the profitability of struggling businesses by offering them incentives to purchase new equipment and machinery. These provisions permitted these companies to sell their tax benefits resulting from new purchases by entering into sale-leaseback transactions with profitable companies. For lessor companies, these relaxed rules offered attractive rates

of return through the purchase of the tax benefits of unprofitable companies. While the ERTA provisions proved to be extremely popular with the business community, the cost was seen to be prohibitive by the Treasury and the ERTA provisions were changed in 1982 by the Tax Equity and Fiscal Responsibility Act (TEFRA). TEFRA restricted the benefits ensuing from various leasing transactions. Significantly, TEFRA reinstituted much of the pre-ERTA nontax economic substance requirements for leases. (Ref 4)

Any acquisition of an asset can be viewed as a combination of interrelated costs, benefits and risks which are allocated among the owners, users, and financiers associated with the transaction. Among these costs and benefits are state and Federal income taxes associated with the financing arrangements of the transaction. Government agencies (Federal, state, and local) are, by and large, exempt from paying taxes and are likewise not able to take advantage of various tax benefits accruing from ownership, such as depreciation deductions and deductions for interest paid on debt instruments. Leasing transactions may indirectly allow the tax exempt entity to enjoy the tax benefits it is normally prohibited from using. This may occur if the lessor passes some of the benefits back to the tax-exempt entity in the form of lower payments than it would normally incur if it were to acquire the asset through some other conventional debt financing arrangement. (Ref 5)

Tax-exempt leasing has come under a great deal of scrutiny from Congress. The primary reason for Congressional concern is the negative impact leasing by nontaxable entities has on tax revenues. When a nontaxable entity structures a lease in a way which generates tax benefits which lower the lessor's tax liability, the Federal Treasury, in effect, subsidizes the acquisition of that asset. So, although a nontaxable entity (such as a Federal agency) may pay a lower price for its acquisition, the total cost to the government may actually be more than if the entity had purchased the asset instead of leasing it. One factor contributing to this was the Accelerated Cost Recovery Schedule (ACRS). ACRS, a by-product of ETRA, had a particularly damaging effect on the Treasury. Prior to 1981, the depreciation schedule was straight line for the life of the equipment, with a 20 percent residual value. The term residual value refers to the market value of the equipment after its expected life. (Ref 6) A \$6 million dollar 20 year aircraft would have an annual depreciation amount of \$240,000 (80% of 6 M / 20 = 240,000). In other words a depreciation deduction of \$240,000 could be taken for the first 20 years of the aircraft's life. The ACRS schedule compresses the entire depreciation of the aircraft into the first five years. The rates for each of the first five years are as follows: year one = 15 percent, year two = 22 percent, and years

three through five = 21 percent (Ref 6). The aircraft is now fully depreciated in the first five years. Table II-1 shows a comparison between the two schedules.

TABLE II-1
STRAIGHT-LINE DEPRECIATION VERSUS ACRS

Purchase Price = 6 M
Number of Years = 20

Year	ACRS	Straight-line
1	\$900,000	\$240,000
2	\$1,320,000	\$240,000
3	\$1,260,000	\$240,000
4	\$1,260,000	\$240,000
5	\$1,260,000	\$240,000
6		\$240,000
7		\$240,000
8		\$240,000
9		\$240,000
10		\$240,000
11		\$240,000
12		\$240,000
13		\$240,000
14		\$240,000
15		\$240,000
16		\$240,000
17		\$240,000
18		\$240,000
20		\$240,000

Under ACRS the first year depreciation amount is \$660,000 more than under straight-line (almost 4 times more). The second year the ACRS deduction is \$1,080,000 more than under straight

line (almost 6 times more). For years 3 through 5 the ACRS deduction is \$1,020,000 more each year than the straight. When the present value of money was taken into effect, the results were devastating to the Treasury. (Current depreciation allowance schedules are discussed in Chapter IV.)

In 1983, Congress directed the General Accounting Office to investigate the tax and budget implications of the Navy's TAKX lease which make use of tax benefit transfers. Among the questions raised in that request, Congress asked GAO to report why Federal agencies were attracted to leasing as an alternative to procurement through the normal appropriation process. GAO reported back that Federal agencies found leasing attractive for three reasons. One, it allowed them to spread the cost of the asset over a longer period of time. Normal procurement procedures require a Federal agency to incur the entire cost of the asset when it is purchased. Two, if lease payments were made from operation and maintenance funds and not from procurement funds, lease proposals were not subjected to the same level of scrutiny normally associated with the procurement process. Three, as was alluded to above, leasing can make acquisition appear less costly because part of the cost is shifted from the agency's budget to the Treasury in the form of reduced tax revenues. (Ref 6)

Clearly, with the passage of the Economic Recovery Tax Act of 1981 and its relaxed leasing regulations, tax-exempt entities

turned to leasing as a means of financing the acquisition of their capital assets. Thus, the Air Force is free to pursue this type of procurement. It must be careful though not to do it at the expense of the Treasury.

In a previous ATC study, two alternatives, a buy and a lease, were considered for TTB aircraft procurement. The "buy" alternative was the purchase of 225 aircraft and 29 simulators through AFSC/ASD. The "lease" alternative was the lease of 200 aircraft and 29 simulators (Ref 7).

For the "buy" alternative, the aircraft and simulator procurement rates were taken from the ASD Decision Package Three (DP-3) profile. This profile was presented by ASD during early iterations of the FY 85-89 POM exercise to meet the operational requirements identified in the System Operational Concept for Specialized Undergraduate Pilot Training. The Decision Package Three profile is shown in Table II-2. (Ref 7)

TABLE II-2

ASD PROCUREMENT ALTERNATIVE

	86	87	88	89	90	91	Total
	--	--	--	--	--	--	-----
Aircraft Deliveries	15	36	48	48	48	30	225
Simulator Deliveries	-	1	6	12	10	-	29

The aircraft and simulator procurement rates under the leasing alternative were developed by ASD and ATC by computing the flying hour requirement during implementation of the TTB aircraft. The leased alternative profile for 200 aircraft and 29 simulators are shown in Table II-3

TABLE II-3

LEASED PROCUREMENT ALTERNATIVE

	86	87	88	89	90	91	Total
	--	--	--	--	--	--	-----
Aircraft Deliveries	-	33	60	74	21	12	200
Attrition Aircraft Purchased	-	1	1	1	1	21	25
Simulator Deliveries	-	6	9	9	5	-	29

The number of aircraft to be leased or to be purchased is pretty well set, the Air Force has yet to decide on the aircraft or the procurement strategy - lease or buy. Current requirements call for an off-the-shelf multi-engine business jet capable of flying a three hour mission and still having a 33 nautical mile divert capability. The aircraft will be expected to cruise at .65 Mach minimum, .70 Mach desired. It also will have the

capability of doing 300 knots indicated air speed at 500 feet above ground level (AGL). (Ref 8)

At the present time four aircraft are under consideration, the Canadair Challenger 600, the British Aerospace Hawker-Sidley 125-700, the Gates Learjet 35, and the Cessna Citation II. Table II-4 shows how the aircraft compare with one another in four important categories: gross weight, fuel flow, maximum airspeed, and unit cost, assuming a 225 aircraft procurement.

TABLE II-4

TTBTS CANDIDATE AIRCRAFT

Aircraft	Gross Wt. (Lbs)	Fuel Flow (Gal per Hr)	Max A/S (Knots)	Cost (Millions)
Canadair Challenger 600	40,550	370	365	10.0
British Aerospace HS 125-700	25,000	250	350	6.0
Gates Learjet 35	17,250	250	350	3.4
Cessna Citation II	13,500	160	262	2.6

At the present time lease information is available only for the Gates Learjet 35 and the Cessna Citation II. This information will be presented in later chapters.

The maintenance concept for the TTB will be the same for Air Force owned or leased aircraft: a blend of organic and contractor support. The specific degree of organic or contractor maintenance cannot be determined at this point due to certain unknown variables. These variables include specific aircraft system peculiarities, commonality of equipment, and the requirement for special skills. The significant costs involved with parts, supply, and maintenance will be included in the contract package. This could become an important factor if one aircraft's maintenance cost is proportionally smaller than another's; however, this does not appear to be the case.

