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Cell Fleet Planning: An Industry Case Study

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CELL FLEET PLANNING: AN INDUSTRY CASE STUDY

by

ARMANDO C. SILVA

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ABSTRACT

The objective of this thesis is to demonstrate the practical use of the Cell Fleet Planning Model in planning the fleet for the U.S. airline industry. The Cell Model is a cell-theory, linear programming approach to fleet planning.

Four scenarios of the Model are presented: three with a nine-cell representation of the system and a test case using a thirty-cell representation. A detailed analysis of the results for each case has been performed. A comparison between the cases, with other forecasts, and with recent historical data which has also been analyzed is shown.

The Cell Model has produced realistic results. It has proven to be efficient regarding computer time and labor intensity given the size of the problem, and to be viable for industry use. Should no dramatic changes in the airline route system structure occur in the next ten years, results obtained show a greater need for small-capacity, short-range aircraft (e.g. B737's, B757's, and DC9's) than for other aircraft types.

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CHAPTER 1.

INTRODUCTION

Aircraft fleet planning is, in simple terms, the process of answering the following five questions:

- How many aircraft will be needed
- What types of aircraft will be needed
- When are these aircraft to be acquired
- Where are these aircraft to be allocated
- How will these aircraft be financed

The aircraft selection process is influenced by a wide range of factors including economic, technological, financial, regulatory/political, environmental, foreign manufacturer competition, and marketing factors. Among the economic factors, the selection process has to consider aircraft productivity defined in terms of available seat miles (ASM) per aircraft. An ASM is defined as:

$$ASM = Capacity * Speed * Utilization$$

Traffic forecasts are extremely important in the fleet planning process. They constrain the market and finally determine the number of seats that will be required in the future. Traffic forecasts define the demand for which the fleet planning process searches the corresponding supply. Operating expenses is another very important economic factor. The goal of fleet planning is to determine the aircraft type at the proper moment in time that will maximize revenues and minimize operating expenses. The objective of an airline, agency, government, or whoever performs the fleet planning, may not be to maximize profits but, for example, to maximize service. This could well be the case in any foreign country with a state-owned airline and that views air transport exlusively as a public service. But even then, the idea is to maximize service at the least possible cost.

The route structure is of great significance in the aircraft selection. The payload-range characteristics of the aircraft must match the requirements of the route structure. A route structure conformed by a majority of short-haul low-demand segments will require a greater number of short-range small-capacity aircraft, since these are the most efficient aircraft types for routes with those characteristics, and viceversa.

The technological factors of aircraft selection involve operations-related and maintenance-related factors. Among the operations-related factors are the flight performance characteristics, the ground operations requirements, airport constraints, air compatibility, and cargo convertibility. Maintenance-related factors can include: service records, parts pools, fleet commonality and product support.

Regulatory and/or political factors also influence the aircraft selection process. Airline deregulation, needless to say, has had a great impact on U.S. airline industry and has been the cause for major changes in route structures. Many studies on the effect of deregulation have been and continue to be made. As a political factor, one could list the foreign governments' support of exports, which translate into export credit financing, tax incentives, direct promotion and assistance. Noise compliance regulations are an example of regulatory and environmental factors affecting aircraft selection.

The aircraft fleet planning process varies according to the sector performing this planning. A different approach is carried, for example, by an airline than by an engine or airframe manufacturer. A fleet planning process by an airline usually involves shorter planning horizons (1 to 5 years) and represents a smaller size problem, since an airline is concerned only with its route network (present or future) as opposed to a manufacturer who is concerned in forecasting the entire airline industry. A manufacturer also has a different time frame which can range from 5 to 15 years. This thesis presents a case study from an industry point of view, that is, a fleet planning process as performed by a manufacturer. The entire U.S. airline route system will compose the planning problem.

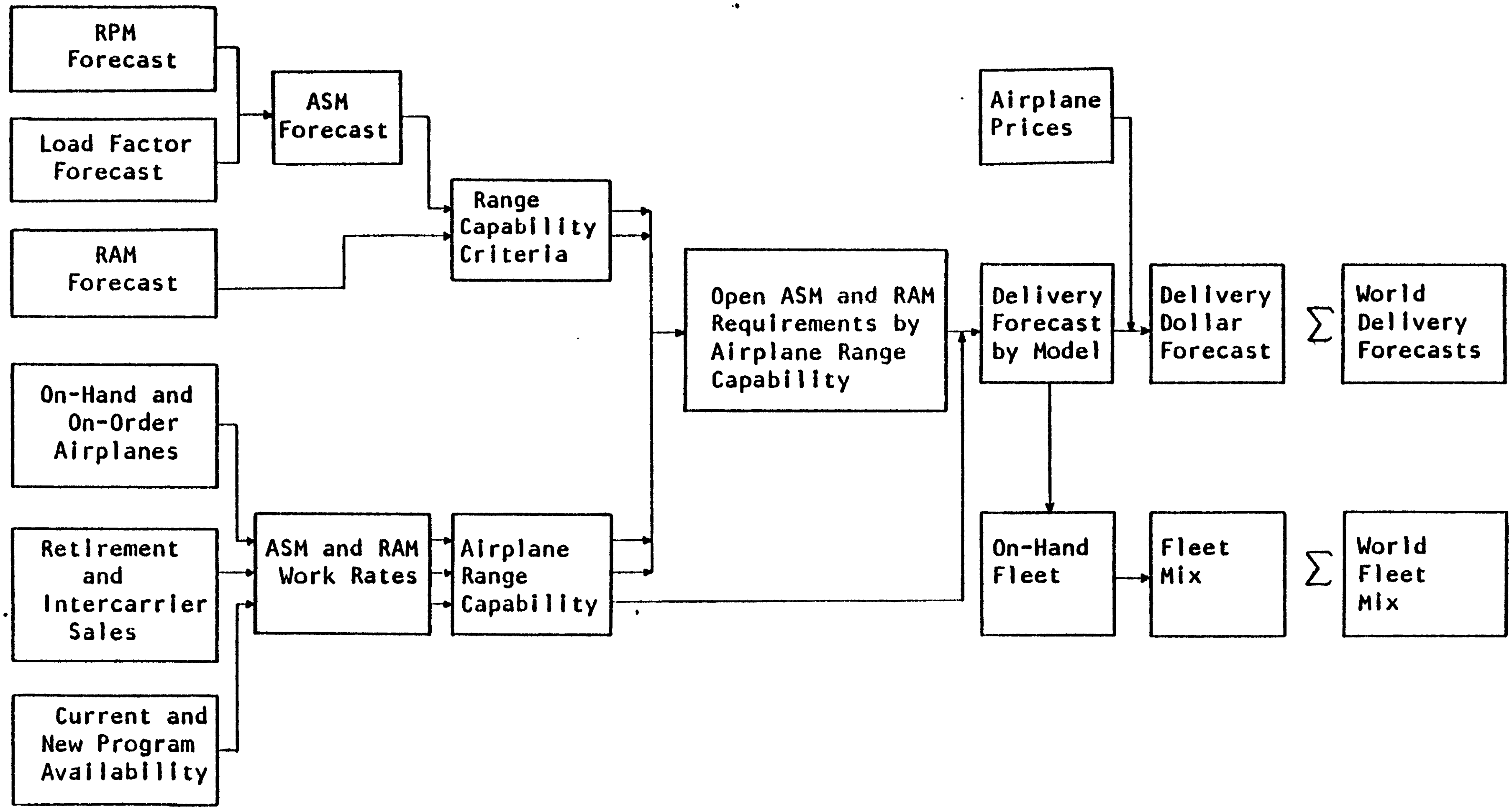
Four approaches are found in fleet planning. These range from very macroscopic to very microscopic and are: the capacity gap approach, the cell theory approach, the fleet assignment approach, and the schedule evaluation approach. In the "capacity gap" approach, the most macro, traffic is forecasted first and then expressed in terms of revenue passenger miles (RPM). These forecasts usually correspond to given geographical regions, for which load factors are assumed. These load factors are applied to the RPM's to obtain ASM's and, therefore, determine the capacity requirements. As mentioned earlier, ASM's represent the supply needed to satisfy the demand represented by RPM's. Having calculated the required capacity, the next step in the capacity gap approach is to determine what portion of that capacity will be covered by the current fleet less the projected and possible aircraft retirements. The "capacity gap" to be filled by new aircraft due to aircraft replacement and traffic growth is then calculated. Finally, this capacity gap is converted into number of aircraft taking into consideration aircraft mix, future availability, and acquisition capabilities. Figure 1.1 shows the flow diagram of a macro fleet planning model used by Boeing.

The most micro approach to fleet planning is schedule evaluation. This approach is generally followed at the airline level since it involves a great amount of detail. It involves the use of actual airline schedules and altering them to find the best way of satisfying projected demand. Future origin-destination traffic is allocated and flights are added or reduced, and equipment changed, to even-out load factors.

