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COMPUTER PROGRAMS FOR ESTIMATING CIVIL AIRCRAFT ECONOMICS

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SUMMARY

Computer programs were developed to calculate airline direct operating cost, indirect operating cost, and return on investment. These programs provide a means for determining commercial aircraft life-cycle cost and economic performance. The program codes can be easily incorporated into existing aircraft design programs. A representative wide-body subsonic jet aircraft was evaluated to illustrate use of the programs.

INTRODUCTION

Those engaged in developing advanced aircraft must evaluate technology candidates for possible incorporation into the aircraft. This is usually done by attempting to understand such trades as: range versus payload; aerodynamic, propulsion, and structural interactions (impact on weight and fuel burned); and noise reduction versus performance change. Also critical, however, to any decision on whether or not to incorporate a suggested beneficial technological advance, is knowledge of the cost of developing the new technology and how it will affect the aircraft's economic performance over its lifetime. The technical tradeoffs made in preliminary aircraft analysis are usually accomplished by complex computer programs which contain individual segments representing the various aeronautical disciplines but lack a means of evaluating the aircraft's economics. Airframe manufacturers and others have developed computer programs to perform these calculations; however, these programs are not available in the open literature. In an effort to fill this need, two computer programs were developed. These programs, while not totally representative of the actual costs which an airline would incur, are sufficient to establish the overall impact which a proposed advanced technology might have on operating cost. This report describes a program that calculates Direct Operating Cost (DOC) (and its sensitivity to a number of parameters), and also a program which calculates Return on Investment (ROI). The ROI program is based on the Direct Operating Cost (DOC) and Indirect Operating Cost (IOC) of the airplane, and also on the discounted cash flow concept. Knowledge of the direct operating cost and its sensitivity to various parameters is sufficient for many advanced aircraft evaluations (ref. 1). An airline's return on investment, however, is the final and most important measure of the efficiency of a commercial aircraft.

Computer codes are compatible with the CDC 6600 computer system. The DOC model is based on the standard Air Transportation Association model (ref. 2) using 1976 cost coefficients (obtained from the Boeing Commercial Airplane Company). The indirect operating cost model is based on a model obtained from the Lockheed-Calfornia Company (ref. 3) using 1976 cost data. Sample calculations are provided to illustrate use of the program.

DESCRIPTION OF COMPUTER PROGRAMS

Direct Operating Cost Program

The DOC program determines costs related to the operation of a subsonic aircraft in making a specific flight. Direct Operating Cost is made up of the following elements: flight operations (which includes crew, fuel, and insurance costs), maintenance (which includes labor costs for the airframe and engine, material costs for the airframe and engine, and maintenance overhead), and depreciation cost.

Appendix A-1 presents the symbol definitions for both the input requirements and the output of the program. Table I shows the equation form used for each cost element and Table II illustrates the parameters that affect these costs. Values for cost coefficients C_1, C_2, C_3 and C_7 are given in the program listing presented in Appendix A-2. The cost coefficient subscript number refers to the order in which the coefficient first appears in the computer program.

Four options are included in the DOC program: crew size may be either two-man or three-man; engine type may be either high bypass ratio or low bypass ratio; the airplane may be either new or used; and either a domestic or international flight may be specified (see Appendix A-2).

The fuel cost includes all gas and oil burned in making the flight plus an allowance for nonrevenue producing flights. Depreciation is based on the straight-line method and is determined by prorating the price paid for the aircraft (plus an allowance for airframe and engine spares) over a baseline lifetime of 14 years. A printout of a sample run is shown in Appendix A-3. Calculations are initially made based on the aircraft's direct operating cost per mile. The printout also provides direct operating costs given in terms of DOC per block hour, DOC per flight hour, DOC per seat statute mile, and DOC per passenger statute mile.

The program also calculates the effect of specific percentage increases in each cost element on the DOC. For example, initially the DOC is found for a base fuel price. The DOC is then determined for a 100 (2F), 200 (3F), and 300 (4F) percent increase over the base fuel price. Other cost sensitivities calculated are increases of 25, 50, 75, and 100 percent in maintenance (MA), crew (CR), and airplane investment costs (AP), as well as the effect of various depreciation periods (DP) from 10 to 15 years.

Return on Investment Program

The Return on Investment program calculates the ratio of airline profit to airline investment generated by the operation of the aircraft during its entire life cycle. Appendix B-1 gives the input and output definitions, Appendix B-2 presents the program listings, and Appendix B-3 shows a sample case printout.

In addition to the direct operating cost (calculated in the same manner as already discussed), the program calculates indirect operating cost and uses a discounted cash flow method to determine the ROI.

The indirect operating cost section of the Return on Investment program determines costs indirectly attributable to the aircraft's operation. IOC is found by summing the following costs (see Table III): systems, local, aircraft control, cabin attendant, food, passenger handling, cargo handling, other passenger service, freight commissions and advertising, and general and administrative. Labor, property, equipment, and station maintenance cost (from ground facilities) is included in the systems cost. Local cost includes landing fees and servicing. Aircraft control cost includes all aircraft handling charges. Cabin attendant cost refers to the stewardesses. In the code, one stewardess is assigned for each 40 seats. The cost of food covers all food and refreshments served without charge to passengers. Passenger handling cost is actually the cost of handling the passenger's baggage. Cargo handling cost results from handling mail, freight, and express cargo. Other passenger service cost encompasses all activities related to passenger comfort, safety, and convenience. Freight commissions and advertising cost is the expense associated with creating a public preference for an individual air carrier, stimulating air travel, and providing timetables. The general and administrative cost represents cost of an overall corporate nature. Individual parameters which affect each IOC cost element are shown in Table IV. The IOC cost model assumes that some individual costs are dependent on the airplane's direct operating cost. In the program printout illustrated in Appendix B-3, IOC is presented as follows: IOC per block hour, IOC per flight hour, IOC per seat mile, IOC per passenger mile, and IOC per aircraft statute mile.

Table V illustrates the form of the equations used to calculate ROI and Table VI presents the parameters which affect its calculation. The following parameters are calculated and listed in the program printout (Appendix B-3): operating cost, revenue, cost of depreciation, profit before tax and interest, book value of aircraft, interest, income tax, profit after tax and interest, present value factor, and discounted cash flow.

Each of these parameters is determined for each year of the aircraft's life. Monies brought in by passenger fares and cargo transportation are calculated using 1976 yields and are included in the revenue data. Direct and indirect operating costs are summed and included under operating costs. Growth in revenue and operating costs can be accounted for by specifying the inflation rate expected in future years (see ROI input section, Appendix B-1).

Cost of depreciation is discussed in the direct operating cost section. Book value is the value of the aircraft during a specific year of the aircraft's life after subtracting the accumulated depreciation expense from the original airplane price. The program assumes that the investment in the aircraft is made with borrowed funds. Interest cost is based on a 10-percent interest rate; however, any desired interest rate can be input. The balance of the aircraft loan is amortized by specifying that a sum of money equal to the yearly depreciation expense is used to repay money borrowed to purchase the aircraft. This means that the amount of borrowed money outstanding at any point in time is also equal to the book value of the aircraft. Income remaining after taxes are paid is referred to as "profit after tax and interest" and this parameter varies for each year of the aircraft's life. Present value calculations are made by taking the profit after tax and interest and discounting this profit at an assumed rate in order to balance the remaining life cycle income (cash flow in) against the original cash investment (cash flow out). Cash inflow is determined for each year of the aircraft's life, and an interative calculation procedure is employed using progressively larger numbers to find the actual discount rate that will balance the discounted cash flow in against the original cash investment. The discount rate that causes all cash flows to balance is the airline's return on investment and is also known as the "internal rate of return."

The present value factor used in the discount cash flow method must always have a value between zero and one. Therefore, if the sum of the profit after taxes and interest is less than the original cash investment, the cash flows cannot be balanced and an ROI (which could be negative) cannot be calculated. In order to allow for the calculation of negative ROI values, the program calculates a constant that is added to each year's profit after taxes and interest. Application of this constant assures a positive value for the difference between the original cash investment and the adjusted profit after taxes and interest. A negative sign is then applied to the ROI.

To limit the calculations to practical values of ROI, the program calculates it within a range of ±100 percent. Should the absolute value of ROI exceed or equal 100 percent, the user is so advised in the printout.

A summary illustration of the many factors which affect a commercial airplane's ROI is given in Table VI.

SAMPLE CALCULATION

A subsonic wide-body commercial jet transport aircraft flying with a 55-percent passenger load factor over a distance of 8336 kilometers (5180 st.mi.) is used to illustrate the information which can be obtained from these economic computer programs. Input values for the sample case are given in Tables VII and VIII. A zero inflation rate is specified for both revenue and operating cost. Freight and cargo loads are considered to be essentially negligible.

Figure 1 presents the effect of increases in crew, maintenance, aircraft cost, and fuel cost on the baseline DOC. Increases in fuel cost have the greatest effect on DOC while increases in aircraft cost have about the same effect as does an increase in maintenance cost. An increase in crew cost has the smallest effect. All calculations in figure 1 (and figs. 3-6) assume the aircraft is depreciated over a 14-year period.

Figure 2 shows the effect of various depreciation time periods (10 to 15 years) on DOC.

Figure 3 illustrates the relative levels of DOC, IOC, interest, income tax, and profit for each year of the aircraft's life. Due to the assumption of zero inflation rate, DOC and IOC are constant over the aircraft's life.

Figure 4 shows the relative importance of each cost element in the DOC and the IOC over the aircraft's 14-year life cycle. In this sample case, the freight commission, airplane control, and cargo handling costs are taken as negligible. The figure also includes a summary of where the airline's revenue dollar will be used over its lifetime.

Figure 5 presents the cash flow generated by the aircraft in each year of its life (discounted to its present value) for various load factors. For load factors near the breakeven point (such as 50 percent), little variation in discounted cash flow occurs. The most profitable case, of course, is for a 100 percent load factor, for which a very high positive discounted cash flow occurs early in the aircraft's life. In later years, when positive cash flow levels are less important, the discounted cash flow tends to approach zero. A large loss occurs when the aircraft is operated with a 30-percent load factor.

The variation of return on investment with load factor is presented in figure 6. Changes in the slope of the curve result from the fact that income tax is paid only in those years in which a profit is made. For load factors above about 50-percent, a positive ROI results. In such instances, income taxes are paid and a profit is realized in each year of the aircraft's life. Below a load factor of about 30 percent, a loss is encountered each year, no income tax is ever paid, and the discounted cash flow ROI is always negative. Between load factors of about 50 percent and 30 percent, a profit may occur in some years of the aircraft's life but it will not be sufficient to return the investment made in the aircraft.

CONCLUDING REMARKS

Computer programs which calculate airline direct operating cost, indirect operating cost, and return on investment were developed to provide a computer model for determining commercial aircraft life-cycle cost and economic performance. These codes can be easily incorporated into existing aircraft design programs. A representative wide-body subsonic jet aircraft was evaluated to illustrate use of the programs.

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1. Maddalon, D. V.; and Wagner, R. D.: Energy and Economic Tradeoffs for Advanced Technology Subsonic Aircraft. NASA TM X 72833, April 1976.

2. Standard Method of Estimating Comparative Direct Operating Costs of Turbine Powered Transport Airplanes. Air Transport Association of America, December 1967.

3. Indirect Operating Cost. Lockheed-California Company Report LW 70-500R, May 1970. Also see revisions to 1969 Lockheed-California Company, Indirect Operating Expense Method Report COA 2061, July 1974.

TABLE I.- DIRECT OPERATING COST EQUATIONS

(Dollars Per Airplane Statute Mile)

FLIGHT OPERATIONS

Crew

$$= \frac{1}{\text{Block Speed}} \left(C_1 \left[(\text{Cruise Speed})\ (\text{Takeoff Gross Weight}) \right]^{C_2} + C_3 \right)$$

Fuel

$$= \frac{1}{\text{Block Distance}} \left[\frac{\left(\text{Non-revenue Factor}\right)\left(\text{Block Fuel}\right)\left(\text{Price of Fuel}\right)}{\text{Density of Fuel}} + \frac{\left(\text{No. of Engines}\right)\left(\text{Oil Burn Rate per Engine}\right)\left(\text{Block Time}\right)\left(\text{Cost of Oil}\right)}{\text{Density of Oil}} \right]$$

Insurance

$$= \frac{(\text{Insurance Rate})\ (\text{Aircraft Cost})}{(\text{Annual Utilization})\ (\text{Block Speed})}$$

MAINTENANCE

Labor on Airframe and Engine

$$= \text{Labor Rate} \left[\frac{\left(\frac{\text{Manhours}}{\text{Flight Hour}}\right)\left(\text{Flight Hours}\right) + \left(\frac{\text{Manhours}}{\text{Flight Cycle}}\right)}{(\text{Block Speed})\ (\text{Block Time})} \right]$$

Material on Airframe and Engine

$$= \left[\frac{\left(\frac{\text{Material Cost}}{\text{Flight Hour}}\right)\left(\text{Flight Hours}\right) + \left(\frac{\text{Material Cost}}{\text{Flight Cycle}}\right)}{(\text{Block Speed})\ (\text{Block Time})} \right]$$

Maintenance Burden

$$= C_7 \left[\text{Labor on Airframe and Engine} \right]$$

DEPRECIATION

Depreciation

$$= \left\{ \frac{\text{Airplane Cost} + \left[\text{Spare Airframe}\right]\left[\text{Airplane Cost} - \left(\text{No. of Engines}\right)\left(\text{Cost Per Engine}\right)\right] + \left(\text{Spare Engines}\right)\left(\text{No. of Engines}\right)\left(\text{Cost Per Engine}\right)}{(\text{Utilization})\ (\text{Block Speed})\ (\text{Depreciation Period})} \right\}$$

Note: Constants given in program listing (Appendix A-2)

TABLE II.- PARAMETERS IMPACTING ELEMENTS OF DIRECT OPERATING COST

PARAMETER	DOC COST ELEMENTS						
	Crew	Fuel	Insurance	Maintenance			Depreciation
				Labor	Material	Burden	
Takeoff gross weight	X						
Airframe weight				X	X	X	
Velocity	X		X	X	X	X	X
Fuel burned		X					
Number of engines		X					X
Block distance		X		X	X	X	
Price of fuel		X					
Price of oil		X					
Block time		X		X	X	X	
Flight time				X	X	X	
Airframe cost			X		X		X
Engine cost							X
Depreciation length							X
Utilization			X				X
Maintenance labor rate			X		X		
Insurance rate			X				
Spare airframe parts							X
Spare engine parts							X

An "X" in the Cost Element Column indicates the parameters that affect the cost element.