Air Training Command is faced with two procurement alternatives to acquire the TTB, leasing or buying. This chapter has discussed those alternatives along with recent legislation directly affecting each. It appears that leasing is a viable option for the Air Force and tentative procurement schedules for both alternatives have been set. The next chapter will review recent OMB guidance for choosing between the two procurement alternatives: leasing or buying.

III. METHODOLOGY

The decision to lease or buy an asset requires the analyst to compare the costs and benefits associated with each form of acquisition. Any such comparison must take into account the timing differences in the cash flows associated with each of the two alternatives. To make a meaningful comparison between the lease or buy alternatives, analysts must reconcile these timing differences because of the time value of money. More simply put, the value of a dollar paid at the beginning of a contract term is greater than a dollar paid at the end of a contract term. The difference is evaluated as equivalent to the interest which can be earned on money that is held rather than spent.

Analysts account for such timing differences using present value calculations which provide the equivalent value now of a series of payments to be made periodically in the future. The Net Present Value approach requires the decision maker to:

(Ref 9)

- a. Determine the amount and timing of the periodic costs to be incurred under the purchase and lease alternatives.

- b. Select an appropriate discount rate which reflects the user's cost of capital in acquiring the asset.
- c. Discount the cost streams determined in step (a) above and select the alternative which has the lowest present value total.

While the process appears simple enough, in practice such analysis is complicated by several factors. First, the quantification in monetary terms of costs and benefits to be included in the analysis can be difficult. In this situation the benefits resulting from the alternatives will be the same. Some elements are easily recognized as certain to occur, but are very difficult to specify in exact monetary terms. Other elements are less certain, and equally difficult to specify in dollar terms.

The treatment of tax benefits and credits has been an increasing problem in the analysis. Guidance was severely lacking on just how these effects should be treated. In fact the tax problem alone has contributed more confusion than any other single factor.

Third, there is no universally accepted method for determining an appropriate discount rate. Arguments abound for using any one of a myriad of methods for discount rate determination including: the incremental cost of debt, the cost

of equity, the weighted average cost of capital and a number of risk adjusted and tax adjusted variants of these methods.

Given these vagaries, it is not suprising that in some cases analysts who have studied the same lease versus purchase decision have reached different conclusions. One study prepared by the Department of Defense Program Analysis and Evaluation (PA&E) section noted that at least four separate lease analysis methods were used by various Federal agencies. Within the Department of Defense, the Navy and the Air Force used significantly different lease evaluation methods. Because of this problem OMB has established directives to guide public sector managers in making financial decisions.(Ref 11)

In 1983, the Office of Management and Budget was directed by Congress in the 1984 Defense Authorization Act to issue guidelines governing the circumstances under which the Department of Defense was authorized to use lease or charter arrangements to procure services of aircraft and ships. Later, in October 1984, OMB and the Department of the Treasury issued a joint set of guidelines prescribing the procedures to be used by the Department of Defense in determining when a long-term lease for aircraft or ships was more advantageous to the government than a direct purchase. Those guidelines apply to: (Ref 10)

- a. Any leases that involve the use of an aircraft or naval vessel built for the express purpose of being leased to a Defense Department component; and
- b. Any other long-term lease, or lease which imposes a substantial termination liability, for an aircraft or naval vessel valued at \$1 million each at the time of acquisition.

The OMB/Treasury guidance defined a long-term lease to be any lease which acquired new property for a period of 3 years or more, or 5 years or more for used property. A termination liability was considered "substantial" if its present value is at least one-fourth of the asset's current fair market value, or if added to the discounted present value of prior lease payments, is more than one-half the price of the asset.

The OMB/Treasury guidelines do not apply to short-term leases of 3 years or less for new property or less than 5 years for used property. Also, the guidelines do not apply to leases which acquire assets valued at less than \$1 million.

The OMB/Treasury guidelines specifically directed the Department of Defense not to use long-term leasing as an alternative to direct purchase unless leasing could be shown to be less expensive than a direct purchase.

The new guidance stipulated that all lease-versus-buy cost comparisons were to be made on the basis of the discounted

(present-value) cost of the lease and the purchase. The cost of leasing was to include both the cost of the lease payments made by the the DOD component and special tax benefits claimed by the lessor as a result of the lease. The guidance considered the Investment Tax Credit and accelerated depreciation deductions to be "special" benefits. (Ref 10)

Finally, the guidance directed the Department of Defense to avoid leases which deferred payment past the time that services would be rendered by the asset. It further directed DOD to structure leases with equal annual payments or payments that decreased over time, and to avoid leases which provided for larger lease payments in later years.

The new guidance directed that Department of Defense lease analysis be conducted using pre-tax cash-flows since expenditures are measured as the direct outlay cost with no consideration for the taxes which may be collected from that outlay. The OMB/Treasury guidance requires that the tax subsidies be converted to an equivalent pre-tax reduction in taxable income. The guidance further directed that lease costs be expressed in current, as opposed to constant dollars. This was done to make sure that there would be no misunderstanding as to what kind of dollars should be used with a nominal discount rate. They were trying to avoid the mistakes made in the past. Lease

costs were considered to consist of direct lease payments plus the cost of the tax benefits claimed by the lessor.

According to the OMB guidance, the cost of the tax subsidy is not the simple summation of the tax benefits claimed by the lessor. The cost of the subsidy provided by accelerated depreciation deductions is not considered to be the entire ACRS deduction, but rather the present value of the excess of the accelerated depreciation deduction allowance over the depreciation deductions that would have been available if the economic depreciation were used for tax purposes (this view is subject to questioning and will be discussed later in the chapter). Theoretically, the economic depreciation represents the actual economic decline in the asset's value over time. For the purposes of the OMB/Treasury guidance, economic depreciation is determined using the IRS Asset Depreciation Range (ADR) schedule. The equivalent reduction in taxable income is determined by dividing the cost of the tax subsidy by one minus the current highest tax rate $(1-T)$, where T is the tax rate. For example, if the ITC associated with a lease was 10 million dollars, the current equivalent pre-tax investment credit would be

$$\text{\$10 million} / (1-.46) = \text{a \$18.5 million}$$

reduction in a corporation's taxable income, where the current

highest corporate tax rate is 46 percent.

The discount rate to be used in computing the present value of the cost of a lease is the "nominal" interest rate on new Treasury securities whose maturity most closely corresponds with the term of the lease, increased by one-eighth of a percent. The additional amount represents the current borrowing fee charged government agencies by the Treasury.

The new OMB/Treasury guidance directs the Department of Defense to use the following computational formula in determining the present cost of a lease. The present value cost of the lease is compared with the present value cost of purchasing to determine whether the lease alternative is less expensive than a direct purchase. If the lease term is less than the useful life of the asset, the cost of the purchase alternative is adjusted to reflect the remaining residual value. To qualify as a lease, the IRS requires that the lessor show that there will be at least an estimated 20% (original cost) residual value and useful life at the end of the lease term. The adjusted cost of a purchase is determined by deducting the discounted value of the asset's estimated market resale value less disposition costs from the purchase price.

The following is the OMB/Treasury formula for determining lease net present value: (Ref 10)

$$\begin{array}{l} \text{Lease} \\ \text{Present} \\ \text{Value} \end{array} = \sum_{t=0}^n \frac{L_t}{(1+d)^t} + \sum_{t=0}^n \frac{\frac{I_t}{(1-T)} + \frac{T(A_t - D_t)}{(1-T)}}{(1+d)^t}$$

where,

L_t = Schedule of lease payments.

I_t = Schedule of ITC available.

T = Lessor's tax rate.

d = Government discount rate

D_t = Economic depreciation.

A_t = Depreciation available under the tax code.

n = Term of the lease.

Two points of contention have arisen from the DOD guidance. One is the fact that it gives no explicit direction on how the buy should be treated. In fact, buying is discussed very little throughout the guidelines. The other point of contention is the inclusion of Economic Depreciation (D_t) in the lease formula. One possible explanation is that they are also including it in the treatment of the buy. In a relatively straight forward manner, the OMB formula can be derived and explained except for the OMB inclusion of the

economic depreciation term. The Air Force perspective can be represented in the following manner concerning lease versus buy. As far as the Air Force is concerned, to acquire the TTB a series of payments must be made, either lease payments or purchase payments. In order to realize the net present value of these payments it is necessary to discount them over the length of the contract period. Thus this is how the Air Force perceives the cost. The lease and buy calculations are shown below. (Ref 15)

Lease	Buy
$\sum_{t=0}^n \frac{L_t}{(1+d)^t}$	$\sum_{t=0}^n \frac{B_t}{(1+d)^t}$

where B_t = Purchase in period t
 L_t = Lease payment in period t
 d = Social discount rate

All that is necessary to develop this into a Treasury or government perspective is to include the tax impact.