A third approach involves the application of fleet assignment and network design optimization models. While still a micro approach, it requires a lesser degree of detail than the schedule evaluation approach. A series of computer models (FA-n) developed at the Flight Transportation Laboratory at M.I.T. are used, which work at the network level of economic analysis. These models optimize the system profit by assigning the number of frequencies with a given aircraft type on a given route. This problem is solved with the aid of mathematical programming techniques. A disadvantage in using the fleet assignment approach to fleet planning lies in that these models yield single period results. Thus, the models need to be run for each of the periods considered in the planning horizon with data projected to each of these periods. A drawback in this procedure is that it does not take into account that decisions taken on a given period may affect decisions on different periods of time.

This brings us to the fourth approach to fleet planning: cell theory. The Cell Theory approach fills a gap between very macro and very micro procedures. It is an option which is more macro than the scheduling evaluation and fleet assignment approaches and yet not as macro as the capacity gap approach. It allows a more complete planning scheme without

Figure 1.1 Boeing's Airplane Forecast Methodology Flow Diagram



Source: Boeing, "Dimensions of Airline Growth", April 1983.

having to get into the level of detail of the more micro approaches. A great advantage over these approaches is that it is a multi-year tool. The Cell Fleet Planning Model, the computer implementation of this cell theory approach, is the subject of analysis of this thesis through an industry case study.

The cell fleet planning process is described in Chapter 2. An explanation of the cell definition, clustering, demand frequency relationships, and the mathematical structure of the Cell Fleet Planning Model is included in this chapter. Chapter 3 analyzes the aircraft fleet composition of the U.S. airline industry during the past five years. It also makes use of the clustering techniques used in the Cell Fleet Planning Model, and described in Chapter 2, to analyze the frequency distribution per aircraft type and aircraft category during these five years. In Chapter 4, the scenarios to be considered in this case study are presented. The actual inputs to and outputs from the Cell Model are shown and described. Chapter 5 performs an analysis of the results obtained in Chapter 4 and compares them to the historical data of Chapter 3 and to other forecasts. Finally, Chapter 6 presents some conclusions on the present study.

CHAPTER 2.

CELL FLEET PLANNING

The Cell Fleet Planning Model is the computer implementation of the Cell Theory—Linear Programming approach to aircraft fleet planning developed by Dr. Dennis F. X. Mathaisel at the Flight Transportation Laboratory.[13]

The cell approach allows the modelling of the entire airline route system without having to consider air traffic in each city pair in detail. The fact that the system is formed by nearly 6000 segments (approximately 3000 for non-directional segments) gives a measure of the size of the problem that would need to be solved. Aggregating segments according to their similarity into a few cells (between 9 and 40) greatly relaxes the problem. Cells are defined by a specific set of attributes as described in section 2.1. From the industry planning point of view, the aggregation can be done without any loss of important information since at this planning level the detailed characteristics of particular city pairs are irrelevant. What is relevant are the generic attributes of the city pairs.

A linear programming problem is formulated to determine the optimal composition of the aircraft fleet over a multi-year period. Fleet requirements are determined by traffic growth and by aircraft replacement due to economic and technological factors. Traffic demand is given by a set of frequency-demand curves described in section 2.2. Section 2.3 presents the mathematical structure of the linear programming problem.

2.1 Cells: Definition and Clustering

2.1.1 Grid Cells and Cluster Cells

Two configurations of cells are possible: grid cells and cluster cells. A grid cell is defined by a partitioning of the dimensions of the cell. The boundaries of each cell are straight lines which form a grid. No overlapping in the attribute ranges occurs and empty cells, or cells containing no elements with attributes within the ranges of that cell, can exist. Figure 2.1.a shows an example of grid cells.

Cluster cells result from a mathematical classification of the network elements. Elements with similar attributes are allocated to the same cell, where similarity is a function of proximity among the attributes of the elements. In the case of cluster cells, there are no empty cells, since the elements themselves by means of their attributes define and create a cell. Every cell contains at least one element (Figure 2.1b).

The major difference between grid cells and cluster cells is the sensitivity of the cluster cell to change its configuration according to the network structure. In the case of the grid cells, the partitioning of the dimensions of the cell is a subjective process in which the analyst has some prior knowledge of the range in which the attributes of the system vary. He then, to the best of his judgement, decides the partitioning of the cells. The disadvantage of this procedure lies in the fact that some important statistical relationships between the attributes are ignored. It has an advantage though, in the sense that the analysis of the cells is easier if the cell definitions are kept constant over time.

Figure 2.1a Example of Grid Cells

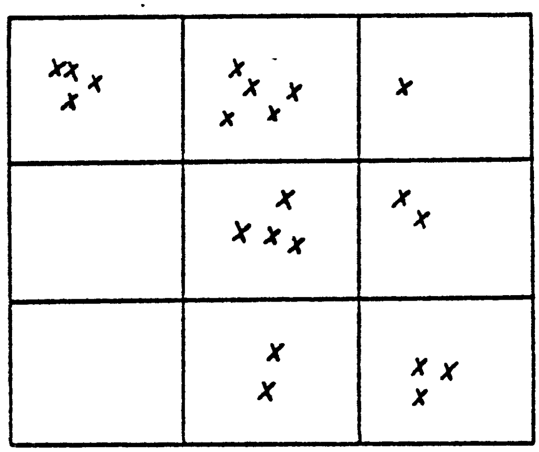
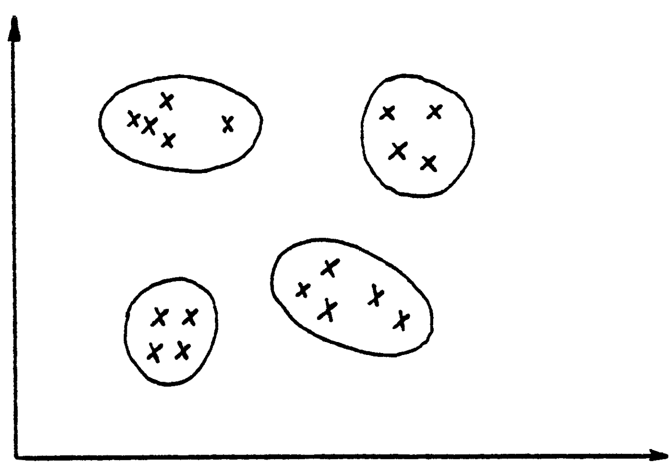


Figure 2.1b Example of Cluster Cells



The migration of elements between cells is more easily detected. However, if the structure of the system changes, the grid configuration does not reflect these variations. Changes in the network structure should be correlated to changes in the cell definitions.

The cluster cell configuration results from an analytical procedure and, therefore, does not depend on the analyst's subjectivity. Nevertheless, it allows control over the proximity parameters and the levels of cell aggregation. It has the advantage that the cell definitions do change to reflect variations in the network structure. Cluster techniques form cells in hierarchical or non-hierarchical ways. Non-hierarchical techniques cluster the elements into a number of cells either specified by the analyst or determined by the clustering procedure. Hierarchical techniques form a hierarchy of partitions which result from either agglomerative or divisive hierarchical methods [14].

A hybrid clustering technique combining k-mean clustering and single-linkage clustering was designed by Anthony M. Wong (Yale, 1979) to cluster large numbers of multi-variate elements. Route elements x_i described by their attributes are partitioned into k clusters with mean y_j $(j=1,2,\ldots,k)$. Each element x_i pertains to only one cell with no empty cells. Transfer of any element between cells increases the within-cluster sum of squares, defined as:

$$WSS = \sum_i \min_j (x_i - y_j)^2$$

2.1.2 Number of Cells

In general, from the above discussion, and since the k-mean clustering is a heuristic, as the number of cells k increases, WSS decreases. However, as k increases the total computation time, and therefore cost, of running the program increases. Besides, the original idea behind clustering elements on cells was to reduce the total size of the original problem and deal only with a reliable representation of the entire system. A very large number of cells would not be consistent with this strategy and would represent a larger number of assumptions and forecasts. Thus, a compromise regarding the total number of cells used must be reached.

A method of determining this number of cells k is to plot WSS versus k for the data to be used, and find on these curves the value of k for which the improvement in WSS becomes relatively small. That is, obtain a point in the "knee" of the curve from where an increase in k does not reflect a major decrease in WSS.