TABLE III.- INDIRECT OPERATING COST EQUATIONS

Systems	$= K_1$ (Block Distance) (Labor on Airframe and Engine)
Local	$= K_2$ (No. of Departures) (Takeoff Gross Weight)
Aircraft Control	$= K_3$ (No. of Departures)
Cabin Attendant	$= K_4$ (No. of Cabin Attendants) (Block Time)
Food	$= K_5 \left(\text{Block Time}\right)\left(\begin{matrix}\text{Passenger}\\ \text{Load}\\ \text{Factor}\end{matrix}\right)\left[C_4\left(\begin{matrix}\text{No. of First}\\ \text{Class Seats}\end{matrix}\right) + \left(\begin{matrix}\text{No. of Tourist}\\ \text{Class Seats}\end{matrix}\right)\right]$
Passenger Handling	$= K_6 \left(\begin{matrix}\text{Passenger}\\ \text{Load}\\ \text{Factor}\end{matrix}\right)\left(\begin{matrix}\text{No. of}\\ \text{Seats}\end{matrix}\right)$
Cargo Handling	$= K_7$ (Weight of Cargo)
Other	$= K_8 \left(\begin{matrix}\text{Passenger}\\ \text{Load Factor}\end{matrix}\right)$ (No. of Seats) (Block Distance)
Freight Commissions and Advertising	$= K_9$ (Weight of Cargo) (Block Distance)
General and Administrative	$= K_0 \left[\left(\begin{matrix}\text{Indirect}\\ \text{Operating Cost}\end{matrix}\right) + \left(\begin{matrix}\text{Direct Operating}\\ \text{Cost of Aircraft}\end{matrix} - \begin{matrix}\text{Cost of}\\ \text{Depreciation}\end{matrix}\right)\left(\begin{matrix}\text{Block}\\ \text{Distance}\end{matrix}\right)\right]$

Note: Constants given in program listing (Appendix B-2).

TABLE IV.- PARAMETERS AFFECTING ELEMENTS OF INDIRECT OPERATING COST

PARAMETER	IOC COST ELEMENTS								
	Systems	Local	Aircraft Control	Cabin Attendant	Food	Handling	Other	Freight Commissions and Advertising	General and Administrative
Takeoff gross weight	X	X							X
Depreciation cost									X
Number of cabin attendants				X					X
Number of total seats Tourist					X	X	X		X
First class					X		X		X
Block distance	X					X	X	X	X
Weight of cargo						X		X	
Labor on airframe and engine	X								X
Block time	X			X	X				X
Passenger load factor					X	X	X		X
Number of trips		X	X						X
Direct operating cost									X
Indirect operating cost									X

An "X" in the Cost Element Column indicates the parameters that affect the cost element.

TABLE V.- RETURN ON INVESTMENT EQUATIONS

Annual Operating Cost = (Total Operating Cost) (Annual Utilization) (Block Speed)

Annual Revenue $$= \left[\frac{\text{(Block Distance) (Annual Utilization)}}{\text{(C6) (Block Time)}}\right] \times \left\{\begin{pmatrix}\text{Passenger}\\ \text{Load}\\ \text{Factor}\end{pmatrix}\left[\begin{pmatrix}\text{Yield from}\\ \text{Tourist Class}\end{pmatrix}\begin{pmatrix}\text{No. of Tourist}\\ \text{Seats}\end{pmatrix} + \begin{pmatrix}\text{Yield from}\\ \text{First Class}\end{pmatrix}\begin{pmatrix}\text{No. of First}\\ \text{Class Seats}\end{pmatrix}\right] + \left(\frac{1}{C_5}\right)\begin{pmatrix}\text{Yield from}\\ \text{Cargo}\end{pmatrix}\begin{pmatrix}\text{Weight of}\\ \text{Cargo}\end{pmatrix}\right\}$$

Profit Before Tax and Interest = (Annual Revenue) - (Operating Costs)

Book Value = (Aircraft Investment) - (Annual Depreciation) (Number of Years Aircraft in Service)

Interest = (Interest Rate) (Book Value of Aircraft)

Taxes = (Tax Rate) (Profit Before Taxes and Interest - Interest)

Profit After Taxes and Interest = Profit Before Tax and Interest - Taxes - Interest

Present Value $$= \frac{1}{(1 + ROI)^n}$$

Discounted Cash Flow $$= \sum_{DP = 1}^{DP = n} \left(\frac{\text{Revenue - Operating Cost - Tax - Interest}}{[1 + ROI]^n}\right)$$

Note: Constants given in program listing (Appendix B-2).
n = number of years

TABLE VI.- PARAMETERS AFFECTING RETURN ON INVESTMENT

PARAMETER	ROI FACTORS							
	Annual Operating Cost	Annual Revenue	Profit before tax and interest	Book Value	Interest	Tax	Profit after tax and interest	Return on Investment
Direct and Indirect operating cost	X		X			X	X	X
Aircraft investment	X		X	X	X	X	X	X
Depreciation	X		X	X	X	X	X	X
Velocity	X		X			X	X	X
Block distance	X	X	X			X	X	X
Block time	X	X	X			X	X	X
Utilization	X	X	X			X	X	X
Number of tourist seats	X	X	X			X	X	X
Number of first class seats	X	X	X			X	X	X
Passenger load factor	X	X	X			X	X	X
Weight of cargo	X	X	X			X	X	X
Years aircraft in service	X		X	X	X	X	X	X
Interest rate					X	X	X	X
Tax rate						X	X	X
Yield from tourist class		X	X			X	X	X
Yield from first class		X	X			X	X	X
Yield from cargo		X	X			X	X	X

An "X" in the ROI Factor Column indicates the parameters that affect the ROI factor.

TABLE VII.- DIRECT OPERATING COST SAMPLE CALCULATION

Input	Program Code	Value	
Block distance, km (st. mi.)	REQRNGS	8,336	(5,180)
Maximum takeoff gross weight, kg (lbm)	WGROSS	352,063	(776,165)
Airframe weight, kg (lbm)	BEWMENG	158,664	(349,794)
Block fuel, kg (lbm)	FUELBL	112,588	(248,215)
Block time, hours	TBLOCK	9.77	
Cruise speed, km/hour (st. mi./hour)	SPEEDE	1,043	(563)
Number of seats	NS	385	
Total thrust, N (lbf)	VCJ	800,680	(180,000)
Number of engines	ENGNO	4	
Time in ground maneuver, hours	TGNDMAN	0.25	
Passenger load factor, percent	LOADF	55	
Cost of gas, $/liter ($/gallon)	CSTGASB	0.1	(0.37)
Cost of oil, $/liter ($/gallon)	CSTOILB	4.0	(15.0)
Oil burn rate, kg/hours (lb/hour)	OILBR	0.061	(0.135)
Labor rate, $/manhour	LABRATE	9	
Depreciation period, years	DEPYR	14	
Insurance rate, percent	INSR	1	
Spares, percent of airplane purchase price			
engines	SPARENG	30	
airframe	SPAREAF	6	
Purchase price of airframe, $	CSTAF	27,500,000	
Purchase price of one engine, $	CSTIENG	1,760,000	
Revenue inflation rate	GREV	0	
Total operating cost inflation rate	GCSTOP	0	

( ) Metric

TABLE VII. (Continued)

Input	Program Code	Value
Crew size, men	BC	3
Airplane condition	BN	New
Engine type	BE	Hi Bypass
Route structure	B	International

( ) Metric

TABLE VIII.- RETURN ON INVESTMENT SAMPLE CALCULATION

Input	Program Code	Value
First class seats (15% of total seats)	SEATSIC	58
Tourist class seats (85% of total seats)	SEATSTC	327
Weight of freight, kg (lbm)	WFREIGT	.045 (0.1)
Weight of cargo, kg (lbm)	WCARGO	.045 (0.1)
Cabin attendants (one per 40 seats)	NCABATT	10
Yield from first class passengers, ¢/pass. km (¢/pass. st. mile)	YLDIC	5.7 (9.1)
Yield from tourist passengers, ¢/pass. km (¢/pass. st. mile)	YLDTC	4.3 (7.0)
Yield from cargo, ¢/ton km (¢/ton st. mile)	YLDCARG	16.8 (27.0)
Tax rate, percent	TAXR	48.0
Interest rate, percent	INTR	10

( ) metric

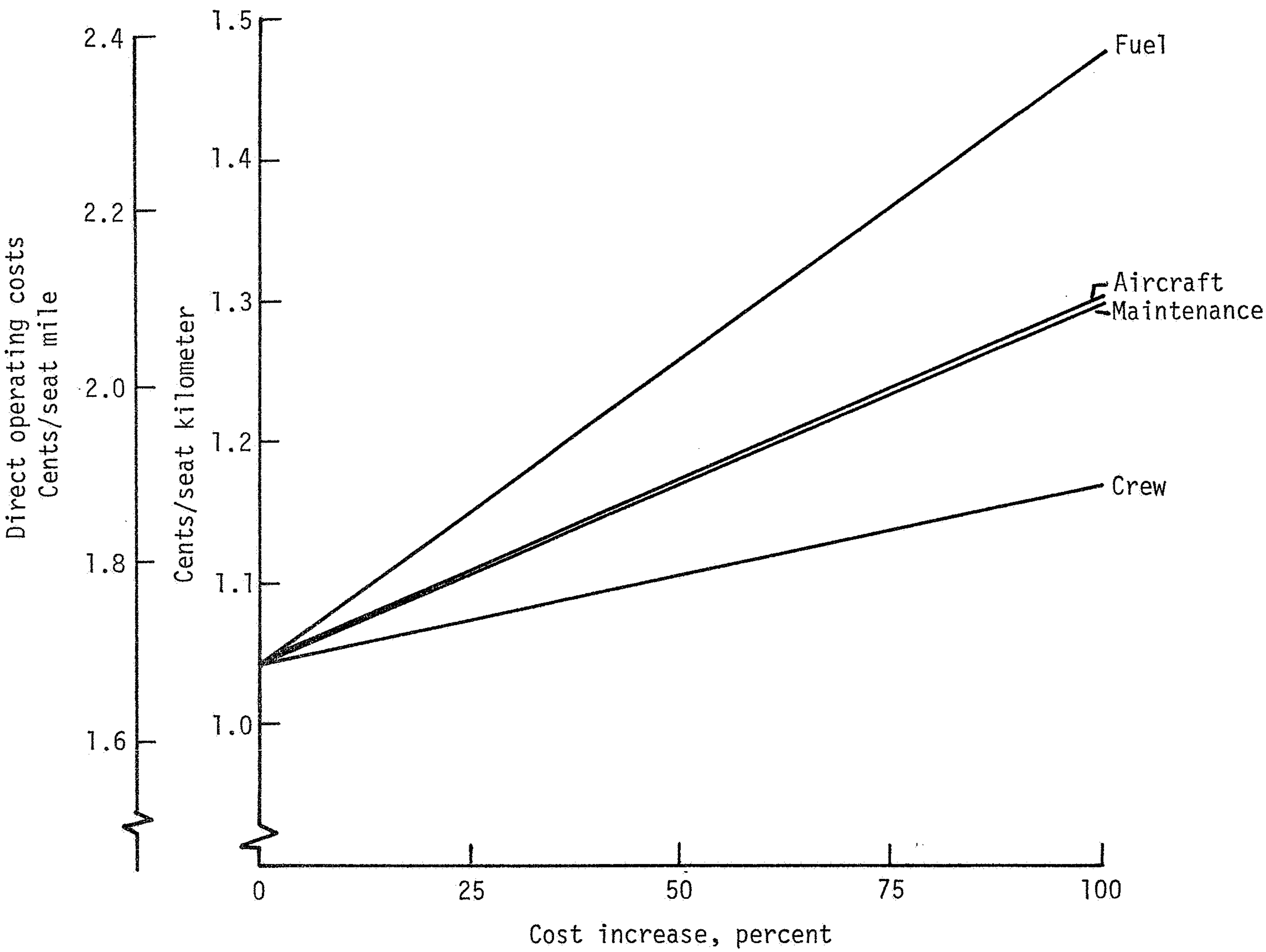


Figure 1.- Effect of cost increases on direct operating cost.