It then becomes

$$\begin{array}{ccc}
 \text{Lease} & & \text{Buy} \\
 \sum_{t=0}^n \frac{L_t - T(L_t - O_t - D_t - A_t)}{(1+d)^t} & & \sum_{t=0}^n \frac{B_t - T(B_t - O_t - D_t)}{(1+d)^t}
 \end{array}$$

where

O_t = Operating cost	B_t = Purchase price
D_t = Depreciation of production equipment	L_t = Lease payment
A_t = Depreciation on leased equipment	d = discount rate
T = Corporation tax rate	

This is the government perspective because of the tax impact mentioned above. The same stream of cost payments, L_t and B_t , still exist but the payments are reduced by the tax on a portion of these payments. Beginning with the lease side, the entire payment is not taxed, only a portion of it. First it may be reduced by the operating cost of the corporation. It is also reduced by the depreciation of equipment used to produce the item (the aircraft in this case). Finally it may be reduced by the depreciation on the item (aircraft) itself. Now looking at the buy side the purchase price may be reduced by the operating cost and also by the depreciation of production equipment. Notice the deduction for the depreciation of the aircraft itself no longer appears since it now belongs to the government. By multiplying through by "T" and separating terms, the following expressions

result

Lease

Buy

$$\sum_{t=0}^n \frac{(1-T)L_t}{(1+d)^t} + \sum_{t=0}^n \frac{TA_t}{(1+d)^t} + \sum_{t=0}^n \frac{T(O+D)_t}{(1+d)^t} \quad \sum_{t=0}^n \frac{(1-T)B_t}{(1+d)^t} + \sum_{t=0}^n \frac{T(O+D)_t}{(1+d)^t}$$

Since both end terms are the same, they may be removed without changing the relative ranking of the lease and buy. The expressions now becomes

Lease

Buy

$$\sum_{t=0}^n \frac{(1-T)L_t}{(1+d)^t} + \sum_{t=0}^n \frac{TA_t}{(1+d)^t} \quad \sum_{t=0}^n \frac{(1-T)B_t}{(1+d)^t}$$

Now going back to the original Air Force perspective,

Lease

Buy

$$\sum_{t=0}^n \frac{L_t}{(1+d)^t} \quad \sum_{t=0}^n \frac{B_t}{(1+d)^t}$$

equivalent expressions for leasing and buying can be developed by multiplying both sides by the same term $(1-T)$. The expressions are equivalent to the original expression in the sense that they will not change the relative rankings of the lease and buy alternatives.

Lease	Buy
$\sum_{t=0}^n \frac{(1-T)L_t}{(1+d)^t}$	$\sum_{t=0}^n \frac{(1-T)B_t}{(1+d)^t}$

Now notice that the only difference in the above terms (the Air Force perspective) and the Treasury/government perspective is the net present cost of the lost tax revenues.

$$\sum_{t=0}^n \frac{TA_t}{(1+d)^t}$$

Note that the Economic Depreciation term does not appear at all

in either of the expressions.

The analysis in the following chapters will use the lease present value formula without the economic depreciation term. There is no Investment Tax Credit for aircraft so that term will always be zero.

The purpose of this chapter has been to explain the current OMB/Treasury guidance for making lease versus buy decisions. The guidance laid down directs three things. One, that then year (or current) dollars be used for cost streams. Two, that the Treasury (nominal) rate be used for discounting. And third, that the government perspective be taken in all comparisons.

The methods used for the analysis in the next chapter will differ slightly from the OMB/Treasury guidance. Constant dollar cost streams will be used along with a real government discount rate. This does not present a problem because using constant dollars with a real discount is equivalent to using then year (current) dollars with a nominal discount rate. The reason OMB spelled out the particular guidance was to prevent the use of constant dollars with a nominal discount rate or current dollars with a real discount rate. The Economic depreciation term (D_t) appearing in the OMB net present value formula will not be used.

IV. ANALYSIS

This chapter will present a model to perform the required cost-benefit analysis. The model is very similar to models used by the Air Force in previous analysis. The major parameters include: the lease cost, the purchase cost, the operating and supporting (O&S) costs, and the amount of capital recovery. Capital recovery is the portion of the lease cost that is purely for leasing the aircraft. The total lease cost consists of capital recovery, as previously mentioned, and contractor logistics support (CLS). This breakdown is necessary because the CLS will be the same for both lease or buy, and will be individually applied when calculating the buy alternative. The cost-benefit analysis for the Cessna Citation II is presented in Tables IV-1 and IV-2. These tables will be used as references in the following examples of how each calculation is made. Table IV-2 takes the results of Table IV-1 and converts the dollar figures into net present value terms.

TABLE IV-1

TTB TYPE CESSNA Citation II

LEASE 458.82
 PURCHASE 2.60
 RECOVERY 182.61 Maintcost 276.21
 TAX-RATE 0.46
 FLY HRS.. 920.00
 QUANTITY 225.00
 T-BILL RT 0.14
 INFLATION 0.03
 AF Dsc Rt 0.11
 Gv Dsc Rt 0.11
 FUEL COST 130.00

Year	Number to BUY	Number to LEASE	AF Perspective		Strt Line	Govt Perspective	
			Lease	Buy		Lease	Buy
1	15	33	17.88	44.61	1.64	11.30	24.09
2	36	60	52.98	112.66	6.28	34.89	60.84
3	48	74	93.07	161.80	12.96	63.21	87.37
4	48	12	99.57	179.74	17.24	71.01	97.06
5	48	21	165.54	197.67	18.89	108.28	106.74
6	30	0	108.34	162.09	19.93	78.44	87.53
7	0	0	108.34	84.09	19.93	78.44	45.41
8	0	0	108.34	84.09	19.93	78.44	45.41
9	0	0	108.34	84.09	19.93	78.44	45.41
10	0	0	108.34	84.09	19.93	78.44	45.41
11	0	0	108.34	84.09	19.93	78.44	45.41
12	0	0	108.34	84.09	19.93	78.44	45.41
13	0	0	108.34	84.09	18.34	76.84	45.41
14	0	0	108.34	84.09	15.35	73.85	45.41
15	0	0	108.34	84.09	11.66	70.17	45.41
16	0	0	108.34	84.09	11.06	69.57	45.41
17	0	0	108.34	84.09	10.07	68.57	45.41
18	0	0	108.34	84.09	0.00	58.51	45.41
19	0	0	108.34	84.09	0.00	58.51	45.41
20	0	0	108.34	84.09	0.00	58.51	45.41
21	0	0	90.47	78.48	0.00	48.85	42.38
22	0	0	57.96	65.03	0.00	31.30	35.11
23	0	0	17.88	47.09	0.00	9.65	25.43
24	0	0	11.38	29.15	0.00	6.14	15.74
25	0	0	0.00	11.21	0.00	0.00	6.05
TOTALS	225	200	2231.86	2266.71	263.02	1468.22	1224.02

TABLE IV-2

CESSNA Citation II
 Cumulative Net Present Cost
 Lease vs Buy
 Discounted cost at .11 Real Rate

AF Perspective		Govt Perspective	
Lease	Buy	Lease	Buy
16.11	40.19	10.18	21.70
59.10	131.62	38.49	71.08
127.15	249.93	84.71	134.96
192.74	368.32	131.49	198.90
290.98	485.63	195.75	262.24
348.91	572.29	237.69	309.04
401.09	612.79	275.47	330.91
448.10	649.28	309.50	350.61
490.46	682.15	340.17	368.36
528.62	711.76	367.79	384.35
562.99	738.44	392.68	398.76
593.96	762.48	415.10	411.74
621.86	784.13	434.89	423.43
646.99	803.64	452.02	433.96
669.64	821.21	466.69	443.46
690.04	837.05	479.79	452.00
708.42	851.31	491.42	459.71
724.97	864.16	500.36	466.65
739.89	875.74	508.41	472.90
753.33	886.17	515.67	478.53
763.44	894.94	521.13	483.26
769.27	901.48	524.28	486.80
770.89	905.75	525.15	489.11
771.82	908.13	525.66	490.39
771.82	908.96	525.66	490.84
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771.82	908.96	525.66	490.84