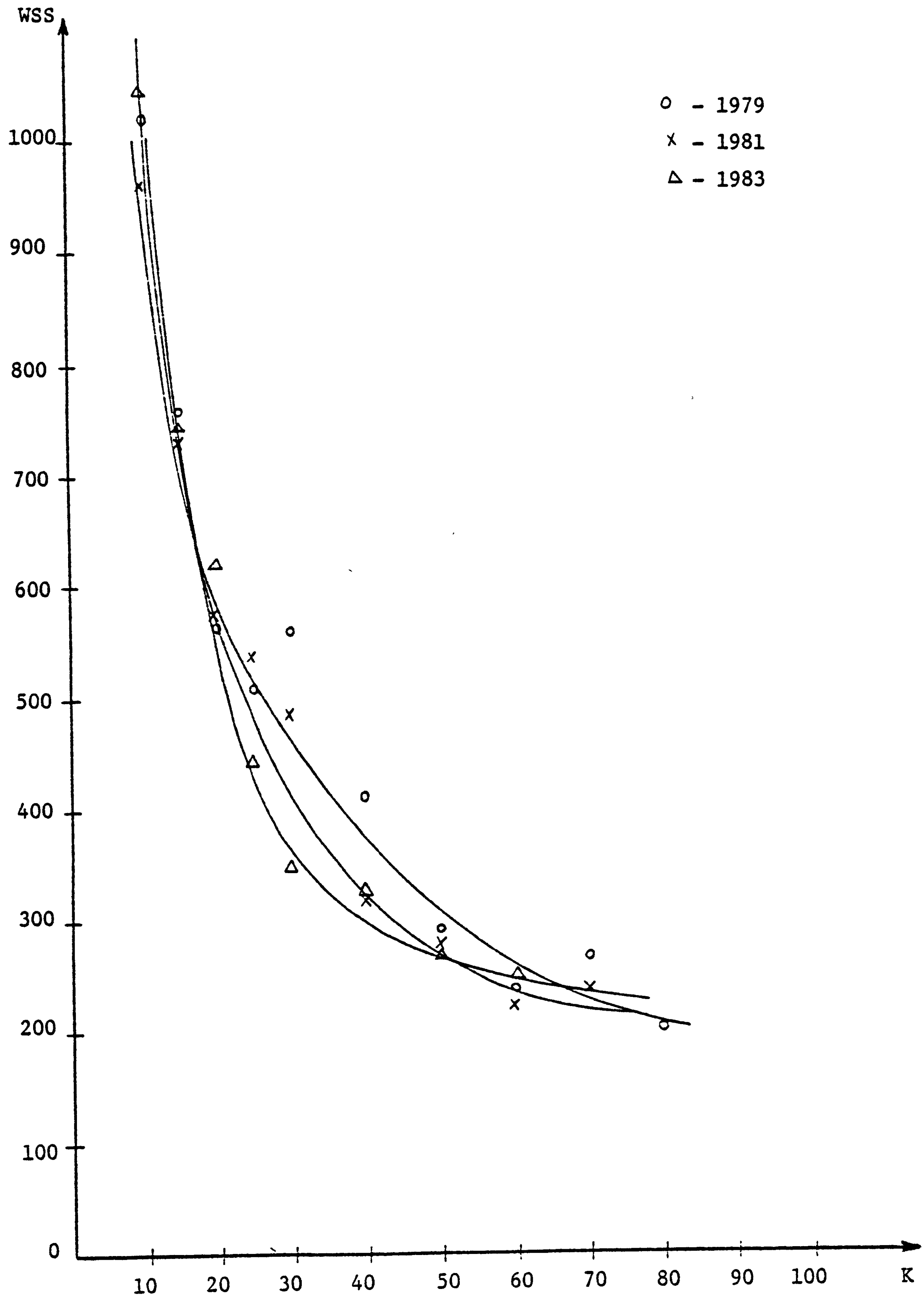
For the present case study, the data to be clustered is composed of five years, 1979 through 1983, of the Official Airline Guide database. Figure 2.2 shows the WSS versus k plots for this case. The "knee" of the curve falls approximately between k=30 and k=40. Thirty cells shall be considered in the case study of chapter 4 [1].

2.1.3 Cell Attributes

Elements on the air transportation route network possess defined

[1] A basic case of 9 cells is also considered in Chapter 4 whose purpose is to compare results with the 30-cell case. Nine cells are chosen as a basic case because there are 3 attributes which could be partitioned as low, medium, and high, thus resulting in 9 possible combinations of attributes.

Figure 2.2 Within-Cluster Sum of Squares vs. Number of Cells Plot



characteristics regarding stage length, frequency, number of seats offered, load factor, fares, etc. The Cell Fleet Planning Model uses three of these attributes to define and cluster its cells:

-frequency: number of flights over a given period of time (usually week or day)

-distance: stage length

-seat volume: number of seats offered over the same period of time.

The reason for choosing these 3 attributes is closely related to payload-range characteristics of aircraft. Since the final objective of the model is to determine the number and characteristics of the airplanes required to satisfy the air transportation market demand in the future, it only makes sense to consider range and seat volume. The range and the size (translated into number of seats) define the different aircraft types. Frequency is directly related to the total seat volume; for a given number of frequencies, a larger aircraft (e.g. DC10) represents a larger seat volume than a smaller airplane (e.g. B737).

Also, these 3 attributes (frequency, distance, and seat volume) are readily obtainable. The OAG database used in this case study contains these 3 items for each segment. Figure 2.3 shows a sample of the OAG database.

2.1.4 Elements of a Cell

Two schools of thought exist regarding the elements that form a cell. One states that these elements should be routes on the network. (Routes can have one or more segments, that is, they can be non-stop or

Figure 2.3 Sample of OAG Database

Segment	a/c type	f	a/c type	f	a/c type	f	...	no. of carriers	freq.	distance	seats(x1(
DFWMEM	727	15	72S	47				2	62	429	78
ATLPMY	72S	28	C9S	14	727	21		2	66	509	80
CLELGA	727	12	72S	6	737	47		2	65	416	69
ATLSRQ	D9S	28	C95	21	727	7	72S 7	2	63	445	66
LAXSLC	727	7	72S	42	73A	7		2	56	589	72
DFWELP	727	14	72S	28	D9S	14	DC9 6	2	62	550	70
ATLCVG	72S	21	C9S	14	L10	14		1	49	372	77
BURSFO	72S	53						1	53	325	84
BUFORD	72S	21	D10	14	727	20		2	55	470	86
LAXSJC	72S	59						1	59	307	94
PHXSAN	707	7	C8S	14	72S	34		4	62	303	100
HNLITO	D95	28	73S	28	D10	7		3	63	215	90
MIAPBI	72S	21	C95	7	727	14	D9S 7 L10 7 737 6	3	59	63	84
ATLCHS	72S	28	C8S	7	D9S	28	727 7	2	70	258	87
DTWMKE	72S	45	727	6	D95	21		2	67	236	83
DFWTUL	707	7	72S	33	727	2	D9S 13 DC9 19	4	70	233	81
BUFLGA	72S	47	D93	12	B11	14		2	73	291	79
LGAPIT	721	26	C93	7	B11	19	727 6 72S 20	2	76	333	82
ATLDAB	D9S	42	72S	21	727	7		2	73	366	82

a/c type = aircraft type

f = frequency

multi-stop routes.) The other, to which at least one manufacturer, Pratt & Whitney subscribes, defines segments as the elements of a cell.

Both definitions are perfectly valid, but for the present fleet planning purposes, considering segments as elements of a cell is much more attractive. Considering cells formed by routes that may contain several segments, some of these very different regarding their attributes, can be a very complicated and troublesome approach. The definition of routes themselves is not very clear. For example, on an aircraft's weekly schedule, where do routes start? Where do they end? Multi-stop routes are important since they involve different phenomena such as "tag-on's" and traffic building. In the simple case of a two-segment (one-stop) route, A to B to C, one is dealing with three markets: A to B, B to C, and A to C. Furthermore, the route structure of the system may change over time and the cells may become an inaccurate representation of the system. Cells having segments as elements, instead of routes, continue to represent the system accurately in the event of variations in the route network, since no matter how routes change, routes will still be formed by segments as a basic unit.

2.1.5 Cell Forecasting - Cell Matching

A concern related to the fleet planning process is the forecast of the cell structure in the future. Cell attributes can change over time, thus changing the definition of cells. Also the number of elements in each cell can increase or decrease over that period of time. These phenomena are known as "cell migration" and "cell growth" respectively.

The clustering process deals with historical data on a one-year-at-a-time basis, that is, elements are clustered for each year. Generally, clusters do not match from one year to the next. For every year clustered a different set of cells, with different set of attributes, is obtained. Then, a "cell matching" process is required which becomes part of the cell forecasting process. A cell matching algorithm is used which results in a series of cluster strings. As many clusters strings as number of cells (k) clustered are obtained. The cluster strings show the trends followed over the number of years examined regarding cell migration and cell growth. An average of the attributes in each cluster string over the period of time is used to define each of the cells to be considered in the fleet planning horizon. Chapter 4 describes the consideration in the Cell Fleet Planning Model of trends that could result in cell variations.

2.2 Demand-Frequency Curves

The demand in a given airline market is significantly affected by price and frequency of service.[17] For a carrier with a given class of service, this demand can be expressed mathematically as:

$$D = M\,I\,T^{\beta}\,P^{\alpha}$$

where:

M = a single market parameter which serves as proxy for all other market variables and which size is the market

I = a single "image" variable as a proxy for all the quality of service variables such as availability, reliability, safety, and comfort

P = price of services

α = price elasticity of demand

β = time elasticity of demand

T = total travel time

The total travel time results from the following expression:

$$T = t_o + \frac{t_i}{n} + \frac{d}{V_c}$$

where:

t_o = air and ground maneuver time for aircraft trip (usually 0.5 hours)

t_i = constant depending on the travel period which is used to compute average waiting time for service of travelers

d = distance between origin and destination

n = frequency

V_c = aircraft cruise speed

The total travel time T for a market is dependent on the schedule of non-stop and multi-stop offerings in the market. Since airlines in a market normally operate at the same jet speed, a portion of the total travel time is approximately constant. The remainder is frequency dependent and results from the average delay that market demand experiences in waiting for the most convenient flight.