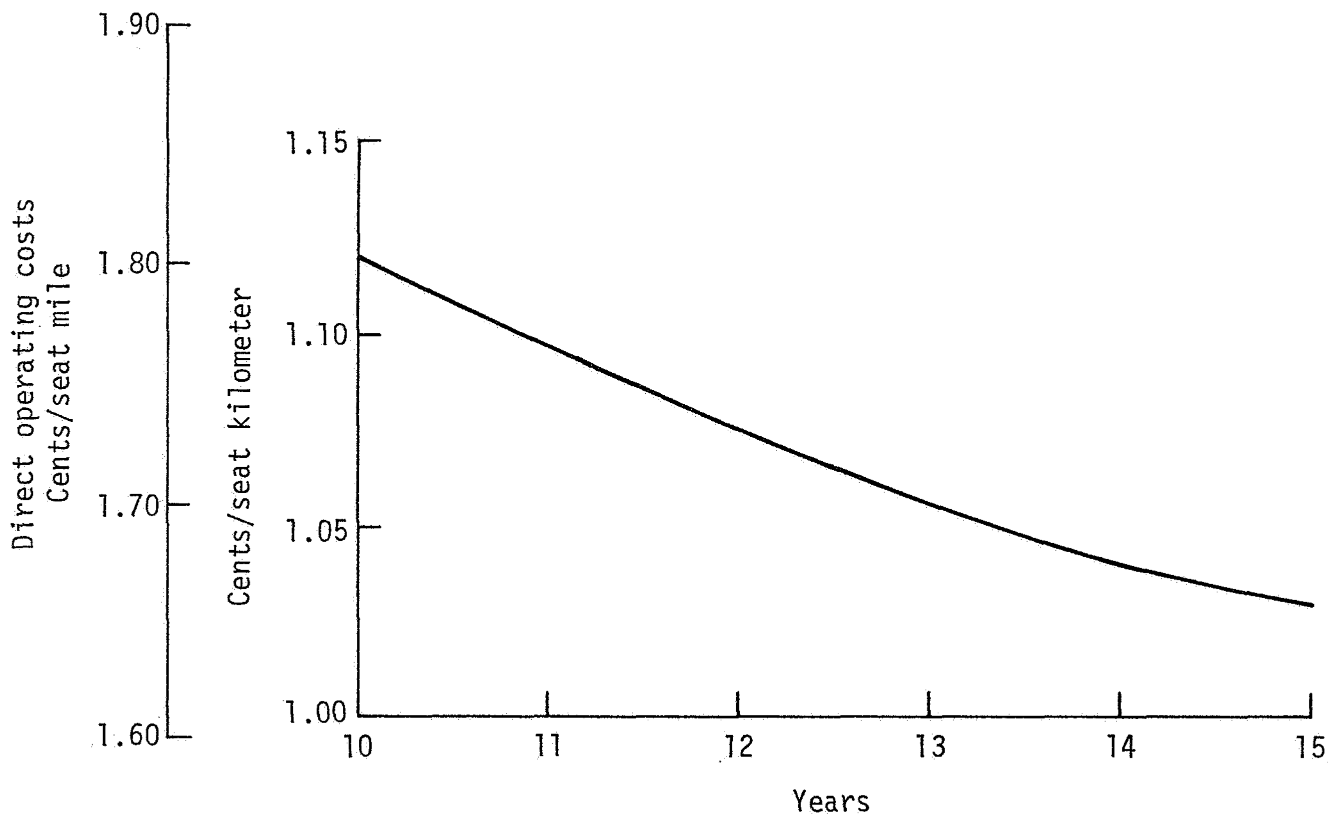


Figure 2.- Effect of variable depreciation period on direct operating cost.

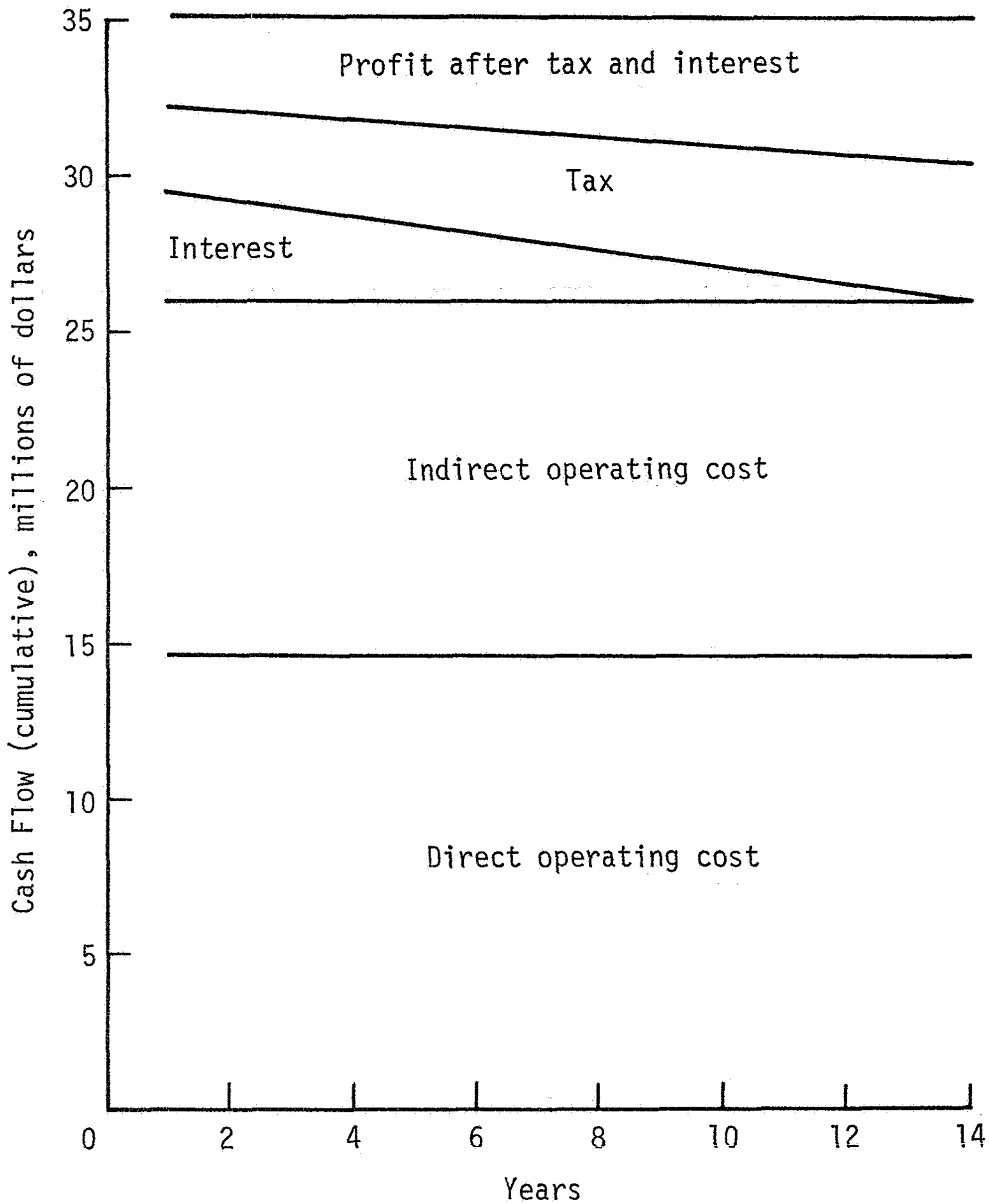
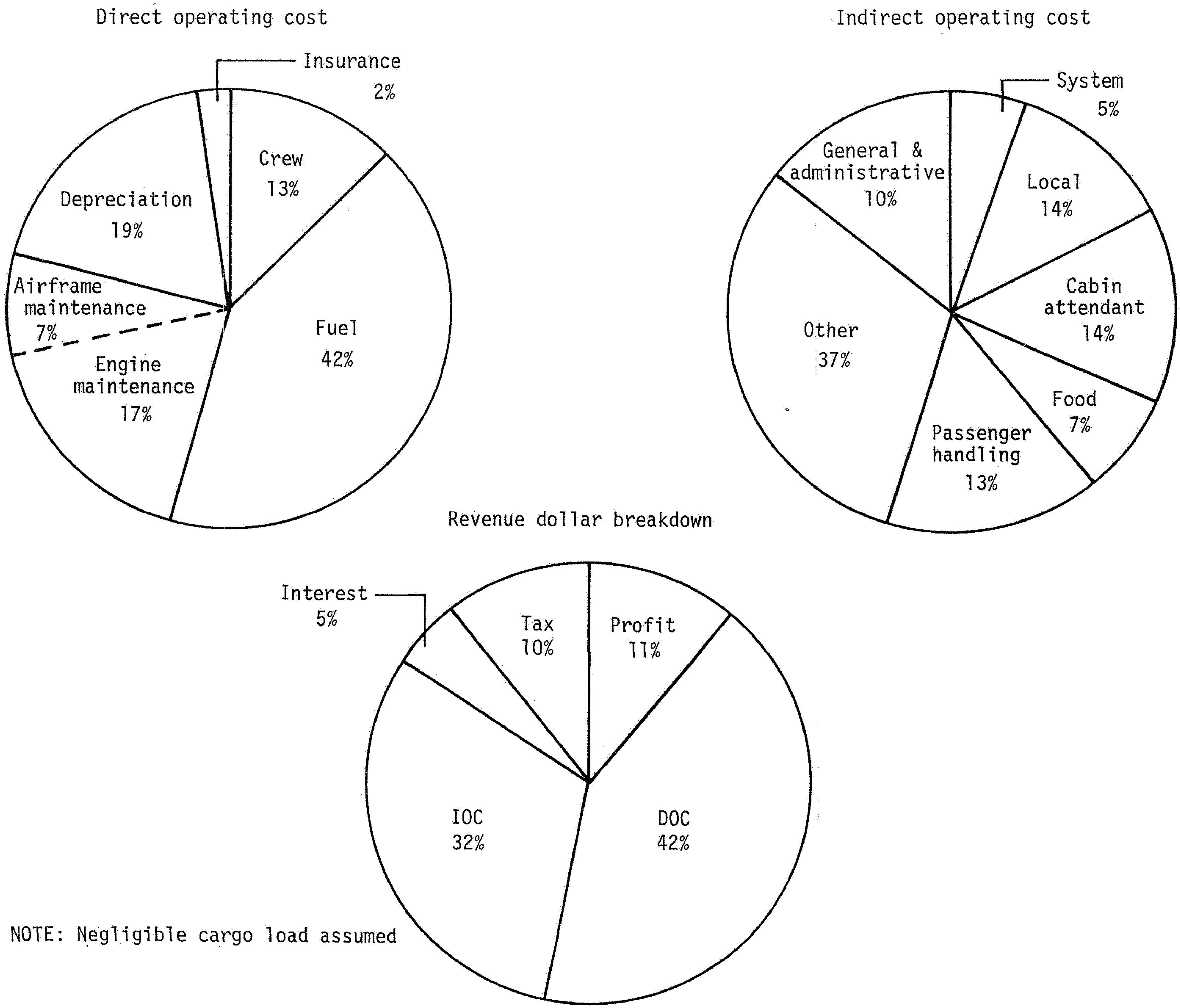


Figure 3.- Cash flow versus aircraft year of life.



NOTE: Negligible cargo load assumed

Figure 4.- Illustration of relative cost levels over aircraft life cycle.

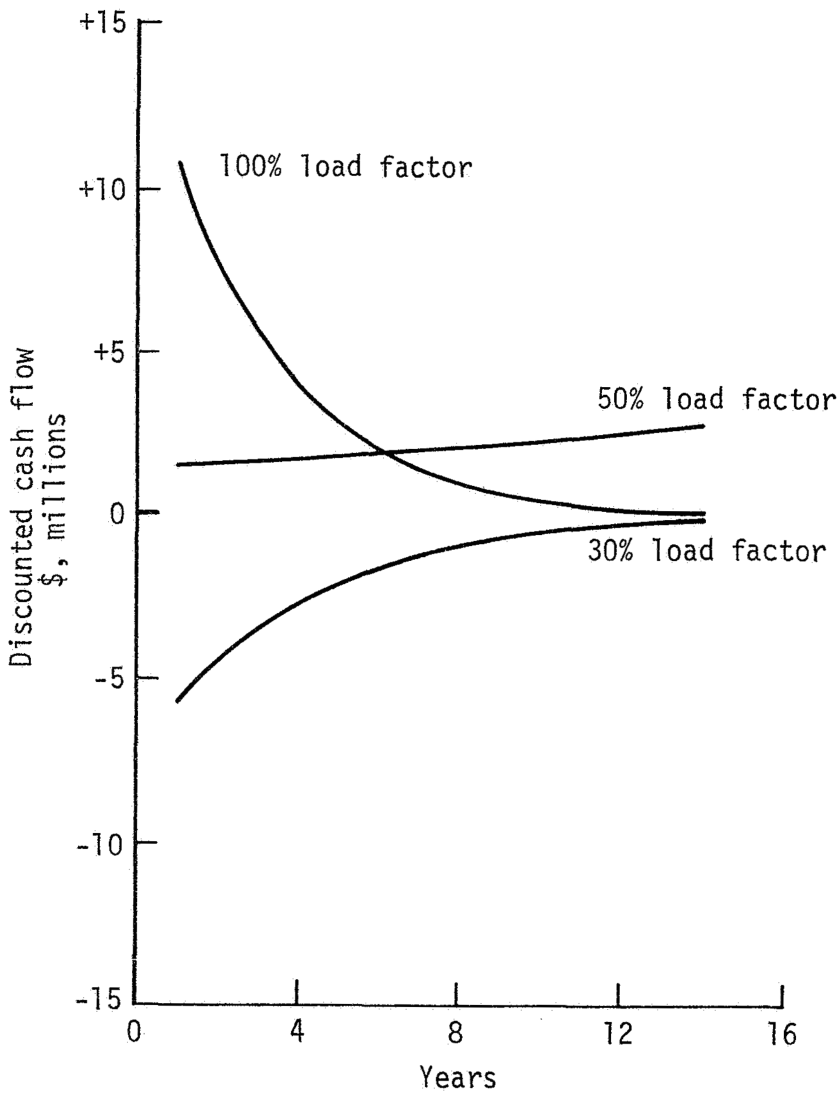


Figure 5.- Discounted cash flow variation with time for various passenger load factors.