In Table IV-1 the lease cost, capital recovery, CLS, and fuel cost are expressed in dollars per flying hour. Column 1 displays the number of years of the contract. Column 2 shows the aircraft to be purchased spread over six years. Column 3 shows the lease schedule for aircraft procurement spread over five years. In year one 15 aircraft will be bought under that option, where as 33 aircraft would be leased under the lease schedule. The calculation of the Air Force perspective lease cost multiplies the number of aircraft times the sum of flying hours times lease price and flying hours times fuel cost. The formula for the first entry is

$$33 \left(\frac{FH * LP}{1,000,000} + \frac{FH * FuelC}{1,000,000} \right)$$

where

$$33 \left(\frac{FH * LP}{1,000,000} \right)$$

is the yearly Air Force lease cost, and

$$33 \left(\frac{FH * FuelC}{1,000,000} \right)$$

is the yearly Air Force fuel cost. FH is the annual flying hours per aircraft and is 920 hours for all aircraft considered. LP is the composite lease cost per flying hour, which varies among the four aircraft. FuelC is the fuel cost per flying hour, and it varies with the different aircraft. Therefore, this column actually represents the Air Force perspective of the annual lease payments and the annual fuel costs.

The Air Force perspective buy column is similar in nature. The calculation for year one would consist of

$$\text{Number of aircraft} \left(\left(\frac{\text{FH} * (\text{LP} - \text{REC})}{1,000,000} \right) + \left(\frac{\text{FH} * \text{FuelC}}{1,000,000} \right) + (15 * \text{PP}) \right)$$

where LP-REC = CLS. The purchase price of each new Cessna TTB aircraft, PP = 2.60 million dollars. The buy option for the Air Force is still purchasing the CLS on each aircraft.

The next column displays depreciation as it now stands. As mentioned before, ACRS is no longer allowed. The new laws require straight-line depreciation over an extended recovery period with no salvage value. The recovery period is determined by the ADR system and is set to be the midpoint life of the property

or 125% of the term of the lease, whichever is greater. The ADR is a set of tables that set allowances of deduction based on the category that the property falls into. The contract for the TTB aircraft is a 5 year lease with option to renew the lease (in this case for 15 additional years). The 5 year category has a mid-point of 12 years. Thus the recovery used in the analysis is 12 years, since it is greater than 6.25 years ($5 \times 125\%$).

The idea behind this is to leave the tax-exempt entity indifferent to leasing or buying the asset from a taxable entity. Its intent is to remove the incentive to lease by significantly reducing the associated tax benefits, therefore eliminating the situation where the Treasury shares another government agencies financing load. (Ref 10)

As mentioned above, the straight line column depreciates 100% of the aircraft in equal amounts over the first 12 years of the aircraft life. IRS allows only half of the aircraft that are acquired during a particular year to be depreciated during that year. For example, if 12 aircraft are to be acquired, the first year and 20 the second year the depreciation allowance for the first year is based on one-half of 12 or 6 aircraft. During the second year all the aircraft acquired in the first year may be depreciated but only one-half of those acquired in the second year (10). Thus the number of aircraft that can be depreciated

in the second year is 16 (6+10). The formula for year one is

$$.083333*PP*33/2*TR$$

where .083333 is one twelfth, PP is purchase price, 33/2 is half of the aircraft for the first year (using the half-year convention), and TR is the corporation tax rate.

The government (or Treasury) perspective simply means that any revenue loss to the Government, resulting from a decision to lease, will be captured in the analysis. With that thought in mind the government perspective lease column is calculated by

$$(1-TR)*LP + DEP$$

where TR is the corporations tax rate, LP is composite lease cost and DEP is the amount of depreciation deduction.

The government perspective buy column is easily calculated, it is simply the Air Force buy cost multiplied by (1-TR).

As previously stated the bottom line for a cost-benefit analysis is the cumulative net present cost for each option. Costs will be discounted at a constant .11 real rate for both the Air Force and government perspective.

The Air Force perspective lease cost is determined

by discounting the Air Force lease price by a 11% real discount rate

$$\sum_{t=0}^i \frac{\text{AF LP}_t}{(1+\text{AF Dsc Rt})^t} \quad \text{and}$$

the Air Force perspective buy is calculated by

$$\sum_{t=0}^i \frac{\text{AF Buy}_t}{(1+\text{AF Dsc Rt})^t} .$$

The government perspective cumulative lease cost is calculated by discounting the government lease price by a .11 real rate or simply

$$\sum_{t=0}^i \frac{\text{Govt. LP}_t}{(1+\text{Gv Dsc Rt})^t} .$$

Finally the government cumulative buy cost is determined by discounting the government buy calculations by a .11 real

discount factor or

$$\sum_{t=0}^n \frac{\text{Govt. Buy}_t}{(1 + \text{Gv Dsc Rt})^t}$$

The first aircraft to be considered in the analysis will be the Cessna Citation II. Again Tables IV-1 and IV-2 provide the information for this aircraft. The results in Table IV-2 indicate that at a nominal discount rate of 14% (current rates for long term Treasury bills), or equivalently a real rate of 11 percent with an annual inflation rate of 3%, leasing saves the Air Force 137.14 million dollars.

Unfortunately, this is not the case from the government's perspective. Table IV-2 shows that it costs the government 34.82 million dollars more to lease than it does to buy. Thus for this aircraft the government will prefer to buy.

Tables IV-3 and IV-4 give similar information for the Gates Learjet 35. In this case the Air Force Perspective indicates a cost savings of 182.06 million dollars to the Air Force if the decision is made to lease. On the other hand the government perspective indicates that it will cost the government 44.48 million dollars more to lease than it will to buy the Gates Learjet. Obviously the government would prefer to buy this

TABLE IV-3

TTD TYPE GATES Learjet 35

LEASE 598.98
 PURCHASE 3.41
 RECOVERY 238.00 Maintcost 360.98
 TAX-RATE 0.46
 FLY HRS.. 920.00
 QUANTITY 225.00
 T-BILL RT 0.14
 INFLATION 0.03
 AF Dsc Rt 0.11
 Gv Dsc Rt 0.11
 FUEL COST 210.00

Year	Number to BUY	Number to LEASE	AF Perspective		Strt Line	Govt Perspective	
			Lease	Buy		Lease	Buy
1	15	33	24.56	59.03	2.16	15.42	31.88
2	36	60	72.63	149.55	8.24	47.45	80.76
3	48	74	127.70	215.68	16.99	85.95	116.47
4	48	12	136.63	240.90	22.61	96.40	130.09
5	48	21	223.87	266.11	24.77	145.66	143.70
6	30	0	148.85	220.49	26.14	106.52	119.07
7	0	0	148.85	118.19	26.14	106.52	63.82
8	0	0	148.85	118.19	26.14	106.52	63.82
9	0	0	148.85	118.19	26.14	106.52	63.82
10	0	0	148.85	118.19	26.14	106.52	63.82
11	0	0	148.85	118.19	26.14	106.52	63.82
12	0	0	148.85	118.19	26.14	106.52	63.82
13	0	0	148.85	118.19	24.05	104.43	63.82
14	0	0	148.85	118.1	20.13	100.51	63.82
15	0	0	148.85	118.1	15.29	95.67	63.82
16	0	0	148.85	118.19	14.51	94.89	63.82
17	0	0	148.85	118.19	13.20	93.58	63.82
18	0	0	148.85	118.19	0.00	80.38	63.82
19	0	0	148.85	118.19	0.00	80.38	63.82
20	0	0	148.85	118.19	0.00	80.38	63.82
21	0	0	124.29	110.31	0.00	67.12	59.57
22	0	0	79.64	91.40	0.00	43.00	49.36
23	0	0	24.56	66.19	0.00	13.26	35.74
24	0	0	15.63	40.97	0.00	8.44	22.13
25	0	0	0.00	15.76	0.00	0.00	8.51
TOTALS	225	200	3062.30	3131.11	344.96	1998.60	1690.80

TABLE IV-4

Gates Learjet
Cumulative Net Present Cost
Lease vs Buy
Discounted cost at .11 Real Rate