Traditionally, the "demand curve" is defined as the variation of market demand with price (Figure 2.4). A demand curve can also be shown as a function of total trip time (Figure 2.5). In this case there is a number of components of total trip time. It should be noticed that decreasing the flight time by increasing the cruise speed to an infinite value will not make the total trip time zero.

There is a third fundamental market demand curve, the demand-

Figure 2.4 Demand-Price Curve

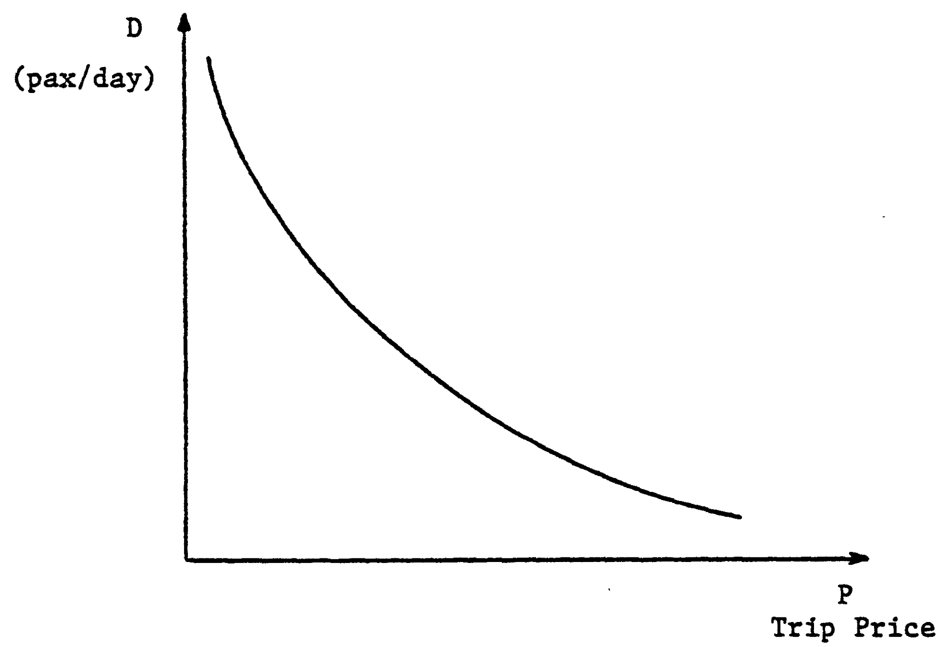
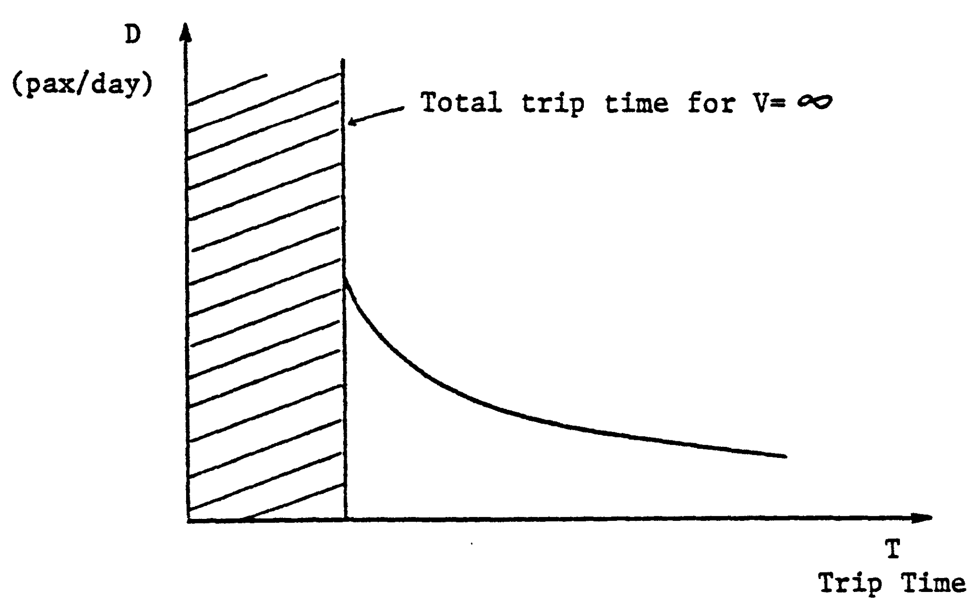


Figure 2.5 Demand-Time Curve



frequency curve (Figure 2.6a). Frequency becomes an important decision variable when airline competition exists. Independent of any postulates about the form of the demand model, it must be intuitively expected that a demand-frequency curve of the form shown in figure 2.6a will exist. At a frequency equal to zero, the demand must be zero. As the demand increases, demand can be expected to increase until, at some large frequency, demand will saturate. That is, no matter how many more flights are added, demand will no longer increase; it has reached a saturation point. This due to the fact that adding one more frequency virtually does not reduce the waiting time and therefore, makes no difference to the passenger.

A frequency elasticity, ε_n, now exists that decreases when n is increased:

$$\varepsilon_n = \frac{\frac{\partial D}{D}}{\frac{\partial n}{n}} = \frac{n}{D} \cdot \left[\frac{\partial D}{\partial T}\right] \cdot \left[\frac{\partial T}{\partial n}\right]$$

$$= \frac{n}{D} \cdot \left[\frac{\beta D}{T}\right] \cdot \left[-\frac{t_1}{n^2}\right]$$

$$= \beta \cdot \left[\frac{-t_1/n}{T}\right]$$

As $n \to \infty$, $\varepsilon_n \to 0$, or saturation takes place.

The shape of the demand-frequency curve depends strongly upon the time elasticity of demand, β, and the total trip time, T.

As mentioned earlier, the solution to the cell fleet planning problem is found by means of solving a linear programming problem. The demand-frequency curves provide the "feasible region" necessary to solve

Figure 2.6a Demand-Frequency Curve

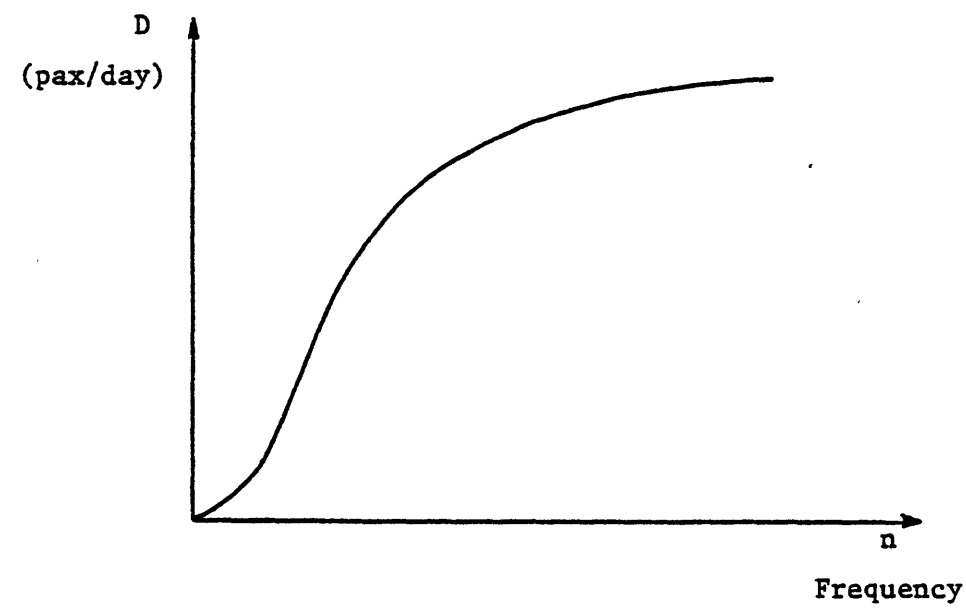
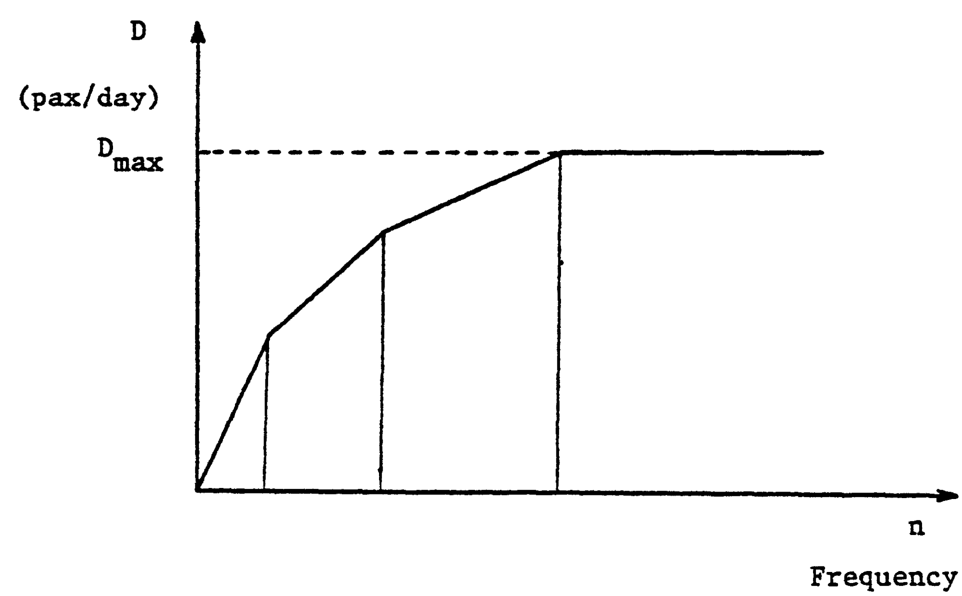


Figure 2.6b Approximated Frequency-Demand Curve



the problem. The curve shown in figure 2.6a obviously does not follow the requirements of convexity and linearity necessary to form a linear programming problem's feasible region. Figure 2.6b shows the approximation of the curve used in the Cell Fleet Planning Model. The curve is linearized over a certain number of intervals. Each interval starts and ends at a "breakpoint" defined by a given frequency and its corresponding demand.