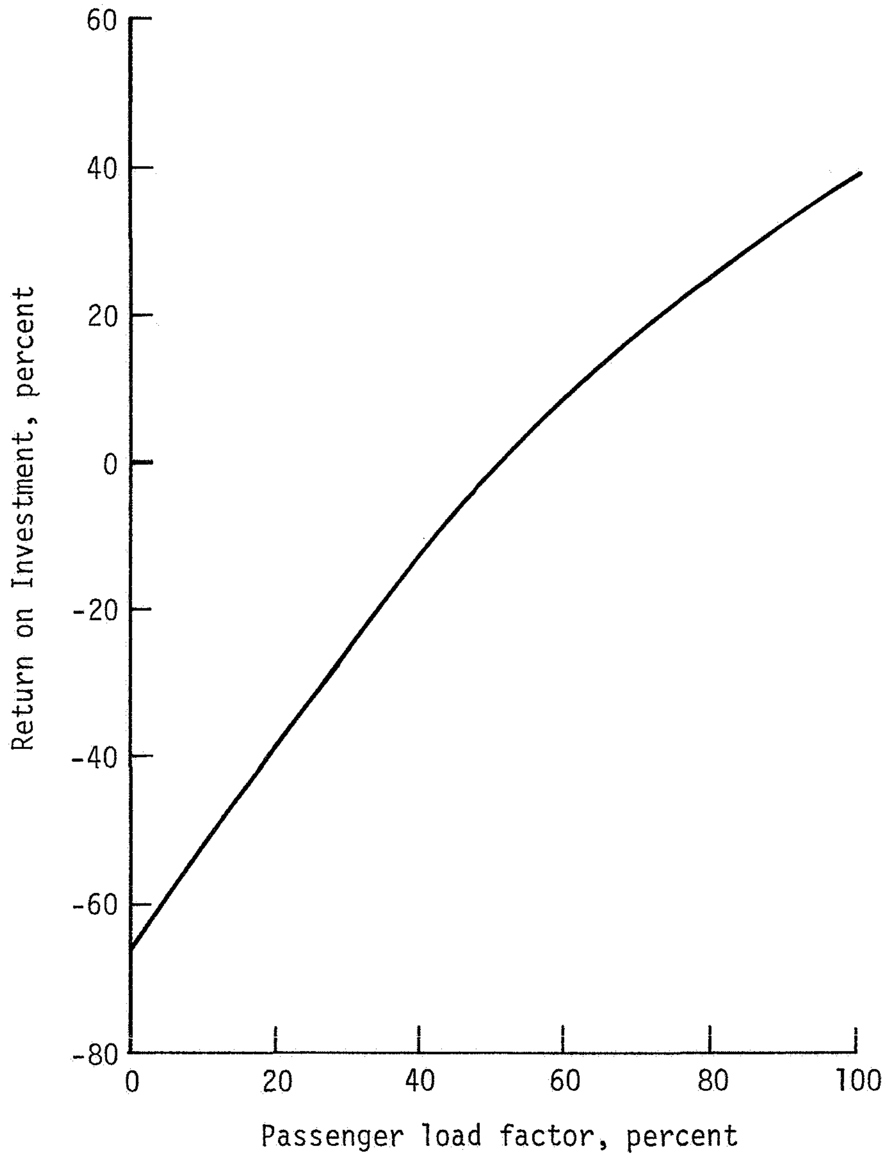


Figure 6.- Return on Investment as a function of passenger load factor.

APPENDIX A-1. - DIRECT OPERATING COST SENSITIVITY PROGRAM

Input

B	input for route type (1 for domestic flight; 2 for international flight)
BC	input for crew costs (2 for two-man crew; 3 for three-man crew)
BE	input for engine costs (2 for low bypass engine; 5 for high bypass engine)
BEWMENG	basic empty structural weight minus engine weight
BN	input for airplane costs (1 for used airplane; 10 for new airplane)
CSTAF	cost of airframe = cost of airplane less engines, $
CSTGASB	cost of gas at base price, $/gallon
CSTOILB	cost of oil at base price, $/gallon
CST1ENG	cost of one engine, $
DEPYR	number of years to depreciate aircraft
ENGNO	number of engines
FUELBL	block fuel, pounds
INSR	insurance rate, percent
LABRATE	labor rate, $/hour
LOADF	passenger load factor, percent
NS	number of seats
OILBR	oil burn rate, pounds/hour/engine
REQRNGS	block distance, miles
SPAREAF	spare airframes, percent of aircraft purchase price
SPARENG	spare engines, percent of aircraft purchase price

SPEEDE	true cruise airspeed, miles/hour
TBLOCK	block time, hours
TGNDMAN	time for ground maneuver, hours
VCJ	maximum certified takeoff thrust, pounds
WGROSS	maximum takeoff gross weight, pounds

Output

AP	airplane price sensitivity
CR	crew cost sensitivity
CSTAP	cost of airplane, $
CSTCREW	cost of crew, $/airplane mile
CSTDEP	cost of depreciation, $/airplane mile
CSTENG	cost of engines, $
CSTFLYO	cost of flying operations, $/airplane mile
CSTFUEL	cost of fuel, $/airplane mile
CSTINS	cost of insurance, $/airplane mile
CSTLABF	cost of labor for airframe maintenance, $/mile
CSTLENG	cost of labor for engine maintenance, $/mile
CSTMAF	cost of material for airframe maintenance, $/mile
CSTMAIN	total cost of maintenance, $/mile
CSTMAOH	cost of maintenance burden, $/mile
CSTMENG	cost of material for engine maintenance, $/mile
DOCAP	direct operating cost of airplane, $/mile
DOCBL	direct operating cost, $/block hour
DOCFH	direct operating cost, $/flight hour
DOCR	direct operating cost, cents/revenue passenger mile
DOCS	direct operating cost, cents/seat mile

DP	depreciation period sensitivity, years
F	fuel cost sensitivity
LABAFFC	labor for airframe maintenance, man-hours/flight cycle
LABAFFH	labor for airframe maintenance, man-hours/flight hour
LABENFC	labor for engine maintenance, man-hours/flight cycle
LABENFH	labor for engine maintenance, man-hours/flight hour
MA	maintenance cost sensitivity
MATAFFC	material cost for airframe maintenance, $/flight cycle
MATAFFH	material cost for airframe maintenance, $/flight hour
MATENFC	material cost for engine maintenance, $/flight cycle
MATENFH	material cost for engine maintenance, $/flight hour
SPEEDBL	block speed, miles/hour
TRCRUISE	time in cruise, hours
TFLIGHT	flight time, hours
UTIL	annual utilization time, hours/year