AF Perspective		Govt Perspective	
Lease	Buy	Lease	Buy
22.13	53.18	13.89	28.72
81.07	174.56	52.41	94.26
174.45	332.27	115.25	179.42
264.45	490.95	178.75	265.11
397.31	648.88	265.20	350.39
476.89	766.76	322.15	414.05
548.59	823.69	373.46	444.79
613.18	874.98	419.68	472.49
671.37	921.18	461.32	497.44
723.79	962.81	498.84	519.92
771.02	1000.31	532.64	540.17
813.57	1034.09	563.08	558.41
851.90	1064.53	589.98	574.85
886.43	1091.95	613.29	589.65
917.54	1116.65	633.29	602.99
945.57	1138.91	651.16	615.01
970.82	1158.96	667.03	625.84
993.57	1177.02	679.32	635.59
1014.06	1193.29	690.38	644.38
1032.52	1207.95	700.35	652.29
1046.41	1220.28	707.85	658.95
1054.43	1229.48	712.18	663.92
1056.66	1235.48	713.38	667.16
1057.93	1238.83	714.07	668.97
1057.93	1239.99	714.07	669.59
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1057.93	1239.99	714.07	669.59

TABLE IV-5

TTB TYPE British Aerospace HS 125-700

LEASE 1054.00
 PURCHASE 6.00
 RECOVERY 419.49 Maintcost 634.51
 TAX-RATE 0.46
 FLY HRS.. 920.00
 QUANTITY 225.00
 T-BILL RT 0.14
 INFLATION 0.03
 AF Dsc Rt 0.11
 Gv Dsc Rt 0.11
 FUEL COST 210.00

Year	Number to BUY	Number to LEASE	AF Perspective		Strt Line	Govt Perspective	
			Lease	Buy		Lease	Buy
1	15	33	38.38	101.65	3.79	24.52	54.89
2	36	60	114.15	255.62	14.49	76.13	138.04
3	48	74	200.20	364.92	29.90	138.01	197.06
4	48	12	214.16	402.21	39.79	155.43	217.19
5	48	21	364.58	439.51	43.58	240.46	237.33
6	30	0	232.58	354.81	46.00	171.59	191.60
7	0	0	232.58	174.81	46.00	171.59	94.40
8	0	0	232.58	174.81	46.00	171.59	94.40
9	0	0	232.58	174.81	46.00	171.59	94.40
10	0	0	232.58	174.81	46.00	171.59	94.40
11	0	0	232.58	174.81	46.00	171.59	94.40
12	0	0	232.58	174.81	46.00	171.59	94.40
13	0	0	232.58	174.81	42.32	167.91	94.40
14	0	0	232.58	174.81	35.42	161.01	94.40
15	0	0	232.58	174.81	26.91	152.50	94.40
16	0	0	232.58	174.81	25.53	151.12	94.40
17	0	0	232.58	174.81	23.23	148.82	94.40
18	0	0	232.58	174.81	0.00	125.59	94.40
19	0	0	232.58	174.81	0.00	125.59	94.40
20	0	0	232.58	174.81	0.00	125.59	94.40
21	0	0	194.20	163.16	0.00	104.87	88.11
22	0	0	124.43	135.19	0.00	67.19	73.00
23	0	0	38.38	97.90	0.00	20.72	52.86
24	0	0	24.42	60.60	0.00	13.19	32.73
25	0	0	0.00	23.31	0.00	0.00	12.59
TOTALS	225	200	4801.52	4846.27	606.97	3199.79	2616.99

TABLE IV-6

British Aerospace HS 125-700
 Cumulative Net Present Cost
 Lease vs Buy
 Discounted cost at .11 Real Rate

AF Perspective		Govt Perspective	
Lease	Buy	Lease	Buy
34.57	91.58	22.09	49.45
127.22	299.05	83.88	161.49
273.60	565.88	184.79	305.57
414.67	830.82	287.18	448.65
631.03	1091.65	429.88	589.49
755.38	1281.35	521.61	691.93
867.40	1365.55	604.26	737.40
968.32	1441.40	678.72	778.36
1059.24	1509.74	745.80	815.26
1141.15	1571.31	806.23	848.51
1214.94	1626.78	860.67	878.46
1281.42	1676.74	909.72	905.44
1341.31	1721.76	952.96	929.75
1395.27	1762.32	990.32	951.65
1443.88	1798.85	1022.19	971.38
1487.67	1831.77	1050.64	989.16
1527.12	1861.42	1075.89	1005.17
1562.67	1888.14	1095.08	1019.60
1594.69	1912.21	1112.37	1032.59
1623.53	1933.89	1127.95	1044.30
1645.23	1952.12	1139.67	1054.15
1657.76	1965.73	1146.43	1061.49
1661.24	1974.61	1148.31	1066.29
1663.24	1979.56	1149.39	1068.96
1663.24	1981.28	1149.39	1069.89

TABLE IV-7

TTB TYPE CANADAIR Challenger 600

LEASE 1756.50
 PURCHASE 10.00
 RECOVERY 698.87 Maintcost 1057.63
 TAX-RATE 0.46
 FLY HRS.. 920.00
 QUANTITY 225.00
 T-BILL RT 0.14
 INFLATION 0.03
 AF Dsc Rt 0.11
 Gv Dsc Rt 0.11
 FUEL COST 310.00

Year	Number to BUY	Number to LEASE	AF Perspective		Strt Line	Govt Perspective	
			Lease	Buy		Lease	Buy
1	15	33	62.74	168.87	6.32	40.20	91.19
2	36	60	186.81	424.17	24.15	125.03	229.05
3	48	74	327.50	604.56	49.83	226.68	326.46
4	48	12	350.31	664.96	66.32	255.48	359.08
5	48	21	600.24	725.35	72.64	396.77	391.69
6	30	0	380.24	583.10	76.67	281.99	314.87
7	0	0	380.24	283.10	76.67	281.99	152.87
8	0	0	380.24	283.10	76.67	281.99	152.87
9	0	0	380.24	283.10	76.67	281.99	152.87
10	0	0	380.24	283.10	76.67	281.99	152.87
11	0	0	380.24	283.10	76.67	281.99	152.87
12	0	0	380.24	283.10	76.67	281.99	152.87
13	0	0	380.24	283.10	70.53	275.86	152.87
14	0	0	380.24	283.10	59.03	264.36	152.87
15	0	0	380.24	283.10	44.85	250.18	152.87
16	0	0	380.24	283.10	42.55	247.88	152.87
17	0	0	380.24	283.10	38.72	244.04	152.87
18	0	0	380.24	283.10	0.00	205.33	152.87
19	0	0	380.24	283.10	0.00	205.33	152.87
20	0	0	380.24	283.10	0.00	205.33	152.87
21	0	0	317.50	264.23	0.00	171.45	142.68
22	0	0	203.43	218.93	0.00	109.85	118.22
23	0	0	62.74	158.54	0.00	33.88	85.61
24	0	0	39.92	98.14	0.00	21.56	53.00
25	0	0	0.00	37.75	0.00	0.00	20.38
TOTALS	225	200	7854.72	7911.99	1011.62	5253.16	4272.47

TABLE IV-8

CANADAIR Challenger 600
Cumulative Net Present Cost
Lease vs Buy
Discounted cost at .11 Real Rate

AF Perspective		Govt Perspective	
Lease	Buy	Lease	Buy
56.52	152.14	36.22	82.15
208.14	496.40	137.69	268.06
447.60	938.46	303.44	506.77
678.36	1376.48	471.74	743.30
1034.58	1806.95	707.20	975.75
1237.86	2118.69	857.97	1144.09
1421.01	2255.05	993.79	1217.73
1585.00	2377.90	1116.16	1284.06
1734.65	2488.57	1226.39	1343.83
1868.56	2588.27	1325.71	1397.67
1989.20	2678.09	1415.18	1446.17
2097.89	2759.01	1495.79	1489.87
2195.81	2831.92	1566.82	1529.23
2284.02	2897.59	1628.15	1564.70
2363.49	2956.76	1680.44	1596.65
2435.09	3010.07	1727.12	1625.44
2499.59	3058.09	1768.51	1651.37
2557.69	3101.35	1799.89	1674.73
2610.04	3140.33	1828.16	1695.78
2657.21	3175.44	1853.63	1714.74
2692.68	3204.97	1872.79	1730.68
2713.16	3227.01	1883.85	1742.59
2718.85	3241.39	1886.92	1750.35
2722.11	3249.41	1888.68	1754.68
2722.11	3252.18	1888.68	1756.18
2722.11	3252.18	1888.68	1756.18

aircraft as well.