2.3 Mathematical Structure of the Cell Fleet Planning Model

A Linear Programming formulation consisting of the objective function and seven constraints is used to solve the cell fleet planning problem . These are now presented.

2.3.1 Objective Function

The objective is to maximize the net present value of profits. Profits are defined as the total operating revenues less the direct and indirect operating costs and the cost of purchasing new aircraft.

$$\text{Maximize } Z_t = \sum_t Z(t)$$

$$Z(t) = \sum_c \frac{(\text{REV/PAX}_t^c * \text{NSEG}_t^c * \text{PAX}_t^c)}{(1+\text{RDISC})^{t-1}} \qquad \text{Operating Revenues}$$

$$- \sum_c \sum_v \frac{(\text{COST/Flight}_{vt}^c * \text{NSEG}_t^c * n_{vt}^c)}{(1+\text{RDISC})^{t-1}} \qquad \text{Operating Costs}$$

$$- \sum_{v} \frac{\text{Cost of Ownership}(IV_{vt}+GI_{vt})}{(1+RDISC)^{t-1}} \qquad \text{Aircraft Purchase Cost}$$

where:

c = cell

t = period of time (year)

v = aircraft type (vehicle)

$REV/PAX_t^{\,c}$ = revenue per passenger for cell c for year t

$NSEG^c{}_t$ = number of segments in cell c in year t

$PAX_t^{\,c}$ = number of passengers per day per segment in cell c in year t

$COST/Flight_{vt}^{\,c}$ = cost per flight using aircraft v in cell c in year t

$n^c{}_{vt}$ = number of flights per day using aircraft v in cell c in year t (frequency)

IV_{vt} = number of aircraft of type v in inventory at t=1 less the aircraft v retired from year 1 to year t

GI_{vt} = number of aircraft of type v purchased between years 1 and t

RDISC = discount rate

2.3.2 Constraints

2.3.2.1 Demand Carried:

The total number of seats supplied over all intervals of the demand-frequncy curve for cell c in year t must satisfy the forecasted number of passengers for that cell and year. Supplied number of seats will depend on the number of flights per day on each segment.

$$\sum_{k} S^{c}_{vt} * NK^{c}_{kt} \quad - \quad PAX^{c}_{t} \;\geq\; 0$$

for all c and t, where:

k = interval in demand-frequency curve

S^{c}_{kt} = slope (seats per day per route segment) for cell c in year t

NK^{c}_{kt} = frequency at interval k (flights per day per segment) for cell c in year t

PAX^{c}_{t} = number of passengers in cell c in year t

2.3.2.2 <u>Sum of Frequencies:</u>

The sum of frequencies for all aircraft types for a given cell c and year t must be equal to the sum of frequencies for all intervals in the demand-frequency curve for that cell c and year t.

$$\sum_{v} n^{c}_{vt} - \sum_{k} nK^{c}_{kt} \;=\; 0$$

for all c and t.

2.3.2.3 <u>Load Factor:</u>

The total capacity supplied by all aircraft types in a given cell c and year t, taking into consideration load factors, must satisfy the number of passengers for that cell and year.

$$\sum_{v} LF_{v} * C_{v} * n^{c}_{vt} \quad - \quad PAX^{c}_{t} \;\geq\; 0$$

for all c and t, where:

LF_v = load factor for aircraft type v

C_v = seat capacity on aircraft type v

n^c_{vt} = number of flights using aircraft type v on cell c in year t (frequency)

2.3.2.4 Frequency Range:

The number of flights per day in cell c and year t can be constrained by lower and upper bounds.

$$LL^c_t \leq \sum_v n^c_{vt} \leq UL^c_t$$

for all c and t, where:

LL^c_t = minimum number of flights in cell c and year t

UL^c_t = maximum number of flights in cell c and year t

2.3.2.5 Fleet Utilization:

The total hours flown for aircraft type v in the system must not exceed the maximum for that aircraft type.

$$\sum_c (Tb^c * NSEG^c_t * n^c_{vt}) - U_{vt}{}^{max} (IV_{vt} + GI_{vt}) \leq 0$$

for all v and t, where:

Tb^c = block time for cell c

$NSEG^c_t$ = number of segments in cell c in year t

n^c_{vt} = number of flights with aircraft v in cell c and year t

$U_{vt}{}^{max}$ = maximum utilization per day for aircraft v in year t

IV_{vt} = number of aircraft of type v in inventory at t=1 less the aircraft v retired from year 1 to year t

GI_{vt} = number of aircraft of type v purchased between years 1 and t

2.3.2.6 Fleet Continuity:

i) Continuity for Inventory Aircraft:

The number of aircraft of type v retired in year t must be equal to the number of aircraft v in inventory at the end of year t less the number of aircraft v in inventory at the end of the previous year.

BP3>

$$IV_{vt} - IV_{v(t-1)} + R_{vt} = 0$$

for all v and t, where:

IV_{vt} = number of aircraft v at the end of year t

$IV_{v(t-1)}$ = number of aircraft v at the end of year t-1

R_{vt} = number of aircraft of type v retired during year t

ii) Continuity for Gap Vehicles:

The number of aircraft of type v purchased in year t must be equal to the number of aircraft of type v in the gap inventory at the end of year t less the number of aircraft of type v in the gap inventory at the end of the previous year. The gap inventory is defined as the number of aircraft of type v purchased between year and year t.

$$GI_{vt} - GI_{v(t-1)} - GV_{vt} = 0$$

for all v and t, where:

GI_{vt} = number of aircraft of type v purchased until the end of year t

$GI_{v(t-1)}$ = number of aircraft of type v purchased until the end of year t-1

GV_{vt} = number of aircraft of type v purchased during year t

CHAPTER 3.

INDUSTRY'S FLEET COMPOSITION IN RECENT YEARS

This chapter presents the composition of the U.S. airline industry's fleet over the last five years, from 1979 to 1983. It is important to look at this data because it provides a clear picture of the current industry's fleet structure, shows actual trends and serves as a basis for comparison to the forecast generated by the Cell Fleet Planning Model and to other forecasts. It is also interesting to analyze these figures because the data corresponding to these five years, 1979 through 1983, is the data used to form the clusters (cells) and the demand-frequency curves described in Chapter 2 upon which the Cell Fleet Planning Model is based.

Only large jet aircraft with capacity of 100 seats or more have been considered on the tables presented since those are the aircraft types included in this fleet planning case study (the smallest types considered are DC9's and B737's). They are presented in two ways: by individual aircraft type and by aircraft group. The generic groups considered are: wide-bodied, 4-engine; narrow-bodied, 4-engine; wide-bodied, 3-engine; narrow-bodied, 3-engine; wide-bodied, 2-engine; and narrow-bodied, 2-engine aircraft. Table 3.1 shows the aircraft types pertaining to each of the six groups.

In table 3.2 the average number of aircraft assigned to service from 1979 to 1982 for each individual type is shown.[1]

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[1]Figures on table 3.2 and table 3.3 were calculated from the Civil

Table 3.1 Composition of Aircraft Groups

WIDE-BODIED, 4-ENGINE:		
	B747	(all series)
NARROW-BODIED, 4-ENGINE:		
	B707	
	DC8	(all series)
WIDE-BODIED, 3-ENGINE:		
	DC10	(all series)
	L1011	(all series)
NARROW-BODIED, 3-ENGINE:		
	B727	(all series)
WIDE-BODIED, 2-ENGINE:		
	A300-B	
	B767	
NARROW-BODIED, 2-ENGINE:		
	B737	(all series)
	B757	
	DC9	(all series)

Table 3.2 Average Number of Aircraft Assigned to Service Per Individual Type

Aircraft	1979	1980	1981	1982	1983*
A300-B	7.5	12.8	20.0	23.3	34
B707	174.2	136.7	71.3	45.4	
B727-100	337.8	341.5	287.7	230.8	187
B727-200	576.1	670.9	786.9	744.6	735
B737-200	136.6	153.6	216.2	250.1	284
B747	85.3	92.5	98.1	94.3	96
B747SP	8.5	12.5	12.7	12.3	13
B757	-	-	-	-	15
B767-200	-	-	-	1.7	50
DC8	80.2	57.8	51.5	34.9	
DC8-73	-	-	-	6.0	42
DC9-10	73.6	58.8	71.6	69.3	349
DC9-30	240.3	250.8	264.2	296.7	
DC9-50	44.0	51.4	50.4	48.9	49
DC9-80	-	-	10.4	39.3	74
DC10-10	85.5	107.8	108.3	111.9	108
DC10-30	4.7	2.9	6.6	4.9	36
DC10-40	20.8	22.1	22.0	22.0	
L1011	85.9	88.3	89.4	98.7	99
L1011-500	-	-	10.5	14.8	15

* Source for 1983 data: Aviation Daily, "Majors, Nationals Fleets"

Table 3.3 presents the average number of aircraft assigned to service aggregated into the six groups mentioned above.