APPENDIX A-2. - DOC SENSITIVITY LISTING


```
      C
      C-------------------------------DECK NUMBER 16---------------------------------
      C----------------DIRECT OPERATING COST SENSITIVITY PROGRAM-----------------
      C
            PROGRAM RANG(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
            DIMENSION ROUTE(2),ARRAY1(100)
            INTEGER B,COUNT,BC,BE,BN
            REAL LABRATE,LOADF,KA,LABAFFH,LABAFFC,MATAFFH,MATAFFC,LABENFH
            REAL LABENFC,MATENFH,MATENFC,INSR,NS
            DATA ROUTE(1)/10H1-DOM.    /,ROUTE(2)/10H2-INT.     /
      C
      C------------------1976 ATA DOC CALCULATION
      C
      C------------------INPUTS
      C  READ IN BLOCK DISTANCE (STATUTE MILES), MAXIMUM TAKEOFF GROSS WEIGHT
      C  (POUNDS), BLOCK FUEL (POUNDS) AND BLOCK TIME (HOURS)
       7113 READ(5,7017)REQRNGS,WGROSS,FUELBL,TBLOCK
            IF(EOF(5)) 7111,7112
       7112 CONTINUE
      C  CRUISE SPEED (STATUTE MILES/HR)
            SPEEDE=563.
      C  NUMBER OF SEATS
            NS=385.
      C  TOTAL THRUST (POUNDS)
            VCJ=180000.
      C  NUMBER OF ENGINES
            ENGNO=4.
      C  TIME IN GROUND MANUEVER (HOURS)
            TGNDMAN=.25
      C  PASSENGER LOAD FACTOR (PERCENT)
            LOADF=55.
      C  PRICE OF GAS AND OIL ($/GALLON)
            CSTGASB=.37
            CSTOILB=15.00
      C  OIL BURN RATE (POUNDS/HOUR)
            OILBR=.135
      C  PRICE OF LABOR FOR MAINTENANCE ($/HOUR/MAN)
            LABRATE=9.
      C  DEPRECIATION PERIOD (YEARS)
            DEPYR=14.
      C  INSURANCE RATE (PERCENT)
            INSR=1.0
```

```
C  PERCENT OF AIRPLANE PURCHASE PRICE THAT MUST BE SPENT FOR SPARES
C  ON ENGINES AND AIRFRAME
      SPARENG=30.
      SPAREAF=6.
C  BASIC EMPTY WEIGHT MINUS ENGINE WEIGHT YIELDS AIRFRAME WEIGHT (POUNDS)
      BEWMENG=349794.
C
C*****************************************************************************
C************************AIRCRAFT OPTIONS SECTION*****************************
C
C----------DOMESTIC FLIGHT B=1 , INTERNATIONAL FLIGHT B=2
      B=1
      B=2
C---------3 MAN CREW BC=3 , 2 MAN CREW BC=2
      BC=2
      BC=3
C----------NEW AIRPLANE BN=10 , USED AIRPLANE BN=1
      BN=1
      BN=10
C---------HI BYPASS ENGINE BE=5 , LO BYPASS ENGINE BE=2
      BE=2
      BE=5
C
C*****************************************************************************
C
C  CHANGE PERCENTAGES FOR PROGRAM COMPATIBILITY
      SPARENG=SPARENG/100.
      SPAREAF=SPAREAF/100.
C
      COUNT=1
      Z1=0.
      Z3=Z4=Z5=Z6=1.0
      KFUELST=0
 7500 KFUELST=KFUELST+1
      Z1=Z1+1.
      IF(KFUELST.EQ.5) Z1=1.0
      IF(KFUELST.EQ.5) KCSTMAI=0
      IF(KFUELST.EQ.5) GO TO 7010
 8000 CONTINUE
C  PURCHASE PRICE OF AIRFRAME AND ONE ENGINE ($)
      CSTAF=27500000.
      CSTIENG=1760000.
```

```
      C
      C--------------------CALCULATION OF DOC
      C
            CSTGAS=Z1*CSTGASB
            CSTOIL=Z1*CSTOILB
            DEPYR=10.+Z5-1.
            IF(KDEPYR.EQ.4) DEPYR=15.
            IF(COUNT.LT.25.OR.COUNT.GT.32) DEPYR=14.
      C  AIRWAY DISTANCE INCREMENT
            KA=0.02*REQRNGS
            IF(REQRNGS.GE.0.0.AND.REQRNGS.LE.1400.) KA=7.+0.015*REQRNGS
            TCRUISE=(REQRNGS+KA+20.)/SPEEDE
            SPEEDBL=REQRNGS/TBLOCK
            TFLIGHT=TBLOCK-TGNDMAN
            IF(B.EQ.1.AND.BC.EQ.2) CSTCREW=(22.211*(SPEEDE*(WGROSS*.00001))
           1 **.3+20.933)/SPEEDBL
            IF(B.EQ.2.AND.BC.EQ.2) CSTCREW=(22.211*(SPEEDE*(WGROSS*.00001))
           1 **.3+44.322)/SPEEDBL
            IF(B.EQ.1.AND.BC.EQ.3) CSTCREW=(29.792*(SPEEDE*(WGROSS*.00001))
           1 **.3+30.750)/SPEEDBL
            IF(B.EQ.2.AND.BC.EQ.3) CSTCREW=(29.792*(SPEEDE*(WGROSS*.00001))
           1 **.3+62.757)/SPEEDBL
            CSTCREW=CSTCREW*((Z4-1.)*.25+1.)
            CSTFUEL=1.0*(FUELBL*CSTGAS/6.7+ENGNO*OILBR*CSTOIL/8.10 *TBLOCK)/
           1 REQRNGS
      C  1.02 ON FUEL AND MAINTENANCE LABOR IS NON-REVENUE FACTOR
            CSTFUEL=CSTFUEL*1.02
            IF(BN.EQ.1) UTIL=3400./(1.+(1./(TBLOCK+.5)))+536.
            IF(BN.EQ.10) UTIL=4000./(1.+(1./(TBLOCK+.5)))+630.
            CSTENG=CST1ENG*ENGNO
            CSTAF=CSTAF*(1.+.25*(Z6-1.))
            CST1ENG=CST1ENG*(1.+.25*(Z6-1.))
            CSTAP=CSTAF+CST1ENG*ENGNO
            CSTINS=INSR*CSTAP/(UTIL*SPEEDBL)/100.
            CSTFLYO=CSTCREW+CSTFUEL+CSTINS
            LABAFFC=(BEWMENG*.001)/(.0419*(BEWMENG*.001)+28.159)
            LABAFFH=(BEWMENG*.001)/(.1035*(BEWMENG*.001)+17.919)
            CSTLABF=((LABAFFH*TFLIGHT+LABAFFC)*LABRATE/(SPEEDBL*TBLOCK))*1.02
            MATAFFH=2.508+1.736*CSTAF*.000001
            MATAFFC=1.235+2.261*CSTAF*.000001
            CSTMAF=((MATAFFH*TFLIGHT+MATAFFC)/(SPEEDBL*TBLOCK))*1.02
            LABENFH=(.0183*(VCJ*.001)+.178)*ENGNO
```

```
      IF(BE.EQ.2) LABENFC=(.0134*(VCJ*.001)+.142)*ENGNO
      IF(BE.EQ.5) LABENFC=(.0244*(VCJ*.001)+.220)*ENGNO
      IF(BE.EQ.2) MATENFH=(10.81*CST1ENG*.000001+1.78)*ENGNO
      IF(BE.EQ.5) MATENFH=(10.256*CST1ENG*.000001+18.115)*ENGNO
      IF(BE.EQ.2) MATENFC=(5.50*CST1ENG*.000001+2.70)*ENGNO
      IF(BE.EQ.5) MATENFC=(16.00*CST1ENG*.000001+19.50)*ENGNO
      CSTLENG=((LABENFH*TFLIGHT+LABENFC)*LABRATE/(SPEEDBL*TBLOCK))*1.02
      CSTMENG=((MATENFH*TFLIGHT+MATENFC)/(SPEEDBL*TBLOCK))*1.02
      CSTMAOH=2.0*(CSTLABF+CSTLENG)
      CSTMAIN=CSTLABF+CSTMAF+CSTLENG+CSTMENG+CSTMAOH
      CSTMAIN=CSTMAIN*(1.+.25*(Z3-1.))
      CSTDEP=(CSTAP+SPAREAF*(CSTAP-ENGNO*CST1ENG)+SPARENG*ENGNO*CST1ENG
     1 )/(SPEEDBL*DEPYR*UTIL)
      DOCAP=CSTDEP+CSTMAIN+CSTFLYO
      ARRAY1(COUNT)=DOCAP/NS*100
      ARRAY1(COUNT+1)=DOCAP/NS/LOADF*10000.
      DOCBL=DOCAP*SPEEDBL
      DOCFH=DOCBL*TBLOCK/TFLIGHT
      IF(KFUELST.NE.1) GO TO 7050
      WRITE(6,1130)
      WRITE(6,1131) REQRNGS,SPEEDBL,TBLOCK,FUELBL,UTIL
      WRITE(6,51)
      WRITE(6,52)NS,VCJ,WGROSS
      WRITE(6,34)DOCBL,DOCFH
      WRITE(6,36)CSTFLYO,CSTMAIN,CSTDEP,DOCAP
      WRITE(6,38)CSTLABF,CSTMAF,CSTLENG,CSTMENG,CSTMAOH
      WRITE(6,41)CSTCREW,CSTFUEL,CSTINS
      WRITE(6,42)CSTAP,CSTAF,CSTENG,CST1ENG
      WRITE(6,51)
      WRITE(6,62)
      WRITE(6,54)KA,SPEEDE,TFLIGHT,TCRUISE
      WRITE(6,56)LABAFFH,MATAFFH,LABENFH,MATENFH
      WRITE(6,57)LABAFFC,MATAFFC,LABENFC,MATENFC
      WRITE(6,58)CSTGASB,CSTOILB,ENGNO,DEPYR
      WRITE(6,59)ROUTE(B),LOADF,OILBR,LABRATE
 7050 COUNT=COUNT+2
      IF(KFUELST.LE.4) GO TO 7500
      IF(KCSTMAI.LE.4) GO TO 7010
      IF(KCSTCRW.LE.4) GO TO 7030
      IF(KDEPYR.LE.4) GO TO 7040
      IF(KCSTPL.LE.4) GO TO 7020
 7010 KCSTMAI=KCSTMAI+1
```

```
      Z3=Z3+1.
      IF(KCSTMAI.EQ.5) Z3=1.0
      IF(KCSTMAI.EQ.5) KCSTCRW=0
      IF(KCSTMAI.EQ.5) GO TO 7030
      GO TO 8000
 7030 KCSTCRW=KCSTCRW+1
      Z4=Z4+1.
      IF(KCSTCRW.EQ.5) Z4=1.0
      IF(KCSTCRW.EQ.5) Z5=0.0
      IF(KCSTCRW.EQ.5) KDEPYR=0
      IF(KCSTCRW.EQ.5) GO TO 7040
      GO TO 8000
 7040 KDEPYR=KDEPYR+1
      Z5=Z5+1.
      IF(KDEPYR.EQ.5) Z5=1
      IF(KDEPYR.EQ.5) KCSTPL=0
      IF(KDEPYR.EQ.5) GO TO 7020
      GO TO 8000
 7020 KCSTPL=KCSTPL+1
      Z6=Z6+1.
      IF(KCSTPL.LE.4) GO TO 8000
      WRITE(6,51)
      WRITE(6,7009)
      WRITE(6,7015) (ARRAY1(I),I=1,8)
      WRITE(6,7012) (ARRAY1(I),I=9,16)
      WRITE(6,7013) (ARRAY1(I),I=17,24)
      WRITE(6,7014) (ARRAY1(I),I=25,32)
      WRITE(6,7011) (ARRAY1(I),I=33,40)
      WRITE(6,51)
      GO TO 7113
 7111 CONTINUE
 7009 FORMAT(9X,*DOCS*,7X,*DOCR*,18X,*DOCS*,7X,*DOCR*,18X,
     1 *DOCS*,7X,*DOCR*,18X,*DOCS*,7X,*DOCR*)
 7011 FORMAT(1X,*1.25AP-*,F6.3,5X,F6.3,9X,*1.50AP-*,F6.3,5X,F6.3,9X,
     1 *1.75AP-*,F6.3,5X,F6.3,9X,*2.00AP-*,F6.3,5X,F6.3)
 7012 FORMAT(1X,*1.25MA-*,F6.3,5X,F6.3,9X,*1.50MA-*,F6.3,5X,F6.3,9X,
     1 *1.75MA-*,F6.3,5X,F6.3,9X,*2.00MA-*,F6.3,5X,F6.3)
 7013 FORMAT(1X,*1.25CR-*,F5.3,5X,F6.3,9X,*1.50CR-*,F6.3,5X,F6.3,9X,
     1 *1.75CR-*,F6.3,5X,F6.3,9X,*2.00CR-*,F6.3,5X,F6.3)
 7014 FORMAT(1X,*DP-10  *,F6.3,5X,F6.3,9X,*DP-11  *,F6.3,5X,F6.3,9X,
     1 *DP-12  *,F6.3,5X,F6.3,9X,*DP-15  *,F6.3,5X,F6.3)
 7015 FORMAT(1X,*1F-    *,F6.3,5X,F6.3,9X,*2F-    *,F6.3,5X,F6.3,9X,
```

```
      1 *3F-     *,F6.3,5X,F6.3,9X,*4F-     *,F6.3,5X,F6.3)
 7017 FORMAT(3F10.0,1F8.4)
   51 FORMAT(1H0)
 1130 FORMAT(1H1/,20X,*1976 ATA DOC CALCULATIONS, SUBSONIC JET, 3 MAN OR
      1 2 MAN CREW,          STATUTE MILES*,/)
 1131 FORMAT(/9H REQRNGS= ,F7.0,7X,8HSPEEDBL= , F8.2,5X,8H TBLOCK= ,F7.3
      1 ,5X,7HFUELBL=,E10.4,6X,5HUTIL=, F9.2)
   34 FORMAT(1H0,*AIRPLANE DOC($ PER HOUR)*,
      1 3X,*DOCBL=*,E10.4,3X,*DOCFH=*,E10.4)
   36 FORMAT(1H0,*COST OF FLT OPS, MAINT,AND DEPRECIATION ($ PER MILE)*,
      1 2X,*CSTFLYO=*,E10.4,2X,*CSTMAIN=*,E10.4,2X,*CSTDEP=*,E10.4,
      2 2X,*DOCAP=*,E10.4)
   38 FORMAT(1H0,*COST OF MAINTENANCE ($ PER MILE)*,
      1 2X,*CSTLABF=*,E10.4,2X,*CSTMAF=*,E10.4,2X,*CSTLENG=*,E10.4,
      2 2X,*CSTMENG=*,E10.4,2X,*CSTMAOH=*,E10.4)
   41 FORMAT(1H0,*COST OF FLT. OPERATIONS ($ PER MILE)*,
      1 3X,*CSTCREW=*,E10.4,3X,*CSTFUEL=*,E10.4,3X,*CSTINS=*,E10.4)
   42 FORMAT(1H0,*COST OF AIRPLANE, AIRFRAME, ENGINE ($)*,3X,*CSTAP=*,
      1 E10.4,5X,*CSTAF=*,E10.4,5X,*CSTENG=*,E10.4,4X,*CST1ENG=*,E10.4)
   52 FORMAT(4H NS=,F5.0,10X,4HVCJ=,E10.4,9X,7HWGROSS=,E10.4)
   54 FORMAT(4H KA= ,E16.4,8X ,7HSPEEDE= ,F7.2,13X,8HTFLIGHT=,F6.3,13X,
      1 8HTCRUISE=,F7.3)
   56 FORMAT(9H LABAFFH= ,E11.4,8X,8HMATAFFH=,E12.4,7X,8HLABENFH=,E11.4,
      1 8X,8HMATENFH=,E12.4)
   57 FORMAT(9H LABAFFC= ,E11.4,8X,8HMATAFFC=,E12.4,7X,8HLABENFC=,E11.4,
      1 8X,8HMATENFC=,E12.4)
   58 FORMAT(9H CSTGASB= ,F6.3,13X,9HCSTOILB= ,F5.2,13X,6HENGNO=,F5.0,
      1 16X,6HDEPYR=,F6.0)
   59 FORMAT(5H B=    ,1X,A9,13X,6HLOADF=,F8.2,13X,6HOILBR=,F8.3,13X,
      1 8HLABRATE=,F6.2)
   62 FORMAT(48X,*MISCELLANEOUS PARAMETERS*)
      END
```

SYMBOLIC REFERENCE MAP (R=2)

ENTRY POINTS	DEF LINE	REFERENCES
4141 RANG	5	

APPENDIX A-3. - DOC SENSITIVITY - SAMPLE CASE

1976 ATA DOC CALCULATIONS, SUBSONIC JET, 3 MAN OR 2 MAN CREW,   STATUTE MILES

```
REQRNGS=  5180.        SPEEDBL=  530.19       TBLOCK=  9.770       FUELBL= .2482E+06       UTIL=  4275.08

NS= 385.           VCJ= .1800E+06          WGROSS= .7762E+06

AIRPLANE DOC($ PER HOUR)   DOCBL= .3425E+04   DOCFH= .3515E+04

COST OF FLT OPS, MAINT,AND DEPRECIATION ($ PER MILE)  CSTFLYO= .3667E+01  CSTMAIN= .1587E+01  CSTDEP= .1207E+01  DOCAP= .6461E+01

COST OF MAINTENANCE ($ PER MILE)  CSTLABF= .1235E+00  CSTMAF= .1067E+00  CSTLENG= .2670E+00  CSTMENG= .3087E+00  CSTMAOH= .7810E+00

COST OF FLT. OPERATIONS ($ PER MILE)   CSTCREW= .8131E+00   CSTFUEL= .2701E+01   CSTINS= .1524E+00

COST OF AIRPLANE, AIRFRAME, ENGINE ($)  CSTAP= .3454E+08    CSTAF= .2750E+08    CSTENG= .7040E+07    CST1ENG= .1760E+07

                                        MISCELLANEOUS PARAMETERS
KA=          .1036E+03        SPEEDE= 563.00           TFLIGHT= 9.520            TCRUISE=  9.420
LABAFFH=     .6463E+01        MATAFFH=     .5025E+02   LABENFH=   .1389E+02      MATENFH=    .1447E+03
LABAFFC=     .8170E+01        MATAFFC=     .6341E+02   LABENFC=   .1845E+02      MATENFC=    .1906E+03
CSTGASB=     .370             CSTOILB= 15.00           ENGNO=     4.             DEPYR=   14.
B=    2-INT.                  LOADF=     55.00         OILBR=     .135           LABRATE=  9.00

        DOCS       DOCR             DOCS      DOCR             DOCS      DOCR             DOCS      DOCR
1F-       1.678      3.051   2F-       2.380     4.327   3F-       3.081     5.602   4F-       3.783     6.878
1.25MA-   1.781      3.238   1.50MA-   1.884     3.426   1.75MA-   1.987     3.613   2.00MA-   2.090     3.800
1.25CR-   1.731      3.147   1.50CR-   1.784     3.243   1.75CR-   1.836     3.339   2.00CR-   1.889     3.435
DP-10     1.803      3.279   DP-11     1.764     3.206   DP-12     1.730     3.146   DP-15     1.657     3.013
1.25AP-   1.783      3.242   1.50AP-   1.888     3.433   1.75AP-   1.993     3.624   2.00AP-   2.098     3.815
```

APPENDIX B-1* - RETURN ON INVESTMENT PROGRAM

Indirect Operating Cost Section

Input

DEPART	number of departures
IR	inflation rate, percent
K_1	system cost coefficient
K_2	local cost coefficient
K_3	airplane control cost coefficient
K_4	cabin attendant cost coefficient
K_5	food and beverage cost coefficient
K_6	passenger-handling cost coefficient
K_7	cargo-handling cost coefficient
K_8	other passenger service cost coefficient
K_9	freight commission cost coefficient
K_0	general and administrative cost coefficient
NCABATT	number of cabin attendants
SEATSIC	number of first-class seats
SEATSTC	number of tourist-class seats
WCARGO	weight of cargo, pounds
WFREIGHT	weight of freight, pounds

Output

APCONT	airplane control cost, $/trip
CABATT	cabin attendant cost, $/trip

*Also see Appendix A-1.