Truly accurate lease cost figures were not available for the foreign made aircraft (the British Aerospace HS 125-700 and the Canadair Challenger 600). The actual lease price for this aircraft will probably be much more expensive than the current lease information used in this analysis. Therefore, only the buy options will be used for comparisons with the other aircraft. The tax reflows normally available to the government through a sale or a lease, will not be available if dealing with a foreign country. This simply means that the government perspective will not reflect the tax reflows or the depreciation allowances. For these two aircraft the government perspective will be the same as the Air Force Perspective. The first foreign aircraft to be considered is the British Aerospace HS 125- It costs 6 million dollars per aircraft and using Tables IV-5 and IV-6 can be shown to cost the government 1.981 billion dollars to buy.

The last aircraft in the study, the Canadair Challenger 600 costs 10 million a copy and would cost the government 3.252 billion dollars to purchase (Tables IV-7 and IV-8).

Table IV-9 shows the comparative results of the analysis accomplished on the four aircraft under consideration as the new TTB aircraft and thus implement Specalized Undergraduate Pilot Training.

TABLE IV-9
COST COMPARISONS

AIRCRAFT	AF Perspective		Govt. Perspective	
	Lease	Buy	Lease	BUY
Cessna Citation II	771 M	909 M	526 M	491 M
Gates Learjet 35	1.08 B	1.24 B	714 M	670 M *
British Aerospace 125-700		1.98 B		1.98 B *
Canadair Challenger 600		3.25 B		3.25 B

*The government perspective buy cost for these two aircraft will reflect the Air Force perspective buy cost.

From Table IV-9 it is easy to see that buying the Cessna Citation II is the most economically efficient choice for the the government. Buying the aircraft rather than leasing it saves the government 34.14 million dollars. The second most economically efficient choice for the government appears to be to lease the Cessna Citation. This saves the government 143.93 million dollars over buying the Gates Learjet. Strictly looking at the Gates Learjet, it is 44.48 million dollars more costly to lease than to buy. The other two aircraft appear to be much too expensive for the Air Force to realistically fund at the

present time.

Finally it appears that it is always cheaper to buy than to lease from the government's perspective, and it is always cheaper to lease than to buy from the Air Force's perspective. It appears that this is certainly valid for the parameters used in this study, but is it always the case? Suppose some of these parameters changed, would the outcome still be the same? At this point sensitivity analysis could be employed to reveal more insight on the potential outcome. Sensitivity analysis allows the decision maker to vary certain parameters to see how these changes will effect the outcome.

Sensitivity Analysis will be accomplished with two parameters 1) the government discount rate and 2) the fuel cost. The discount rate will be varied from 5 to 17 percent to see if our decision is sensitive to this parameter and if it is, at what point this occurs.

For this example the Cessna Citation II will be used since it was the best choice in the analysis. Table IV-10 shows the results of discount rate sensitivity analysis. The first column represents the lease and buy figures from an Air Force perspective. Column four and five represent the lease and buy figures from the government perspective. The costs are in millions of dollars.

TABLE IV-10

DISCOUNT RATE SENSITIVITY ANALYSIS
FOR THE CESSNA CITATION

Discount Rate	Air Force Lease	Perspective Buy	Government Lease	Perspect Buy
3 %	\$1592.95	\$1678.67	\$1061.41	\$906.48
5 %	\$1299.85	\$1407.31	\$ 872.28	\$759.95
7 %	\$1077.44	\$1199.61	\$ 727.35	\$647.79
9 %	\$ 906.00	\$1037.60	\$ 614.62	\$560.30
11 %	\$ 771.82	\$ 908.96	\$ 525.66	\$490.84
13 %	\$ 665.31	\$ 805.12	\$ 454.50	\$434.36
15 %	\$ 579.60	\$ 720.00	\$ 396.86	\$388.80
16 %	\$ 542.95	\$ 683.05	\$ 372.10	\$368.85
16.5 %	\$ 525.95	\$ 665.78	\$ 360.59	\$359.52
16.8 %	\$ 517.75	\$ 657.43	\$ 355.00	\$355.04
17 %	\$ 509.76	\$ 649.25	\$ 349.62	\$350.60

From Table IV-10 it is apparent that the point at which the government becomes indifferent to leasing or buying occurs at a discount rate of 16.8 percent. At discount rates below this amount the government will prefer to buy and at discount rates above this amount they will prefer to lease. This rate was also applied to the other aircraft to see if the results would change the overall ranking. Table IV-11 displays the breakdown for the other aircraft using a 16.8 discount rate.

TABLE IV-11

SENSITIVITY ANALYSIS AT 16.8 PERCENT
(Millions of Dollars)

Aircraft	Air Force Perspective		Government Perspective	
	Lease	Buy	Lease	Buy
Cessna Citation II	\$517.75	\$657.43	\$355.00	\$355.04
Gates Learjet	\$709.39	\$892.48	\$482.03	\$481.91
British		\$1443.63		\$1443.63
Canadiar		\$2374.49		\$2374.49

From Table IV-11 it would appear that 16.8 percent is very close to the point at which the government becomes indifferent to leasing or buying. The reason this occurs is that much of the money for the buy option is up front in the first five

years. The greater the initial outlay the greater the discounted value at the end. The converse of this is true for the lease option. Its outlay initially is lower and naturally its discounted value at the end is lower. How then does discount rates affect the analysis? With lower discount rates the lease option is less attractive, the cost savings resulting from deferred payments becomes much less significant. With higher discount rates the outlay in the earlier years becomes much more significant and the lease option grows more attractive as the government discount rate increases.

2) Fuel cost: For the fuel cost sensitivity analysis the fuel cost was decreased by one-third of its total price. The new net present cost values for the four aircraft are listed in Table IV-12. The British Aerospace has the same fuel efficiency (Table IV-4) as the Gates Learjet even though it is almost twice as heavy and much more expensive. Even with the superior fuel efficiency it was able to make up very little ground on the Cessna in net present value. The Cessna Citation II buy option was still the hands down winner. The net present value calculations in Table IV-12 use the government perspective buy options for all four aircraft.

TABLE IV-12

SENSITIVITY ANALYSIS FOR FUEL COST

Aircraft	Fuel Cost (Dollars)	New F.C. (Millions)	NPV Cost (Millions)	Saves (Million)	New NPV (Millions)
Cessna	\$130	\$87	\$490.84	\$29.08	\$461.76
Gates	\$210	\$140	\$669.59	\$47.33	\$622.26
British	\$210	\$140	\$1981.28	\$47.33	\$1933.85*
Canadaair	\$310	\$207	\$3252.18	\$69.64	\$3182.54*

*For these two aircraft the government perspective buy cost will reflect the Air Force perspective buy cost.

This chapter has rank ordered the alternative TTB aircraft using net present cost. The best alternative appears to be the Cessna Citataion II. Two types of sensitivity analysis were accomplished and the relative ranking of the alternatives was virtually unchanged. The Cessna Citation II is the most economically efficient aircraft based on a net present cost analysis.

V. COMPARISON OF STUDY RESULTS WITH PREVIOUS ATC STUDY

In early 1983, Air Training Command performed a very detailed analysis to determine whether it would be more economically efficient to lease or buy a new TTB aircraft. The Secretary of the Air Force had recently approved Specialized UPT, but a new aircraft was needed to implement this new training system.

ATC performed this study in three phases, and in effect used 3 different Measures of Effectiveness. The first portion of the study took constant lease and buy money streams and summed them over the term of the procurement contract (20 years).

$$\text{Net Present Cost} = \sum_{t=0}^i C_t$$

where C is the lease payment or buy payment in year t in constant dollars and i is the number of years of the contract period. This has the same effect as taking the sum of then-year dollars

discounted by the expected inflation rate (i.e. with inflation taken out). This calculation assumes the government real discount rate is 0 percent. Or mathematically,

$$\sum_{t=0}^i \frac{F_t}{(1+I)^t (1+\theta)^t}$$

where F is the then-year-dollar stream of lease or buy payments, and I is the inflation rate. Mathematically,

$$\sum_{t=0}^i C_t = \sum_{t=0}^i \frac{F_t}{(1+I)^t (1+\theta)^t}$$

In the second portion of their study, Air Training Command took the Air Force perspective in their research analysis. They took the constant dollar streams (payments) and discounted these value streams by a real discount, d . Mathematically,

$$\sum_{t=0}^i \frac{C_t}{(1+d)^t}$$

where C_t is a constant dollar stream, d is the real discount rate, and t is the contract year. (In their analysis d was set at 10 percent.) This is a net present value sum over t years, where t ranges from 0 to i . By discounting the Air Force is now taking into account the time value of money. This has the same effect as summing then-year-dollar streams discounted by the inflation rate and also by a real government discount rate, or mathematically

$$\sum_{t=0}^i \frac{F_t}{(1+I)^t (1+d)^t}$$

where F_t are then-year-dollars discounted by a inflation rate of I and a real discount rate of d over the contract period i .