In analyzing table 3.3 it is interesting to note that some aircraft groups remain relatively stable while others show a steady increase or decrease. The group corrresponding to narrow-bodied, 4-engine aircraft is steadily decreasing its number of aircraft. This constitutes no surprise since the group is formed by B707's and DC8's which are being phased out due to their old age and inefficiency compared to new aircraft, and to noise restrictions. The DC8-73, a re-engined version of the DC8-62, is an exception to this group as can be seen in table 3.2.

Three groups that grew regularly during this period were the wide-bodied, 3-engine, and wide-bodied and narrow-bodied, 2-engine groups. Until 1981 the wide-bodied, 2-engine groups was formed solely by the increasing number of Airbuses (A300-B's). In 1982 the B767 was introduced and then accounted for a small percentage of aircraft in this group. The increase in the narrow-bodied, 2-engine group is due mainly to the increasing number of B737-200's and DC9-30's and to the introduction of the DC9-80 in 1981 (table 3.2). The growing number of DC10-10's and L1011's and the introduction of L1011-500's in 1981 are responsible for the increase of the wide-bodied, 3-engine group.

Aeronautics Board Aircraft Operating Costs and Performance Reports. The average number of aircraft assigned to service for each type is the sum of majors and regionals international and local service domestic operations. The 1984 C.A.B. report which contains 1983 data is not available as of this date. Data for 1983 included in tables 3.2 and 3.3 comes from a different source and may not be consistent with the C.A.B. data.

Table 3.3 Average Number of Aircraft Assigned to Service per Aircraft Group

Aircraft Group	1979	1980	1981	1982	1983
WB-4	93.8	105.0	110.0	106.7	109
NB-4	181.9	194.5	122.8	80.3	42
WB-3	167.1	221.1	236.9	252.4	258
NB-3	914.7	1013.4	1074.6	975.4	922
WB-2	7.5	12.8	20.0	25.0	84
NB-2	524.1	532.3	621.3	684.9	771

where:

WB-4: wide-bodied, 4-engine aircraft
NB-4: narrow-bodied, 4-engine aircraft
WB-3: wide-bodied, 3-engine aircraft
NB-3: narrow-bodied, 3-engine aircraft
WB-2: wide-bodied, 2-engine aircraft
NB-2: narrow-bodied, 2-engine aircraft

The wide-bodied, 4-engine group composed of B747's and the narrow-bodied, 3-engine group composed of B727's (the most popular jet aircraft in commercial aviation history), did not show a defined increasing or decreasing pattern as did the other groups during these four years. They both show a reduction in number of aircraft in 1982 after having increased during the previous three years.

Figure 3.1 plots the variation in the number of aircraft in each group over the period of time extending from 1979 to 1982.

Given the availability of the clustring program and the OAG data for 1979 through 1983 which are used in the Cell Fleet Planning Model, historical data from the frequency point of view is now presented. These figures will be useful in the analysis on the Cell Model results since these include frequency-related data.

The clustering program enables us to determine which segments of the OAG data fall into each of nine cells as described in Chapter 2. Nine cells are used because for each of the three attributes of each cell (frequency, distance, and seat volume) the possibility of them being high, low, or medium in magnitude is considered. This gives 3x3=9 possible combinations of attributes which result in the nine cells being used.

Each segment record contains information on the three attributes which define its corresponding cell and the frequency flown with each aircraft type on that segment. By means of simple Fortran computer programs the total frequency for each and all of the aircraft types flown on the same cell has been aggregated. The present study focuses on the large jet aircraft listed in table 3.2, therefore, table 3.4 presents the daily frequency flown by each of these selected aircraft types aggregated for every one of the five years analyzed in this chapter. Appendix A.1

Figure 3.1 Average Number of Aircraft Assigned to Service per Aircraft Group

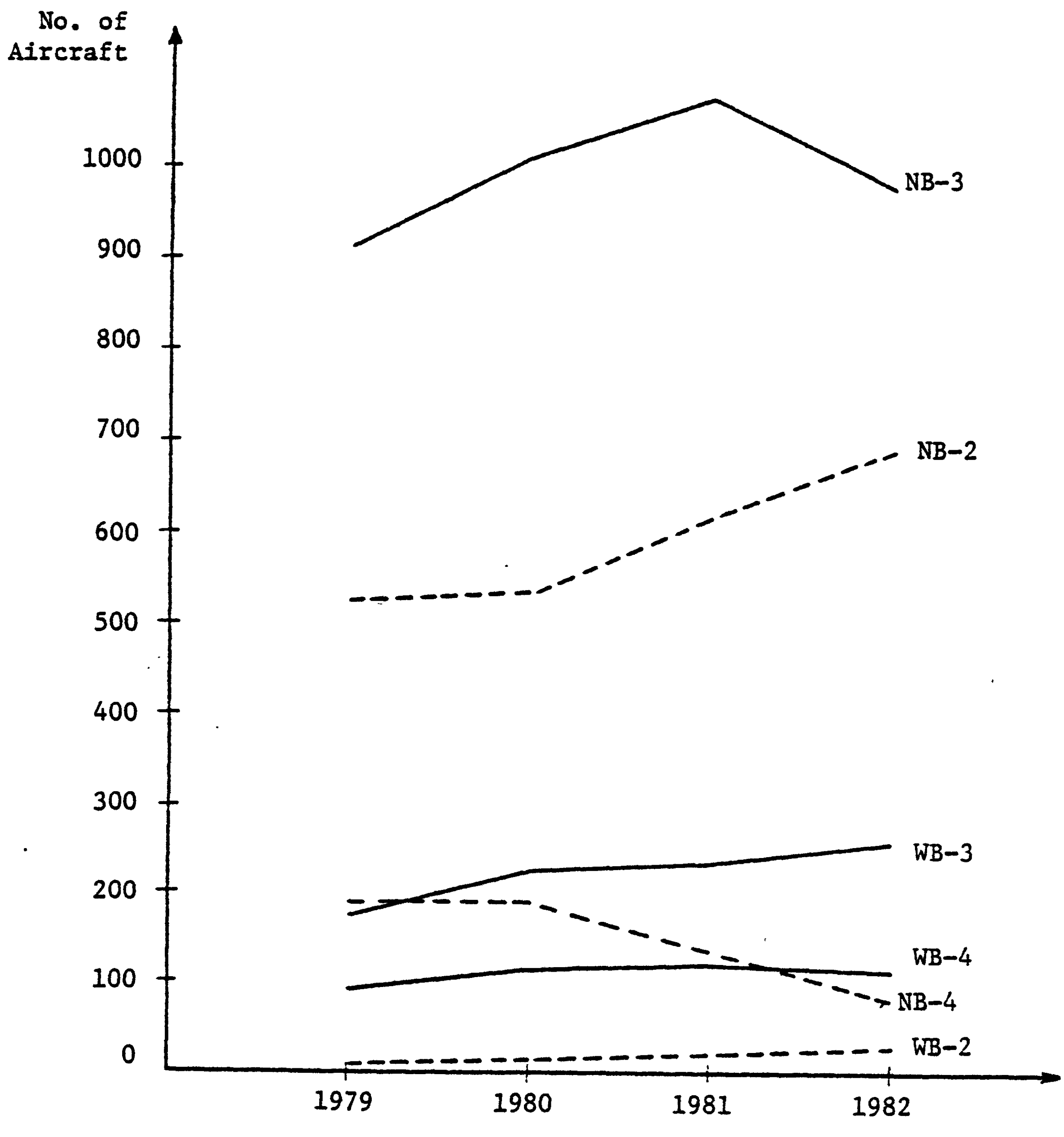

Table 3.4 Historical Daily Frequencies per Aircraft Type

Aircraft	1979	1980	1981	1982	1983
A300B	38	67	76	106	129
B707	544	386	202	112	35
B727-100	1969	1535	1439	1137	942
B727-200	3911	4064	4320	3886	4039
B737-100	673	592	508	540	740
B737-200	931	1010	1435	1510	1822
B747	211	209	204	207	201
B747SP	13	24	22	21	22
B757-2	-	-	-	-	51
B767-2	-	-	-	-	141
DC8	80	7	-	-	-
DC8-60,70	218	189	187	155	163
DC9-10	449	531	578	569	583
DC9-30	1770	1883	1914	2261	2270
DC9-50	481	531	500	476	447
DC9-80	-	-	65	282	400
DC10	432	427	452	456	433
L1011	352	345	364	358	373
L1011-500	-	21	30	28	27

shows this daily frequency for every cell throughout the five years. Appendix A.3 presents the complete list of aircraft and their frequencies on each cell, which includes from B747's to small propeller aircraft.