CARHAN	cargo-handling cost, \$/trip
FGTCOM	freight commission cost, \$/trip
FOOD	food and beverage cost, \$/trip
GENADM	general and administrative cost, \$/trip
IOC	indirect operating cost, \$/trip
IOCAP	indirect operating cost of airplane, \$/mile
IOCBL	indirect operating cost, \$/block hour
IOCFH	indirect operating cost, \$/flight hour
IOCR	indirect operating cost, \$/passenger mile
IOCS	indirect operating cost, \$/seat mile
LOCAL	local costs, \$/trip
OTHSER	other passenger service cost, \$/trip
PAXHAN	passenger-handling cost, \$/trip
SYSTEM	system expense, \$/trip
TOC	total operating cost (direct and indirect), \$/trip

Return on Investment Section

Input

DCFROI	internal rate of return on investment, percent
DCSHFLO	discounted cash flow, dollars
INTR	interest rate, percent
TAXR	tax rate, percent
YLDCARG	yield from cargo, cents/ton-mile
YLDTC	yield from tourist seats, cents/passenger mile
YLDIC	yield from first class passengers, cents/passenger mile

Output

BOOK	original purchase price minus accumulated depreciation, $
CSTOP	cost of operating, $/year
CSTOPMD	cost of operating minus depreciation, $/year
INTREST	interest, $/year
NET	net dollar inflow and outlfow over the life of aircraft
PROATAI	profit after taxes and interest, $/year
PROBTAI	profit before taxes and interest, $/year
REV	revenue, $/year
TAX	tax, $/year