The above term is equivalent to then year dollars discounted

by a nominal discount rate (nominal rate includes inflation).

$$\sum_{t=0}^i \frac{F_t}{(1+n)^t}$$

F_t is the then-year-dollar value streams and n is the nominal discount rate. Therefore,

$$\sum_{t=0}^i \frac{C_t}{(1+d)^t} = \sum_{t=0}^i \frac{F_t}{(1+I)^t (1+d)^t} = \sum_{t=0}^i \frac{F_t}{(1+n)^t}$$

Using the sum of constant dollars over the life of the lease or buy period, the Air Training Command found that it cost between 46.610 million and 355.949 million dollars less to buy than it did to lease.

Using the Air Force perspective and discounting the constant dollars by a real discount rate of 10 percent, ATC found that it was actually 273.925 million dollars less to lease than it was to buy.

Under the final portion of their study, ATC found that by summed then year dollars using a discount rate of 0 percent. It cost 439.277 million dollars more to lease than it did to buy.

These three methods will now be used with the current data and compared to the results that ATC arrived at. The first method will compare the cost in constant dollars with 0 discount rate for the four aircraft. Table V-1 shows the result of the comparison.

TABLE V-1
AIR FORCE PERSPECTIVE
COSTS IN CONSTANT DOLLARS

Aircraft	Air Force Perspective	
	Lease	Buy
Cessna Citation II	\$2231.86 M	\$2266.71 M
Gates Learjet 35	\$3062.30 M	\$3131.11 M
British Aerospace HS 125-700	*	\$4846.27 M
Canadair Challenger 600	*	\$7911.99 M

*There is no lease option for these aircraft.

Table V-2 shows the best options when judged strictly on the summation of constant dollars.

TABLE V-2

BEST OPTION USING CONSTANT DOLLARS AND AF PERSPECTIVE

Aircraft	Best Option	Apparent Savings
Cessna Citation II	Lease	34.45 Million
Gates Learjet 35	Lease	68.81 Million
British Aerospace HS	Buy	*
Canadair Challenger	Buy	*

*There is no lease option for these two aircraft.

It appears that from the Air Force Perspective it is always less expensive to lease than it is to buy, when using constant dollars as the measure of effectiveness.

Now the constant lease and buy payments will be discounted at a real rate of 10 percent. The results are displayed in Table V-3.

TABLE V-3
AIR FORCE PERSPECTIVE
LEASE VERSUS BUY USING DISCOUNTED CONSTANT DOLLARS
10 PERCENT REAL RATE
CUMULATIVE NET PRESENT COSTS

Aircraft	Air Force Perspective	
	Lease	Buy
Cessna Citation II	\$834.93 M	\$969.71 M
Gates Learjet	\$1144.53 M	\$1324.16 M
British Aerospace		\$2110.56 M
Canadair Commander		\$3462.96 M

Table V-4 shows the best option using Air Force perspective and discounting by a real rate of 10 percent.

TABLE V-4
AIR FORCE PERSPECTIVE
BEST OPTION USING DISCOUNTED CONSTANT DOLLARS
WITH 10 PERCENT REAL RATE

Aircraft	Option	Apparent Savings
Cessna Citation	Lease	\$134.78 M
Gates Learjet	Lease	\$179.63 M
British Aerospace		*
Canadair Commander		*

*Only a buy option for these aircraft.

Again it appears that the best option for the Air Force is to lease when taking the Air Force perspective and discounting at a real rate of 10 percent.

The final analysis will consider the Air Force perspective using then-year dollars (current dollars). An inflation rate of 3 percent will be used. Table V-5 shows the results of this portion of the analysis.

TABLE V-5
AIR FORCE PERSPECTIVE USING THEN-YEAR DOLLARS
INFLATION RATE OF 3 PERCENT

Aircraft	Air Force Perspective	
	Lease	Buy
Cessna Citation	\$3224.14	\$3180.48
Gates Learjet	\$4424.98	\$4409.03
British Aerospace		\$6933.20
Canadair Challenger		\$11340.50

It would seem that in this case the buy option is always the most economical. Table V-6 shows the possible savings.

TABLE V-6
APPARENT SAVINGS USING THEN YEAR DOLLARS
INFLATION RATE OF 3 %

Aircraft	Option	Apparent Savings
Cessna Citaion	Buy	\$43.66 M
Gates Learjet	Buy	\$15.95 M
British		*
Canadair		*

*There is no lease option for these aircraft.

Table V-7 gives a summary of Tables V-1 through V-6.

TABLE V-7
SUMMARY OF THREE METHODS OF ANALYSIS

Aircraft	Constant Dollars		Discounted 10%		Then Year \$	
	Lease	Buy	Lease	Buy	Lease	Buy
Cessna	2231.86	2266.71	834.93	969.71	3224.14	3180.48
Gates	3062.30	3131.11	1144.53	1324.16	4424.98	4409.03
British		4846.27		2110.56		6761.81
Canadair		7911.99		3452.96		11021.6

The best option for each category is underlined above.

Using the analysis that ATC recommends this would be the cost for procurement. Table V-8 shows a comparison between the analysis used in the previous chapter (this time with a 10 % discount rate as ATC used) and the results from Table V-7.

TABLE V-8
COMPARISON OF ANALYSIS METHODS

Aircraft	Air Force Perspective			Govt. Perspective	
	Constant\$	Discounted\$	Then Year\$	NPV Cost\$	
Best Option	Lease	Lease	Buy	Buy	Lease
Cessna	\$2231.86	\$834.93	\$3180.48	\$490.84	\$525.66
Gates	\$3062.30	\$1144.53	\$4409.03	\$669.59	\$714.07
British			\$6761.81	\$1139.70	
Canadair			\$11021.60	\$1870.00	

Using the recent OMB/Treasury guidance it is obvious that a buy would be the best alternative in all four cases. The first 2 portions of ATC's study is obviously in error. Just summing the constant dollars does not take into account the time value of money which is essential in this type of analysis. In addition, being an Air Force perspective, it does not take into account the tax impact.

The second portion of their analysis does consider the time value of money but again disregards the tax impact. The apparent savings in Table V-5 and V-6 would have been very real losses had a lease been made.

The final portion of their study came up with the proper answer but again they failed to discount their costs which could

be very misleading. (If the costs had been discounted it would have shown leasing is cheaper than buying).

There is no explanation of why ATC accomplished their study in three parts. But it is obvious that their methodology never took a government perspective as directed by recent OMB guidance. With the new guidance there should be much less confusion in the future and much less of a chance of public sector managers erroneously taking only their services perspective.

VI. CONCLUSIONS AND RECOMMENDATIONS

Air Training Command plans to divide Undergraduate Pilot Training into a dual track training system. All students would go through initial training in the T-37 aircraft (T-46A when operational). Upon completion of the T-37 phase the students would meet an Advanced Training Recommendation Board. This board would recommend students for either the fighter-attack-reconnaissance (FAR) track or the transport-tanker-bomber (TTB) track. Those students selected for the FAR track would continue further training in the T-38 aircraft. The students selected for the TTB track would continue in a TTB trainer aircraft. ATC already has Secretary of the Air Force approval for this dual track system, Specialized UPT. They are convinced it is absolutely essential for their training purposes that Specialized UPT be implemented at the earliest possible date. But in order to initiate this new training system a new aircraft must be procured to fill this new training role.

The research question for the study was to determine the best alternative for ATC to pursue for procurement of the TTB aircraft considering the four aircraft under consideration. Due to timing problems with funding for other new aircraft (T-

46A, B-1, etc.), ATC is faced with a major funding problem. Therefore, it is absolutely essential that they secure the most attractive procurement package available. The purpose then for this study is to determine that best alternative. Since four different aircraft were under consideration it was necessary to expand the analysis to include lease versus buy information for all four aircraft.