Analyzing Table 3.4 it may be seen that the aircraft types that increased their daily frequencies are the A300-B, B737-200, DC9-30, and DC9-80. The DC9-80 was introduced in 1981. Other two aircraft types introduced during these five years were the B757 and B767-200, that were put into service in 1983. Some aircraft types decreased their total number of daily frequencies: the B707, B727-100, and DC8. These frequency figures correlate with the decreasing number of aircraft shown in Table 3.2. Aircraft types such as the B727-200, B737-100, B747, B747SP, DC10, and L1011 showed variations in their total daily frequencies throughout the five years, but showed no defined trends.

The attributes for each cell shown in Appendix A.1 correspond to daily figures per individual segment. (In table 3.5 some examples of segments pertaining to each of the nine cells for 1983 are shown to provide a concrete insight of the cells and their attributes.) The "daily frequency" listed is the total number of flights per day with the given aircraft type over all segments in that cell. The "% of total cell frequency" corresponds to the percentage of the total number of frequencies of that cell flown by each of the aircraft types. It should be noted that these percentages do not add 100% since only selected aircraft types are listed. Should all types shown in Appendix A for each cell had been listed, the sum would have resulted in 100%.

The "% of total type frequency" is the percentage of the total number of frequencies flown by that aircraft type in that year on that particular cell. The sum of these percentages over the nine cells for each

<u>Table 3.5</u> Examples of Segments in Each Cell for 1983

<u>CELL No. 1</u>

Freq. = 32.3/day   Distance = 376 mi.   Seats = 4302/day

Washington D.C. - La Guardia (NYC)

<u>CELL No. 2</u>

Freq. = 1.3/day   Distance = 173 mi.   Seats = [illegible]75/day

Albuquerque - Silver City (N.M.)

<u>CELL No. 3</u>

Freq. = 1.6/day   Distance = 908 mi.   Seats = 223/day

Atlanta - Albuquerque

<u>CELL No. 4</u>

Freq. = 7.0/day   Distance = 499 mi.   Seats = 835/day

Albany (N.Y.) - Chicago

<u>CELL No. 5</u>

Freq. = 4.1/day   Distance = 246 mi.   Seats = 327/day

Albany (N.Y.) - Pittsburg

<u>CELL No. 6</u>

Freq. = 11.9/day   Distance = 517 mi.   Seats = 1448/day

Atlanta - Baltimore

<u>CELL No. 7</u>

Freq. = 1.0/day   Distance = 4321 mi.   Seats = 316/day

Athens - J.F. Kennedy (NYC)

Table 3.5 (cont.)

CELL No. 8

Freq. = 16.3/day   Distance = 736 mi.   Seats = 2627/day

Boston - Chicago

CELL No. 9

Freq. = 1.6/day   Distance = 1888 mi.   Seats = 291/day

Hartford - Dallas/Fort Worth

year is equal to 100%. The word frequencies should be emphasized since it must be noted that percentage of frequencies is not equal to percentage of number of aircraft due to utilization and stage length considerations. Furthermore, aircraft are not allocated to just a single cell; they are flown on more than one cell.[1]

The lower portion of the tables in Appendix A.1 shows the aggregation of the aircraft types into each of the six groups defined earlier. The total daily frequency and the percentage of the total frequencies in the cell flown by a given aircraft group are presented.

One must be very careful in comparing cells through the five years since it must be noticed that two cells having the same number do not necessarily have similar attributes. This is due to the different characteristics of data corresponding to each of the five years which results in a different clustering scheme. As an example take the cell which has as attributes a distance greater than 4000 miles, a frequency of approximately one flight per day, and a seat volume of approximately 300 per day. These attributes are found in cell 3, cell 3, cell 5, cell 6, and cell 7 in years 1979 through 1983 respectively. Fortunately this problem does not appear when analyzing the results of the Cell Fleet Planning Model in Chapter 5 since a matching of cells is performed as part of the overall process.

Table 3.6 presents the total number of frequencies per aircraft

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[1]For example consider the case of an airplane flying the route Boston-New York-Madrid. The Boston-New York and New York-Madrid legs of the flight fall into different cells but the same aircraft is used.

Table 3.6 Daily Frequencies per Aircraft Group

	1979	1980	1981	1982	1983
WB-4	229	238	230	234	227
NB-4	851	589	397	270	203
WB-3	789	799	854	852	844
NB-3	5887	5607	5765	5040	4987
WB-2	38	70	77	107	294
NB-2	4300	4143	4456	5892	6333

group from 1979 to 1983. These figures result from the aggregation over all cells of the frequencies shown in tables 3.4.

Performing an analysis similar to that of table 3.3 it can be seen that the wide- and narrow-bodied, 2-engine aircraft groups show an increasing trend regarding the total number of frequencies. The narrow-bodied, 3- and 4-engine groups have decreased their total number of flights while the wide-bodied, 3- and 4-engine groups have remained relatively stable.

Let us now compare table 3.6 against table 3.3, that is, the number of frequencies per aircraft group versus the actual number of aircraft assigned to service. The decrease in frequencies for the narrow-bodied, 4-engine aircraft group is a direct consequence of the reduction in the number of airplanes (DC8's and B707's) mentioned in the description of table 3.3. The increasing trend in number of frequencies for the wide- and narrow-bodied, 2-engine aircraft matches their trend for the number of airplanes assigned to service and therefore explains it. There is also consistency in the trends followed by the frequencies and number of aircraft in the wide-bodied, 4-engine group (B747's).

In the case of the wide- and narrow-bodied, 3-engine aircraft some discrepancy is found in their trends regarding number of frequencies and number of aircraft. The number of wide-bodied, 3-engine aircraft increased during the period while the total frequencies did not follow the upward pattern and remained approximately constant. For the narrow-bodied, 3-engine aircraft (B727's) the number of aircraft shows no defined trend while its frequencies show decrease. The explanation for these discrepancies is found in the frequency per cell data of Appendix A.1: there has been a trend from 1979 to 1982 to assign wide- and narrow-bodied, 3-engine aircraft, DC10's, L1011's, and B727's, to longer range routes. In other words, the number of frequencies for these airplanes tends to increase in cells with larger distance attribute while it tends to decrease in those cells with shorter distance. With similar utilizations, if the average stage length for these aircraft is increased, the total number of frequencies has to decrease.

The frequency-related data presented in this chapter (table 3.4 and 3.6 and Appendices A) could be very useful in future studies concerning the routes and structure of the U.S. airline industry. Results of the Fleet Planning Model provide data in this form and Chapter 5 refers to the model's results and to the historical data of the present chapter in its analysis.

CHAPTER 4.

APPLICATION OF THE CELL FLEET PLANNING MODEL: A CASE STUDY

This chapter presents an application of the Cell Fleet Planning Model to an industry-wide scenario. This is from the stand point of a manufacturer, who in his long term planning is not concerned with individual airlines or group of airlines or even regions, but is interested in forecasting the total number of aircraft that will be needed. This is equally true in the case of airframe manufacturers, such as Boeing, McDonnell Douglas, and Airbus, as in the case of engine manufacturers such as Pratt & Whitney, General Electric, and Rolls Royce.

Four runs of the Model have been performed: three considering nine cells and another considering thirty cells. The three nine-cell cases considered, case A, case B, and case C, include three different scenarios. Two of these cases, A and B, use the same input data, but case B was run with a slight modification to the Cell Fleet Planning Model[1]; in case B the Model is forced to utilize the aircraft it has available each year of the planning period. As will be seen in the outputs, this will result in a higher overall utilization of inventory aircraft and in less aircraft purchases. In cases A and C, the Model has the freedom of grounding some of its inventory aircraft which it considers inefficient

[1]In case B, the Fleet Utilization Constraint (Section 2.3.2.5) has been changed from a "less than or equal" relationship to an equality. This forces the aircraft in inventory to be utilized since the total hours flown (block hours x frequency) must match the aircraft utilization.

or not optimal to be flown. The scenario in case C shows two changes with respect to cases A and B: i)the maximum number of aircraft available for each year some aircraft types has been constrained to a higher degree than in cases A and B, to reflect the scenario of a slower production rate by the manufacturers or a lesser purchase capability by the airlines; and, ii) the minimum number of aircraft for each year has been relaxed for some aircraft types (e.g. B727-200) to reflect the case of a higher rate of retirements. This is done through the Maximum and Minimum Fleet Count by Type by Year Table (Section 4.2.9). The reason for using nine cells and the procedure for determining an "optimal" number of cells, thirty, have been described in Chapter 2. One of the objectives of this thesis is to compare the results obtained for these two cases. This is done in Chapter 5. Sections 4.2 and 4.3 describe and present respectively the actual inputs and outputs for the nine-cell and thirty-cell cases.