APPENDIX B-2. - ROI LISTING


```
      C
      C--------------------------------DECK NUMBER 14---------------------- ----------
      C------------------------RETURN ON INVESTMENT PROGRAM--------------- ----------
      C
            PROGRAM RANG(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
            DIMENSION PRESVAL(30),DCSHFLO(30),ARRAY1(100),ROUTE(2),COSTDEP(30)
            DIMENSION PROATAI(30),BOOK(30),INTREST(30),PROBTAI(30),TAX(30)
            DIMENSION REV(30),            CSTOP(30),TEST(30)
            DIMENSION RPATAI(30),RDCF(30)
            INTEGER B,COUNT
            REAL IR,INFLATE,INSR,INTR,INTREST,NET,NS
            REAL K0,K1,K2,K3,K4,K5,K6,K7,K8,K9
            REAL IOC,IOCAP,IOCS,IOCR,LOCAL,IOCBL,IOCFH,NCABATT,IOCP
            REAL LABRATE,LOADF,KA,LABAFFH,LABAFFC,MATAFFH,MATAFFC,LABENFH
            REAL LABENFC,MATENFH,MATENFC
            DATA ROUTE(1)/10H1-DOM.     /,ROUTE(2)/10H2-INT.      /
      C
      C-------------------1976 ATA DOC CALCULATION
      C
      C-------------------INPUTS
      C  READ IN BLOCK DISTANCE (STATUTE MILES), MAXIMUM TAKEOFF GROSS WEIGHT
      C  (POUNDS), BLOCK FUEL (POUNDS) AND BLOCK TIME (HOURS)
       7113 READ(5,7017)REQRNGS,WGROSS,FUELBL,TBLOCK
            IF(EOF(5)) 7111,7112
       7112 CONTINUE
      C  CRUISE SPEED (STATUTE MILES/HR)
            SPEEDE=563.0
      C  NUMBER OF SEATS
            NS=385.
      C  TOTAL THRUST (POUNDS)
            VCJ=180000.
      C  NUMBER OF ENGINES
            ENGNO=4.
      C  TIME IN GROUND MANUEVER (HOURS)
            TGNDMAN=.25
      C  PASSENGER LOAD FACTOR (PERCENT)
            LOADF=55.
      C  PRICE OF GAS AND OIL ($/GALLON)
            CSTGASB=.37
            CSTOILB=15.00
      C  OIL BURN RATE (POUNDS/HOUR)
            OILBR = .135
```

```
      C  PRICE OF LABOR FOR MAINTENANCE ($/HOUR/MAN)
            LABRATE=9.
      C  DEPRECIATION PERIOD (YEARS)
            DEPYR=14.
      C  INSURANCE RATE (PERCENT)
            INSR=1.0
      C  PERCENT OF AIRPLANE PURCHASE PRICE THAT MUST BE SPENT FOR SPARES
      C  ON ENGINES AND AIRFRAME
            SPARENG=30.
            SPAREAF=6.
      C  BASIC EMPTY WEIGHT MINUS ENGINE WEIGHT YIELDS AIRFRAME WEIGHT (POUNDS)
            BEWMENG=349794.
      C
      C*************************************************************** *********
      C***********************AIRCRAFT OPTIONS SECTION***************** *********
      C
      C----------DOMESTIC FLIGHT B = 1, INTERNATIONAL FLIGHT B = 2
            B=1
            B=2
      C----------3 MAN CREW BC = 3, 2 MAN CREW BC = 2
            BC=2
            BC=3
      C----------NEW AIRPLANE BN=10 , USED AIRPLANE BN=1
            BN=1
            BN=10
      C----------HI BYPASS ENGINE BE = 5, LO BYPASS ENGINE BE = 2
            BE=2
            BE=5
      C
      C*************************************************************** *********
      C
      C  CHANGE PERCENTAGES FOR PROGRAM COMPATIBILITY
            SPARENG=SPARENG/100.
            SPAREAF=SPAREAF/100.
      C
            COUNT=1
            Z1=0.
            Z3=Z4=Z5=Z6=1.0
            KFUELST=0
       7500 KFUELST=KFUELST+1
            Z1=Z1+1.
            IF(KFUELST.EQ.5) Z1=1.0
```

```
      IF(KFUELST.EQ.5) KCSTMAI=0
      IF(KFUELST.EQ.5) GO TO 7010
 8000 CONTINUE
C  PURCHASE PRICE OF AIRFRAME AND ONE ENGINE ($)
      CSTAF=27500000.
      CST1ENG=1760000.
C
C--------------------CALCULATION OF DOC
C
      CSTGAS=Z1*CSTGASB
      CSTOIL=Z1*CSTOILB
      DEPYR=10.+Z5-1.
      IF(KDEPYR.EQ.4) DEPYR=15.
      IF(COUNT.LT.25.OR.COUNT.GT.32) DEPYR=14.
C  AIRWAY DISTANCE INCREMENT
      KA=0.02*REQRNGS
      IF(REQRNGS.GE.0.0.AND.REQRNGS.LE.1400.) KA=7.+0.015*REQRNGS
      TCRUISE=(REQRNGS+KA+20.)/SPEEDE
      SPEEDBL=REQRNGS/TBLOCK
      TFLIGHT=TBLOCK-TGNDMAN
      IF(B.EQ.1.AND.BC.EQ.2) CSTCREW=(22.211*(SPEEDE*(WGROSS*.00001))
     1 **.3+20.933)/SPEEDBL
      IF(B.EQ.2.AND.BC.EQ.2) CSTCREW=(22.211*(SPEEDE*(WGROSS*.00001))
     1 **.3+44.322)/SPEEDBL
      IF(B.EQ.1.AND.BC.EQ.3) CSTCREW=(29.792*(SPEEDE*(WGROSS*.00001))
     1 **.3+30.750)/SPEEDBL
      IF(B.EQ.2.AND.BC.EQ.3) CSTCREW=(29.792*(SPEEDE*(WGROSS*.00001))
     1 **.3+62.757)/SPEEDBL
      CSTCREW=CSTCREW*((Z4-1.)*.25+1.)
      CSTFUEL=1.0*(FUELBL*CSTGAS/6.7+ENGNO*OILBR*CSTOIL/8.10 *TBLOCK)/
     1 REQRNGS
C  1.02 ON FUEL AND MAINTENANCE LABOR IS NON-REVENUE FACTOR
      CSTFUEL=CSTFUEL*1.02
      IF(BN.EQ.1) UTIL=3400./(1.+(1./(TBLOCK+.5)))+536.
      IF(BN.EQ.10) UTIL=4000./(1.+(1./(TBLOCK+.5)))+630.
      CSTENG=CST1ENG*ENGNO
      CSTAF=CSTAF*(1.+.25*(Z6-1.))
      CST1ENG=CST1ENG*(1.+.25*(Z6-1.))
      CSTAP=CSTAF+CST1ENG*ENGNO
      CSTINS=INSR*CSTAP/(UTIL*SPEEDBL)/100.
      CSTFLYO=CSTCREW+CSTFUEL+CSTINS
      LABAFFC=(BEWMENG*.001)/(.0419*(BEWMENG*.001)+28.159)
```

```
      LABAFFH=(BEWMENG*.001)/(.1035*(BEWMENG*.001)+17.919)
      CSTLABF=((LABAFFH*TFLIGHT+LABAFFC)*LABRATE/(SPEEDBL*TBLOCK))*1.02
      MATAFFH=2.508+1.736*CSTAF*.000001
      MATAFFC=1.235+2.261*CSTAF*.000001
      CSTMAF=((MATAFFH*TFLIGHT+MATAFFC)/(SPEEDBL*TBLOCK))*1.02
      LABENFH=(.0183*(VCJ*.001)+.178)*ENGNO
      IF(BE.EQ.2) LABENFC=(.0134*(VCJ*.001)+.142)*ENGNO
      IF(BE.EQ.5) LABENFC=(.0244*(VCJ*.001)+.220)*ENGNO
      IF(BE.EQ.2) MATENFH=(10.81*CST1ENG*.000001+1.78)*ENGNO
      IF(BE.EQ.5) MATENFH=(10.256*CST1ENG*.000001+18.115)*ENGNO
      IF(BE.EQ.2) MATENFC=(5.50*CST1ENG*.000001+2.70)*ENGNO
      IF(BE.EQ.5) MATENFC=(16.00*CST1ENG*.000001+19.50)*ENGNO
      CSTLENG=((LABENFH*TFLIGHT+LABENFC)*LABRATE/(SPEEDBL*TBLOCK))*1.02
      CSTMENG=((MATENFH*TFLIGHT+MATENFC)/(SPEEDBL*TBLOCK))*1.02
      CSTMAOH=2.0*(CSTLABF+CSTLENG)
      CSTMAIN=CSTLABF+CSTMAF+CSTLENG+CSTMENG+CSTMAOH
      CSTMAIN=CSTMAIN*(1.+.25*(Z3-1.))
      CSTDEP=(CSTAP+SPAREAF*(CSTAP-ENGNO*CST1ENG)+SPARENG*ENGNO*CST1ENG
     1 )/(SPEEDBL*DEPYR*UTIL)
      DOCAP=CSTDEP+CSTMAIN+CSTFLYO
      ARRAY1(COUNT)=DOCAP/NS*100
      ARRAY1(COUNT+1)=DOCAP/NS/LOADF*10000.
      DOCBL=DOCAP*SPEEDBL
      DOCFH=DOCBL*TBLOCK/TFLIGHT
      IF(KFUELST.NE.1) GO TO 7050
      CSTDEPB=CSTDEP
      CSTAPB=CSTAP
      DOCAP1F=DOCAP
      CST1ENB=CST1ENG
      CSTAPBS=CSTAPB+SPAREAF*(CSTAPB-ENGNO*CST1ENB)+SPARENG*ENGNO*
     1 CST1ENB
      WRITE(6,1130)
      WRITE(6,1131)REQRNGS,SPEEDBL,TBLOCK,FUELBL,UTIL
      WRITE(6,51)
      WRITE(6,52)NS,VCJ,WGROSS
      WRITE(6,34)DOCBL,DOCFH
      WRITE(6,36)CSTFLYO,CSTMAIN,CSTDEP,DOCAP
      WRITE(6,38)CSTLABF,CSTMAF,CSTLENG,CSTMENG,CSTMAOH
      WRITE(6,41)CSTCREW,CSTFUEL,CSTINS
      WRITE(6,42)CSTAP,CSTAF,CSTENG,CST1ENG
      WRITE(6,51)
      WRITE(6,62)
```

```
      WRITE(6,54)KA,SPEEDE,TFLIGHT,TCRUISE
      WRITE(6,56)LABAFFH,MATAFFH,LABENFH,MATENFH
      WRITE(6,57)LABAFFC,MATAFFC,LABENFC,MATENFC
      WRITE(6,58)CSTGASB,CSTOILB,ENGNO,DEPYR
      WRITE(6,59)ROUTE(B),LOADF,OILBR,LABRATE
   51 FORMAT(1H0)
 1130 FORMAT(1H1/,20X,*1976 ATA DOC CALCULATIONS, SUBSONIC JET, 3 MAN OR
     1 2 MAN CREW,          STATUTE MILES*,/)
 1131 FORMAT(/9H REQRNGS= ,F7.0,7X,8HSPEEDBL= , F8.2,5X,8H TBLOCK= ,F7.3
     1 ,5X,7HFUELBL=,E10.4,6X,5HUTIL=, F9.2)
   34 FORMAT( 1H0,*AIRPLANE DOC ($ PER HOUR)*,
     1 3X,*DOCBL=*,E10.4,3X,*DOCFH=*,E10.4)
   36 FORMAT(1H0,*COST OF FLT OPS, MAINT,AND DEPRECIATION ($ PER MILE)*,
     1 2X,*CSTFLYO=*,E10.4,2X,*CSTMAIN=*,E10.4,2X,*CSTDEP=*,E10.4,
     2 2X,*DOCAP=*,E10.4)
   38 FORMAT(1H0,*COST OF MAINTENANCE ($ PER MILE)*,
     1 2X,*CSTLABF=*,E10.4,2X,*CSTMAF=*,E10.4,2X,*CSTLENG=*,E10.4,
     2 2X,*CSTMENG=*,E10.4,2X,*CSTMAOH=*,E10.4)
   41 FORMAT(1H0,*COST OF FLT. OPERATIONS ($ PER MILE)*,
     1 3X,*CSTCREW=*,E10.4,3X,*CSTFUEL=*,E10.4,3X,*CSTINS=*,E10.4)
   42 FORMAT(1H0,*COST OF AIRPLANE, AIRFRAME, ENGINE ($)*,3X,*CSTAP=*,
     1 E10.4,5X,*CSTAF=*,E10.4,5X,*CSTENG=*,E10.4,4X,*CSTIENG=*,E10.4)
   52 FORMAT(4H NS=,F5.0,10X,4HVCJ=,E10.4,9X,7HWGROSS=,E10.4)
   54 FORMAT(4H KA= ,E16.4,8X ,7HSPEEDE= ,F7.2,13X,8HTFLIGHT=,F6.3,13X,
     1 8HTCRUISE=,F7.3)
   56 FORMAT(9H LABAFFH= ,E11.4,8X,8HMATAFFH=,E12.4,7X,8HLABENFH=,E11.4,
     1 8X,8HMATENFH=,E12.4)
   57 FORMAT(9H LABAFFC= ,E11.4,8X,8HMATAFFC=,E12.4,7X,8HLABENFC=,E11.4,
     1 8X,8HMATENFC=,E12.4)
   58 FORMAT(9H CSTGASB= ,F6.3,13X,9HCSTOILB= ,F5.2,13X,6HENGNO=,F5.0,
     1 16X,6HDEPYR=,F6.0)
   59 FORMAT(5H B=    ,1X,A9,13X,6HLOADF=,F8.2,13X,6HOILBR=,F8.3,13X,
     1 8HLABRATE=,F6.2)
   62 FORMAT(48X,*MISCELLANEOUS PARAMETERS*)
 7050 COUNT=COUNT+2
      IF(KFUELST.LE.4) GO TO 7500
      IF(KCSTMAI.LE.4) GO TO 7010
      IF(KCSTCRW.LE.4) GO TO 7030
      IF(KDEPYR.LE.4) GO TO 7040
      IF(KCSTPL.LE.4) GO TO 7020
 7010 KCSTMAI=KCSTMAI+1
      Z3=Z3+1.
```

```
      IF(KCSTMAI.EQ.5) Z3=1.0
      IF(KCSTMAI.EQ.5) KCSTCRW=0
      IF(KCSTMAI.EQ.5) GO TO 7030
      GO TO 8000
 7030 KCSTCRW=KCSTCRW+1
      Z4=Z4+1.
      IF(KCSTCRW.EQ.5) Z4=1.0
      IF(KCSTCRW.EQ.5) Z5=0.0
      IF(KCSTCRW.EQ.5) KDEPYR=0
      IF(KCSTCRW.EQ.5) GO TO 7040
      GO TO 8000
 7040 KDEPYR=KDEPYR+1
      Z5=Z5+1.
      IF(KDEPYR.EQ.5) Z5=1.0
      IF(KDEPYR.EQ.5) KCSTPL=0
      IF(KDEPYR.EQ.5) GO TO 7020
      GO TO 8000
 7020 KCSTPL=KCSTPL+1
      Z6=Z6+1.
      IF(KCSTPL.LE.4) GO TO 8000
      WRITE(6,51)
      WRITE(6,7009)
      WRITE(6,7015)(ARRAY1(I),I=1,8)
      WRITE(6,7012)(ARRAY1(I),I=9,16)
      WRITE(6,7013)(ARRAY1(I),I=17,24)
      WRITE(6,7014)(ARRAY1(I),I=25,32)
      WRITE(6,7011)(ARRAY1(I),I=33,40)
      WRITE(6,51)
 7009 FORMAT(9X,*DOCS*,7X,*DOCR*,18X,*DOCS*,7X,*DOCR*,18X,
     1 *DOCS*,7X,*DOCR*,18X,*DOCS*,7X,*DOCR*)
 7011 FORMAT(1X,*1.25AP-*,F6.3,5X,F6.3,9X,*1.50AP-*,F6.3,5X,F6.3,9X,
     1 *1.75AP-*,F6.3,5X,F6.3,9X,*2.00AP-*,F6.3,5X,F6.3)
 7012 FORMAT(1X,*1.25MA-*,F6.3,5X,F6.3,9X,*1.50MA-*,F6.3,5X,F6.3,9X,
     1 *1.75MA-*,F6.3,5X,F6.3,9X,*2.00MA-*,F6.3,5X,F6.3)
 7013 FORMAT(1X,*1.25CR-*,F6.3,5X,F6.3,9X,*1.50CR-*,F6.3,5X,F6.3,9X,
     1 *1.75CR-*,F6.3,5X,F6.3,9X,*2.00CR-*,F6.3,5X,F6.3)
 7014 FORMAT(1X,*DP-10  *,F6.3,5X,F6.3,9X,*DP-11  *,F6.3,5X,F6.3,9X,
     1 *DP-12  *,F6.3,5X,F6.3,9X,*DP-15  *,F6.3,5X,F6.3)
 7015 FORMAT(1X,*1F-    *,F6.3,5X,F6.3,9X,*2F-    *,F6.3,5X,F6.3,9X,
     1 *3F-    *,F6.3,5X,F6.3,9X,*4F-    *,F6.3,5X,F6.3)
 7017 FORMAT(3F10.0,1F8.4)
C
```

```
C--------------------1976 LOCKHEED IOC CALCULATIONS
C
C--------------------INPUTS
C  ASSIGNMENT OF INTEGER VALUES TO FIRST CLASS SEATS (15 PERCENT OF TOTAL SEATS)
C  AND TOURIST SEATS (85 PERCENT OF TOTAL SEATS)
      ISEAT=NS*.15+.5
      SEATS1C=ISEAT
      SEATSTC=NS-SEATS1C
C  WEIGHT OF FREIGHT (POUNDS)
      WFREIGT=.1
C  WEIGHT OF CARGO (POUNDS)
      WCARGO=.1
C  NUMBER OF CABIN ATTENDANTS
      ICABATT=NS/40.+.9999
      NCABATT=ICABATT
C  NUMBER OF DEPARTURES
      DEPART=1.0
C  INFLATION RATE (PERCENT)
      IR=0.
C  INFLATION UPDATE FOR 1976 COSTS (PERCENT)
      INFLATE=1.0+IR*.01
      IF(B.EQ.2) GO TO 6051
C  DOMESTIC COEFFICIENTS
      K1 = .52
      K2 =1.86
      K3 =23.83
      K4 =29.33
      K5 =.96
      K6 =6.56
      K7 =98.2
      K8 =.0056
      K9 =.0082
      K0 =.048
      GO TO 6050
 6051 CONTINUE
C  INTERNATIONAL COEFFICIENTS
      K1 =.56
      K2 =4.64
      K3 =67.72
      K4 =37.0
      K5 =.63
      K6 =15.84
```

```
      K7 =150.69
      K8 =.0088
      K9 =.0099
      K0 =.053
 6050 CONTINUE
      SYSTEM=K1*(CSTLABF+CSTLENG)*REQRNGS*INFLATE
      LOCAL=K2*WGROSS/1000.*DEPART*INFLATE
      APCONT=K3*DEPART*INFLATE
      CABATT=K4*NCABATT*TBLOCK*INFLATE
      FOOD=K5*LOADF*(2.25*SEATS1C+SEATSTC)*TBLOCK/100.*INFLATE
      IF(B.EQ.2) FOOD=K5*(3.5*SEATS1C+SEATSTC)*TBLOCK*LOADF/100.*INFLATE
      PAXHAN=K6*LOADF*NS/100.*INFLATE
      CARHAN=K7*WCARGO*INFLATE
      OTHSER=K8*LOADF*NS*REQRNGS/100.*INFLATE
      FGTCOM=K9*WFREIGT*REQRNGS*INFLATE
      IOC=SYSTEM+LOCAL+APCONT+CABATT+FOOD+PAXHAN+CARHAN+OTHSER+FGTCOM
      GENADM=K0*(IOC+(DOCAP1F-CSTDEPB)*INFLATE*REQRNGS)
      IOC=IOC+GENADM
      IOCS=IOC/REQRNGS/NS*100.
      IOCR=IOCS/LOADF*100.
      IOCAP=IOC/REQRNGS
      IOCBL=IOC/TBLOCK
      IOCFH=IOC/TFLIGHT
C
C-------------------TOTAL OPERATING COST CALCULATION
C
C  TOTAL OPERATING COST ($/STATUTE MILE)
      TOCAP=IOCAP+DOCAP1F
C  INDIRECT OPERATING COST. PERCENTAGE OF TOTAL OPERATING COST
      IOCP=IOCAP/TOCAP*100.
C  DIRECT OPERATING COST, PERCENTAGE OF TOTAL OPERATING COST
      DOCP=DOCAP1F/TOCAP*100.
      WRITE(6,6000)IR
      WRITE(6,6011)IOCBL
      WRITE(6,6012)IOCFH
      WRITE(6,6014)IOCS
      WRITE(6,6013)IOCR
      WRITE(6,6015)IOCAP
      WRITE(6,6045)
      WRITE(6,6016)
      WRITE(6,6017)SYSTEM
      WRITE(6,6018)LOCAL
```

```
      WRITE(6,6020)APCONT
      WRITE(6,6021)CABATT
      WRITE(6,6022)FOOD
      WRITE(6,6023)PAXHAN
      WRITE(6,6024)CARHAN
      WRITE(6,6025)OTHSER
      WRITE(6,6026)FGTCOM
      WRITE(6,6027)GENADM
      WRITE(6,6045)
      WRITE(6,6007)
      WRITE(6,6008)WGROSS,NS,REQRNGS,WCARGO,TBLOCK,TFLIGHT
      WRITE(6,6009)
      WRITE(6,6010)CSTLABF,CSTLENG,CSTDEPB,DOCAP1F,LOADF
      WRITE(6,6030)
      WRITE(6,6031)SEATS1C,SEATSTC,NCABATT,DEPART,WFREIGT
      WRITE(6,6040)TOCAP
      WRITE(6,6060)DOCP,IOCP
 6000 FORMAT(1H1/,10X,* LOCKHEED IOC METHOD*,///,4X,
     1 *1976 UPDATE-*,F5.1,* PERCENT INFLATION*,/)
 6007 FORMAT(40X,*AIRPLANE INPUTS REQUIRED*)
 6008 FORMAT(1X,*WGROSS=*E10.3,3X,*NS=*,F5.0,3X,*REQRNGS=*,E10.3,3X,
     1 *WCARGO=*,E10.3,3X,*TBLOCK=*,E10.3,3X,*TFLIGHT=*,E10.3,/)
 6009 FORMAT(40X,*INPUTS FROM DOC PROGRAM*)
 6010 FORMAT(1X,*($/MILE COSTS)  CSTLABF=*,E10.3,3X,*CSTLENG=*,E10.3,3X,
     1 *CSTDEP=*,E10.3,3X,*DOCAP=*,E10.3,/,1X,*LOADF=*,F6.2)
 6011 FORMAT(1X,*$/BLOCK HOUR*,10X,*IOCBL=*,E12.5)
 6012 FORMAT(1X,*$/FLIGHT HOUR*,9X,*IOCFH=*,E12.5)
 6013 FORMAT(1X,*CENTS/PASSENGER MILE  IOCR=*,E13.5)
 6014 FORMAT(1X,*CENTS/SEAT MILE*,7X,*IOCS=*,E13.5)
 6015 FORMAT(1X,*$/AIRCRAFT MILE*,7X,*IOCAP=*,E12.5)
 6016 FORMAT(1X,*1976 BREAKDOWN ($/TRIP)*,/)
 6017 FORMAT(2X,*SYSTEM=*,E13.5)
 6018 FORMAT(2X,*LOCAL= *,E13.5)
 6020 FORMAT(2X,*APCONT=*,E13.5)
 6021 FORMAT(2X,*CABATT=*,E13.5)
 6022 FORMAT(2X,*FOOD=  *,E13.5)
 6023 FORMAT(2X,*PAXHAND=*,E12.5)
 6024 FORMAT(2X,*CARHAND=*,E12.5)
 6025 FORMAT(2X,*OTHSER=*,E13.5)
 6026 FORMAT(2X,*FGTCOM= *,E12.5)
 6027 FORMAT(2X,*GENADM=*,E13.5)
 6030 FORMAT(40X,*MISCELLANEOUS PARAMETERS*)
```

```
 6031 FORMAT(1X,*SEATS1C=*,F5.0,3X,*SEATSTC=*,F5.0,3X,*NCABATT=*,F5.0,4X
     1 ,*DEPART=*,F08.2,5X,*WFREIGHT=*,E10.3)
 6040 FORMAT(//,1X,*1976 TOC ($/MILE)=*,E09.3)
 6060 FORMAT(1X,*DOC IS*,F6.2,* PERCENT OF TOC*,/,* IOC IS*,F6.2,
     1 * PERCENT OF TOC*)
 6045 FORMAT(//)
C
C-------------------RETURN ON INVESTMENT CALCULATIONS
C
C-------------------INPUTS
C  YIELD FROM FIRST CLASS PASSENGERS (CENTS/PASSENGER STATUTE MILE)
      YLD1C=9.1
C  YIELD FROM TOURIST SEATS (CENTS/PASSENGER STATUTE MILE)
      YLDTC=7.0
C  YIELD FROM CARGO (CENTS/TON STATUTE MILE)
      YLDCARG=27.
C  TAX RATE (PERCENT)
      TAXR=48.
C  INTEREST RATE (PERCENT)
      INTR=10.
C  CHANGE VALUES FOR PROGRAM COMPATIBILITY TO PERCENTAGES
      TAXR=TAXR/100.
      INTR=INTR/100.
C
      STEP=.1
      DCFROI=0.
      I=DEPYR
C  INITILIZE SUMMATION VARIABLES TO ZERO
      SREV=0.
      SCSTOP=0.
      SCSTDEP=0.
      SPBT=0.
      SINT=0.
      STAX=0.
      SPAT=0.
      SUM = -CSTAPBS
      SRDCF = 0.
C  GREV=REVENUE INFLATION RATE
      GREV=0.
C  GCSTOP=TOTAL OPERATING COST INFLATION RATE
      GCSTOP=0.
C  YEAR OF AIRCRAFTS LIFE UNDER CONSIDERATION
```

```
      DO 6150 N=1,I
      FN=N
      REV(N)=((YLDTC*SEATSTC+YLD1C*SEATS1C)*LOADF/100.+
     1 (YLDCARG*WCARGO/2000.))*REQRNGS*UTIL/TBLOCK/100.
      REV(N)=REV(N)*(1.+GREV/100.)**N
      CSTOP(N)=TOCAP*UTIL*SPEEDBL
      CSTOP(N)=CSTOP(N)*(1.+GCSTOP/100.)**N
      COSTDEP(N)=CSTDEPB*UTIL*SPEEDBL
      PROBTAI(N)=REV(N)- CSTOP(N)
      BOOK(N)=CSTAPBS-COSTDEP(N)*FN
      INTREST(N)=INTR*BOOK(N)
      TAX(N)=TAXR*(PROBTAI(N)-INTREST(N))
      TEST(N)=PROBTAI(N)-INTREST(N)
      IF(TEST(N).LE.0.0) TAX(N)=0.0
      PROATAI(N)=PROBTAI(N)-INTREST(N)-TAX(N)
      SREV=SREV+REV(N)
      SCSTOP=SCSTOP+CSTOP(N)
      SCSTDEP=SCSTDEP+COSTDEP(N)
      SPBT=SPBT+PROBTAI(N)
      SINT=SINT+INTREST(N)
      STAX=STAX+TAX(N)
      SPAT=SPAT+PROATAI(N)
 6150 CONTINUE
      KEY = 1
  100 CONTINUE
      SDCF = 0.
C  PRESENT VALUE ($)
C  DISCOUNTED CASH FLOW FIGURES ($)
      DO 110 N = 1,I
      PRESVAL(N)=(1.+DCFROI)**(-N)
      DCSHFLO(N)=PROATAI(N)*PRESVAL(N)
      SDCF = SDCF + DCSHFLO(N)
  110 CONTINUE
      IF (KEY .LT. 0.) GO TO 220
      NET = SDCF + SUM
      IF (DCFROI .EQ. 0. .AND. NET .LT. 0.) GO TO 200
  120 CONTINUE
      IF (ABS(NET) .LT. 1000.) GO TO 6164
      IF (NET) 6157,6164,6158
  200 CONTINUE
      KEY = -1
      ALOSS = NET / I
```

```
  220 CONTINUE
      SRPAT = 0.
      SRDCF = 0.
      DO 210 N = 1,I
      RPATAI(N) = PROATAI(N) - ALOSS * 2.
      RDCF(N) = RPATAI(N) * PRESVAL(N)
      SRDCF = SRDCF + RDCF(N)
  210 CONTINUE
      NET = SRDCF + SUM
      GO TO 120
 6158 CONTINUE
      DCFROI=DCFROI+STEP
      IF (DCFROI .GT.1.) GO TO 6164
      GO TO 100
 6157 CONTINUE
      DCFROI=DCFROI-STEP
      STEP = STEP / 10.
      GO TO 100
 6164 CONTINUE
      DCFROI= DCFROI*100.
      IF (SPAT .LT. CSTAPRS) DCFROI = -DCFROI
      WRITE(6,6165)SUM
      DO 6152 N=1,I
      IF (KEY .LT.0.) DCSHFLO(N) = 0.
      WRITE(6,6155)N,REV(N),CSTOP(N),
     1COSTDEP(N),PROBTAI(N),BOOK(N),INTREST(N),TAX(N),
     1 PROATAI(N),PRESVAL(N),DCSHFLO(N)
 6152 CONTINUE
 6155 FORMAT(1X,I4,10E13.3)
      WRITE(6,6182)SREV,SCSTOP,SCSTDEP,SPBT,SINT,STAX,SPAT,NET
      WRITE(6,8888)CSTAPRS
      WRITE(6,6166)NET,LOADF
      WRITE(6,6168)YLDIC,YLDTC,YLDCARG
      WRITE(6,6169)SEATSIC,SEATSTC,WCARGO
C  TEST FOR RETURN ON INVESTMENT BEING GREATER THAN 100 PERCENT
      IF(DCFROI.LE.100.) GO TO 985
      WRITE(6,905)
  905 FORMAT(1X,*RETURN ON INVESTMENT IS GREATER THAN 100 PERCENT*)
  985 CONTINUE
C  TEST FOR RETURN ON INVESTMENT BEING LESSER THAN -100 PERCENT
      IF(DCFROI.GE.-100.) GO TO 989
      WRITE(6,906)
```

```
      906 FORMAT(1X,*RETURN ON INVESTMENT IS LESS THAN -100 PERCENT*)
      989 CONTINUE
          IF(DCFROI.GE.100.) GO TO 986
          WRITE(6,6167)DCFROI
      986 CONTINUE
          IF  (KEY .GT. 0.) GO TO 7119
          WRITE (6,250)
      250 FORMAT (T95,*REVISED CSHFLOS + DCSHFLOS WHEN ROI IS NEG*)
          DO 300 N = 1,I
      300 WRITE (6,310) RPATAI(N), RDCF(N)
          WRITE (6,311) SRPAT,-2*ALOSS,SRDCF
      310 FORMAT (T97,E13.3,T123,E13.3)
      311 FORMAT (T87,*TOTAL*,T97,3E13.3)
     7119 CONTINUE
          GO TO 7113
     7111 CONTINUE
     6165 FORMAT(1H1,/,20X,*RETURN ON INVESTMENT CALCULATIONS*,///,
         1 2X,*YEAR*,5X,*REVENUE*,5X,*OPERATING*,4X,
         2 *COST OF*,3X,*PROFIT BEFORE*,5X,*BOOK*,7X,
         3 *INTEREST*,8X,*TAX*,5X,*PROFIT AFTER*,3X,*PRESENT*,5X,
         4 *DISCOUNTED*,/,25X,*COST*,5X,
         5 *DEPRECIATION*,3X,*TAX  AND*,44X,*TAX  AND*,
         6 6X,*VALUE*,6X,*CASH  FLOW*,/,49X,*INTEREST*,44X,*INTEREST*,/,
         7T123,E13.3)
     6166 FORMAT(1X,*RESIDUE=*,E12.4,1X,*DOLLARS*,
         1 70X,*LOADF=  *,F6.2,*  PERCENT*)
     6167 FORMAT(1X,*RETURN ON INVESTMENT (INTERNAL)=*,F12.3,* PERCENT*)
     6168 FORMAT(1X,*YLD1C=*,E12.4,* YLDTC=*,E12.4,* YLDCARG=*,E12.4)
     6169 FORMAT(1X,*SEATS1C=*,F5.0,*  SEATSTC=*,F5.0,*  WCARGO=*,E12.4,//)
     6182 FORMAT(1X,135(1H-),/,1X,*TOTAL*,4E13.4,13X,3E13.4,13X,E13.4,//)
     8888 FORMAT(1X,*BASE AIRPLANE AND SPARES COST=*,E12.4,1X,*DOLLARS*)
          END
```