The study focused on two alternative forms of financing (leasing and buying) and the four aircraft to select from. All of the aircraft either meet or exceeded the requirements imposed by ATC, thus elimination of any of the aircraft on that basis was impossible.

The Department of Defense and many of its services had suffered much confusion as to how this type of analysis should properly be accomplished. The individual services were performing analysis from their perspective only, with little regard for the overall impact on the Treasury. Tax laws had undergone many changes over a short period of time. These changes included increased depreciation allowances (ACRS) and investment tax credits. The intention of these laws had been to spur the economy but much of the results was to deplete the Treasury. The numerous tax incentives contributed significantly to misunderstandings on how proper lease/buy calculations should be accomplished. Addressing this problem OMB/Treasury set down a specific methodology as to how lease versus buy analysis should

and would be accomplished. They directed the use of net present value of costs calculation for each alternative. The option with the smaller net present value of cost would be the winner.

The methodology used for this study differed only slightly from that laid down by OMB. In this study constant dollar cost streams were used rather than current dollars as directed by OMB. This doesn't present a problem because the constant dollars are discounted by a real discount rate which is equivalent to discounting current dollars at a nominal discount rate. A thorough development of equivalent service and government (Treasury) perspectives was presented for the analysis. This development does not include the economic depreciation term as used by OMB, therefore it was not used in this study. The service and government perspectives were carried throughout the analysis. This was done to add insight and reflect the view each one was taking. It also makes the significance of the tax impact much clearer.

An 11 percent real discount rate was used for the study based on current OMB information. This discount rate was used to determine the Air Force's cumulative net present value of costs for each aircraft. Adjustments were then made to account for the tax and depreciation allowances to arrive at the government perspective. After calculating net present value of costs for the lease and buy options on all four aircraft, the results were compared. The findings showed that from a service perspective it

was always cheaper to lease than to buy. From the government perspective it was always less to buy than it is to lease. The study also indicated that the Air Force should pursue procurement of a new TTB aircraft by buying the Cessna Citation II. The second best alternative would be to lease the Cessna . Buying the Cessna would save the government 34.82 million dollars over leasing it. While leasing the Cessna saved 143.93 million dollars over the purchase of the next best alternative, the Gates Learjet. As far as the Gates Learjet, it is 44.48 million dollars less to buy than it is to lease.

Setting the government discount rate has come under much discussion and much disagreement. Numerous rates were being used in public sector analysis. To alleviate this problem OMB guidance directed the use of a discount rate equivalent to the interest paid on long term treasury notes. To avoid making a recommendation based on a discount rate subject to change, additional analysis was accomplished. The discount rate was varied from 5% to 17%, and additional analysis was accomplished on the Cessna Citation. This analysis revealed that in order to reach a point where the government lease and buy costs would be identical, the real discount rate would have to climb to 16.8%. Similar analysis on the other aircraft revealed almost identical results.

The sensitivity analysis revealed that with lower discount rates the lease option becomes less attractive, the cost savings from deferred payments becomes much less significant. As discount rates rise to a higher level, the outlay in the initial years becomes much more of a factor and the lease option grows more attractive. Given a high enough discount rate the lease option would become the preferred method of procurement. Regardless of the discount rate though, the Cessna was still the best choice of aircraft from an economical standpoint.

Sensitivity analysis was accomplished on fuel costs with very little overall effect. Fuel prices were reduced by one-third for all aircraft, but the rank order remained the same.

The results of the study were compared to the results of a recent ATC study concerning acquisition of a TTB. It seems ATC was unsure how they would structure their analysis. They basically used three different measures of effectiveness to get their results. ATC never addressed the government perspective or the tax impact issue, but most of the other services were making similar mistakes. Additionally the first portion of their study summed constant dollar costs over the 20 year period. This method does not take into account the time value of money.

In the second portion of their study ATC recognized the need to discount their dollars but continued to only use the Air Force perspective. The third and final portion of the study

summed then year or current dollars, again with no regard for discounting. It is unclear why ATC performed the study as they did. It seems they were either confused about how to properly structure the analysis, or they were trying to cover all extreme cases. Either way their analysis was not based on a government perspective.

The research question has been answered using the parameters presented in this study. Additional studies should be accomplished by ATC when more information becomes available, using the government perspective methodology.

APPENDIX: MULTIPLAN PROGRAM

"AF Perspect"

• • • • •

'Lease'

[illegible]

```

200*((FH*LP/1000000
)+(FUELC*FH)/100000
0)
200*((FH*LP/1000000
)+(FUELC*FH)/100000
0)
200*((FH*LP/1000000
)+(FUELC*FH)/100000
0)
200*((FH*LP/1000000
)+(FUELC*FH)/100000
0)
200*((FH*LP/1000000
)+(FUELC*FH)/100000
0)
167*((FH*LP/1000000
)+(FUELC*FH)/100000
0)
107*((FH*LP/1000000
)+(FUELC*FH)/100000
0)
33*((FH*LP/1000000
)+(FUELC*FH)/1000000
)
21*((FH*LP/1000000
)+(FUELC*FH)/1000000
)
0*((FH*LP/1000000)+
(FUELC*FH)/1000000)

```

```

*-----*
SUM(R24:48C4)

```

[illegible][illegible]

225*((FH*(LP-REC)/1
 000000)+(FUELC*FH/1
 000000))
 225*((FH*(LP-REC)/1
 000000)+(FUELC*FH/1
 000000))
 225*((FH*(LP-REC)/1
 000000)+(FUELC*FH/1
 000000))
 225*((FH*(LP-REC)/1
 000000)+(FUELC*FH/1
 000000))
 210*((FH*(LP-REC)/1
 000000)+(FUELC*FH/1
 000000))
 174*((FH*(LP-REC)/1
 000000)+(FUELC*FH/1
 000000))
 126*((FH*(LP-REC)/1
 000000)+(FUELC*FH/1
 000000))
 78*((FH*(LP-REC)/10
 00000)+(FUELC*FH/10
 00000))
 30*((FH*(LP-REC)/10
 00000)+(FUELC*FH/10
 00000))

 SUM(R24:48C5)

"Strt"
"Line"

RC[-3]/2*(0.0833333
*PP*TR)
(33*RC[-3]/2)*(0.08
33333*PP*TR)
(93*(RC[-3]/2))*(0.
0833333*PP*TR)
(167*RC[-3]/2)*(0.0
833333*PP*TR)
(179*RC[-3]/2)*(0.0
833333*PP*TR)
(200)*(0.0833333*PP
*TR)
(200)*(0.0833333*PP
*TR)
(200)*(0.0833333*PP
*TR)
(200)*(0.0833333*PP
*TR)
(200)*(0.0833333*PP
*TR)
(200)*(0.0833333*PP
*TR)
(200)*(0.0833333*PP
*TR)
(200)*(0.0833333*PP
*TR)
(184)*(0.0833333*PP
*TR)
(154)*(0.0833333*PP
*TR)
117*0.083333*PP*TR
111*0.083333*PP*TR
101*0.083333*PP*TR
0*0.083333*PP*TR
0*0.083333*PP*TR
0*0.083333*PP*TR
0*0.083333*PP*TR
0*0.083333*PP*TR
0*0.083333*PP*TR
0*0.083333*PP*TR
0*0.083333*PP*TR

"-----"
SUM(R24:48C6)

"Lease"

79

"Govt Perspective"

"-----"

"Buy"

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

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(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

(1-TR)*RC[-3]

"-----"

SUM(R24:48C8)

"Cumulative"
"AF Perspective"
"-----"
"Lease"

$$\begin{aligned} & RC[-5]/(1+PRETAX)^1 \\ & (RC[-5]/(1+PRETAX))^2 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^3 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^4 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^5 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^6 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^7 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^8 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^9 \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{10} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{11} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{12} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{13} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{14} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{15} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{16} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{17} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{18} \\ & RC[-8]+RC[-1]C \\ & (RC[-5]/(1+PRETAX))^{19} \\ & RC[-8]+RC[-1]C \end{aligned}$$

"Cumulative"
"AF Perspective"
"-----"
"Buy"

[illegible]

[illegible]

"Cumulative"
"Govt Perspective"
"-----"
"Buy"

[illegible]

(RCI-41)/(1+AFT)^RCI
-111)+RCI-11C

RCI-51C

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