SYMBOLIC REFERENCE MAP (R=3)

```
ENTRY POINTS     DEF LINE     REFERENCES
 4141  RANG          5
```

APPENDIX B-3. - ROI SAMPLE CASE

1976 ATA DOC CALCULATIONS, SUBSONIC JET, 3 MAN OR 2 MAN CREW.   STATUTE MILES

```
REQRNGS=  5180.      SPEEDBL=  530.19      TBLOCK=  9.770      FUELBL= .2482E+06      UTIL=  4275.08

NS= 385.        VCJ= .1800E+06        WGROSS= .7762E+06

AIRPLANE DOC ($ PER HOUR)   DOCBL= .3425E+04   DOCFH= .3515E+04

COST OF FLT OPS, MAINT,AND DEPRECIATION ($ PER MILE)  CSTFLYO= .3666E+01  CSTMAIN= .1587E+01  CSTDEP= .1207E+01  DOCAP= .6460E+01

COST OF MAINTENANCE ($ PER MILE)  CSTLABF= .1235E+00  CSTMAF= .1067E+00  CSTLENG= .2670E+00  CSTMENG= .3087E+00  CSTMAOH= .7810E+00

COST OF FLT. OPERATIONS ($ PER MILE)   CSTCREW= .8131E+00   CSTFUEL= .2701E+01   CSTINS= .1524E+00

COST OF AIRPLANE, AIRFRAME, ENGINE ($)   CSTAP= .3454E+08   CSTAF= .2750E+08   CSTENG= .7040E+07   CSTIENG= .1760E+07

                                          MISCELLANEOUS PARAMETERS
KA=        .1036E+03         SPEEDE= 563.00            TFLIGHT= 9.520           TCRUISE=  9.420
LABAFFH=   .6463E+01         MATAFFH=    .5025E+02     LABENFH=  .1389E+02      MATENFH=    .1447E+03
LABAFFC=   .8170E+01         MATAFFC=    .6341E+02     LABENFC=  .1845E+02      MATENFC=    .1906E+03
CSTGASB=   .370              CSTOILB= 15.00            ENGNO=    4.             DEPYR=   14.
B=    2-INT.                 LOADF=    55.00           OILBR=     .135          LABRATE=  9.00

         DOCS      DOCR              DOCS      DOCR              DOCS      DOCR              DOCS      DOCR
1F-      1.678     3.051     2F-     2.380     4.326     3F-     3.081     5.602     4F-     3.783     6.877
1.25MA-  1.781     3.238     1.50MA- 1.884     3.426     1.75MA- 1.987     3.613     2.00MA- 2.090     3.800
1.25CR-  1.731     3.147     1.50CR- 1.784     3.243     1.75CR- 1.836     3.339     2.00CR- 1.889     3.435
DP-10    1.803     3.279     DP-11   1.764     3.206     DP-12   1.730     3.146     DP-15   1.657     3.013
1.25AP-  1.783     3.242     1.50AP- 1.888     3.433     1.75AP- 1.993     3.624     2.00AP- 2.098     3.815
```

LOCKHEED IOC METHOD

1976 UPDATE- 0.0 PERCENT INFLATION

$/BLOCK HOUR	IOCBL=	.26522E+04
$/FLIGHT HOUR	IOCFH=	.27218E+04
CENTS/SEAT MILE	IOCS=	.12993E+01
CENTS/PASSENGER MILE	IOCR=	.23624E+01
$/AIRCRAFT MILE	IOCAP=	.50023E+01

1976 BREAKDOWN ($/TRIP)

SYSTEM=	.11328E+04
LOCAL=	.36016E+04
APCONT=	.67720E+02
CABATT=	.36149E+04
FOOD=	.17942E+04
PAXHAND=	.33541E+04
CARHAND=	.15069E+02
OTHSER=	.96524E+04
FGTCOM=	.51282E+01
GENADM=	.26739E+04

AIRPLANE INPUTS REQUIRED

WGROSS= .776E+06 NS= 385. REQRNGS= .518E+04 WCARGO= .100E+00 TBLOCK= .977E+01 TFLIGHT= .952E+01

INPUTS FROM DOC PROGRAM

($/MILE COSTS) CSTLABF= .124E+00 CSTLENG= .267E+00 CSTDEP= .121E+01 DOCAP= .646E+01

LOADF= 55.00

MISCELLANEOUS PARAMETERS

SEATS1C= 58. SEATSTC= 327. NCABATT= 10. DEPART= 1.00 WFREIGHT= .100E+00

1976 TOC ($/MILE)= .115E+02

DOC IS 56.36 PERCENT OF TOC

IOC IS 43.64 PERCENT OF TOC

RETURN ON INVESTMENT CALCULATIONS

YEAR	REVENUE	OPERATING COST	COST OF DEPRECIATION	PROFIT BEFORE TAX AND INTEREST	BOOK	INTEREST	TAX	PROFIT AFTER TAX AND INTEREST	PRESENT VALUE	DISCOUNTED CASH FLOW
										-.383E+08
1	.351E+08	.260E+08	.274E+07	.913E+07	.356E+08	.356E+07	.268E+07	.290E+07	.958E+00	.278E+07
2	.351E+08	.260E+08	.274E+07	.913E+07	.328E+08	.328E+07	.281E+07	.304E+07	.917E+00	.279E+07
3	.351E+08	.260E+08	.274E+07	.913E+07	.301E+08	.301E+07	.294E+07	.318E+07	.878E+00	.280E+07
4	.351E+08	.260E+08	.274E+07	.913E+07	.274E+08	.274E+07	.307E+07	.333E+07	.841E+00	.280E+07
5	.351E+08	.260E+08	.274E+07	.913E+07	.246E+08	.246E+07	.320E+07	.347E+07	.806E+00	.280E+07
6	.351E+08	.260E+08	.274E+07	.913E+07	.219E+08	.219E+07	.333E+07	.361E+07	.772E+00	.279E+07
7	.351E+08	.260E+08	.274E+07	.913E+07	.192E+08	.192E+07	.347E+07	.375E+07	.739E+00	.277E+07
8	.351E+08	.260E+08	.274E+07	.913E+07	.164E+08	.164E+07	.360E+07	.390E+07	.708E+00	.276E+07
9	.351E+08	.260E+08	.274E+07	.913E+07	.137E+08	.137E+07	.373E+07	.404E+07	.678E+00	.274E+07
10	.351E+08	.260E+08	.274E+07	.913E+07	.109E+08	.109E+07	.386E+07	.418E+07	.649E+00	.271E+07
11	.351E+08	.260E+08	.274E+07	.913E+07	.821E+07	.821E+06	.399E+07	.432E+07	.622E+00	.269E+07
12	.351E+08	.260E+08	.274E+07	.913E+07	.547E+07	.547E+06	.412E+07	.447E+07	.596E+00	.266E+07
13	.351E+08	.260E+08	.274E+07	.913E+07	.274E+07	.274E+06	.425E+07	.461E+07	.570E+00	.263E+07
14	.351E+08	.260E+08	.274E+07	.913E+07	.238E-06	.238E-07	.438E+07	.475E+07	.546E+00	.259E+07
TOTAL	.4916E+09	.3637E+09	.3830E+08	.1279E+09		.2490E+08	.4943E+08	.5355E+08		.7823E+03

BASE AIRPLANE AND SPARES COST= .3830E+08 DOLLARS
RESIDUE= .7823E+03 DOLLARS LOADF= 55.00 PERCENT
YLDIC= .9100E+01 YLDTC= .7000E+01 YLDCARG= .2700E+02
SEATSIC= 58. SEATSTC= 327. WCARGO= .1000E+00

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16. Abstract

Computer programs to calculate airline direct operating cost, and indirect operating cost and return on investment were developed to provide a means for determining commercial aircraft life-cycle cost and economic performance. These program codes can be easily incorporated into existing aircraft design programs. A representative wide-body subsonic jet aircraft was evaluated to illustrate use of the program.

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