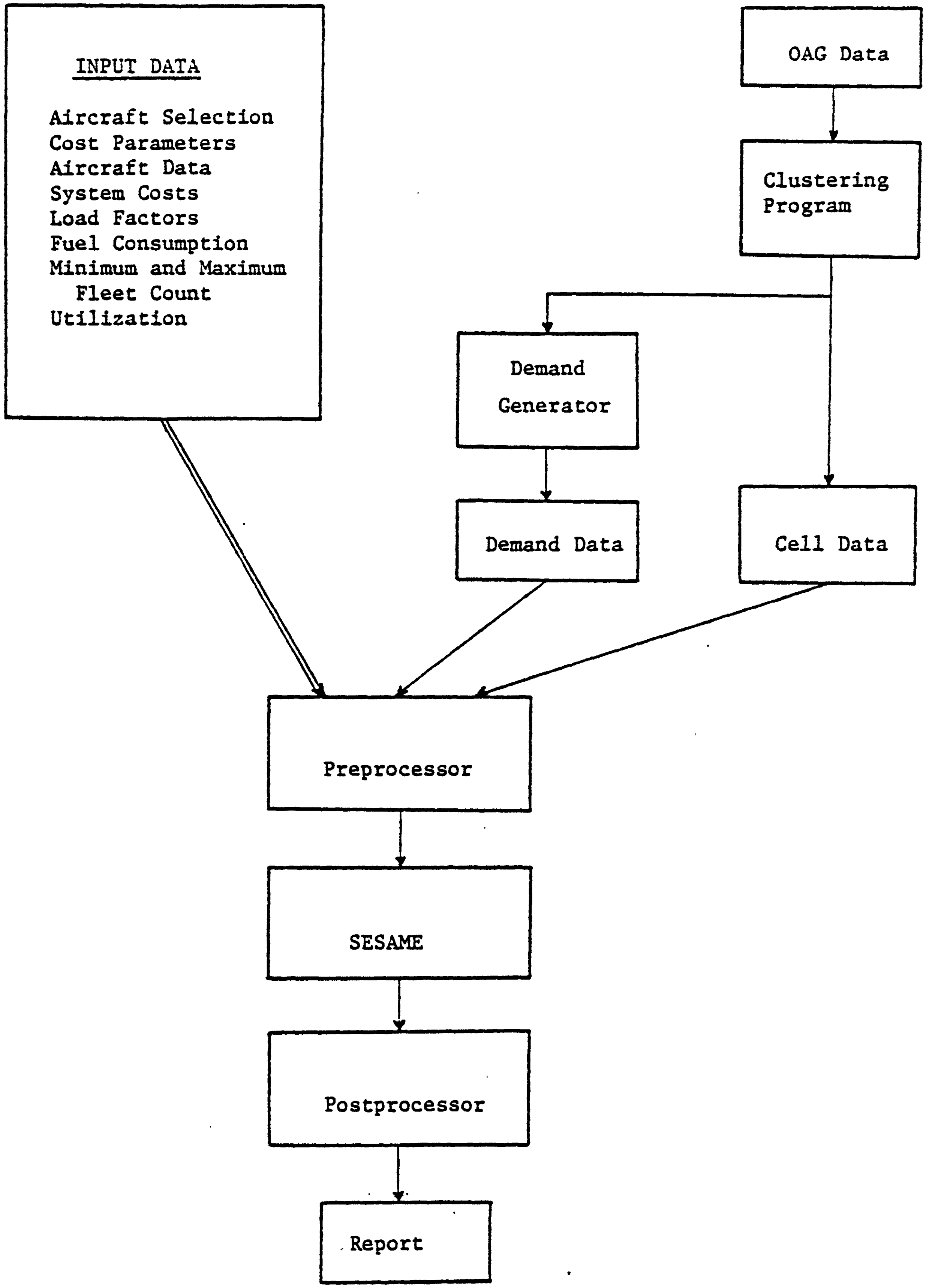
4.1 Computer Implementation of the Cell Fleet Planning Model

A flowchart describing the computer implementation of the Cell Fleet Planning Model is shown in Figure 4.1. It consists of ten input tables, a demand generator program, the clustering programs, a preprocessor, a Linear Programming package, and a postprocessor.

As mentioned earlier, the cell fleet planning problem is formulated as a Linear Programming problem, and, it is solved by means of a standard software package. Currently the Model is loaded on M.I.T.'s IBM 3031 system and the Linear Programming package used is SESAME, an M.I.T. equivalent of IBM's MPSX.

The purpose of the preprocessor is to process the data contained in

Figure 4.1 Flowchart of the Cell Fleet Planning Model



the input tables and build the objective function and constraints of the Model. The output of this preprocessor is a standard matrix which constitutes the input to SESAME. The input tables are described in the following section.

The output from SESAME is a matrix containing the optimal solution values for the decision variables. The function of the postprocessor is to read these values and build an output report as the ones shown and described in Section 4.3.

4.2 Inputs

Different types of data are required as inputs to the Cell Fleet Planning Model, such as aircraft operating and cost data, financial data, demand data, etc. Most of the aircraft-related input data used here was provided by Pratt & Whitney who is the principal industry supporter of this study within the framework of a Cooperative Research Program between M.I.T. and the industry. Pratt & Whitney is a member of this consortium.

Ten input tables or files exist. These are now described.

4.2.1 Aircraft Selection Table

This table contains the aircraft types to be considered in the run of the Model. In the present case, thirty-one types have been considered. They are all large jet aircraft and include the airplanes built by the leading manufacturers and most used by airlines all over the world. Some non-existing aircraft types have also been included to reflect possible new aircraft appearances during the planning term. These types are the B150, B767-3, B767-XX, F100, and TA11.

The B150 represents a 150-seat airplane manufactured by Boeing. The

B767-3 or B767-300 would be an enhanced version of the B767-200, and the B767-XX and even more advanced and larger capacity version of the 767 family. The F100 represents a short range-100 seat aircraft by Fokker, and the TA11 a long range-large capacity airplane by Airbus Industrie.

4.2.2 Parameters Table

This table contains five pieces of information. It first provides the number of periods to be used in the run. In the present case study the number of periods is ten years, from 1982 to 1991. Ten years are used because this time range is considered to be an adequate one for the actual planning purposes. The year 1982 has been chosen as the first period for calibration purposes. At the time this study was started, the latest fully processed data (operating statistics, financial data, etc.) corresponded to 1982. Setting the first period of the run to 1982 allows the comparison with actual results and the calibration of the Model.

A second piece of information provided by this table is the discount rate. A 10% annual discount rate has been assumed.

The following two sets of data correspond to forecasts on yield and cost escalators for each of the periods considered. These are expressed as the percentage change in yields and costs from one year to the next.

The last data contained in the Parameters table is an estimate of the fuel price (dollars per gallon) over the planning period.

4.2.3 Aircraft Input Table

This table contains most of the information related to each aircraft type. It provides seating capacity, cost per nautical mile, cost per departure, purchase price, years to depreciation, and average age for each aircraft.

The cost per nautical mile data is divided into three categories: "0 to 750" nautical miles, "751 to 2000" nautical miles, and "over 2000" nautical miles. This is done to reflect changes in cost with range due to flight performance characteristics. The Cell Fleet Planning Model has the capability of handling cost per block hour instead of cost per nautical mile if it were required.

In the present case, costs per departure have been set to zero because they have already been aggregated into the costs per nautical mile. The purchase price listed is in millions of dollars and is used by the Model to calculate ownership costs. The "years to depreciation" data represents the number of years left for each aircraft type to be fully depreciated, that is, to incur zero ownership cost. An average life of eighteen years has been assumed for all new aircraft.

4.2.4 System Costs Table

This table allows the inclusion of different system costs such as commissions, reservations, food, cargo, overhead, etc. In this case only overhead has been included and is to represent 50% of total expenses. This table becomes more useful when applying the Model to an airline case.

4.2.5 Cell Data Table

This table contains information related to each cell. The Cell Data as well as the Demand-Frequency Data requires the run of the Hybrid Clustering and Matching programs. The Hybrid Clustering program was run five times, one for each historical year, from 1979 to 1983. In each case the input was the Official Airline Guide (OAG) database for the respective year. The output for each year is the clustering of the airline segments into nine or thirty cells, depending on the case. These five results are the input to the Matching program which performs the matching over the five years of the nine (or thirty) cells, and provides the average attributes of the matched cells. These attributes define the cells used to run the Cell Fleet Planning Model. Results of the Matching program are used to build the Cell Data table.

The cell data includes average stage length, number of segments, average block time, minimum and maximum frequencies, passengers yields per revenue passenger mile (cents/RPM), maximum aircraft utilization (hours per day), and passenger and segment growth rates (%). The stage length is the distance attribute for each cell. The number of segments represents the amount of OAG airline segments that have been clustered into each of the cells.

In this case, no maximum or minimum frequencies on each cell have been established to allow the model to determine its own optimum frequencies. The passsenger and segment growth rates (positive or negative) has been obtained from an analysis of the trends on the five year clustering.

4.2.6 Demand-Frequency Data Table

This table is generated automatically after the matching process. The average frequency and seat volume attributes obtained are fed into a Demand Generator program which creates the linearized demand-frequency curves described in Section 2.2. The shape of the curves is a function of the attributes of the cells and is derived from market sharefrequency theory.[18] A historical frequency-demand point is used to calculate the amplitude of each curve.

In the present case, a curve of four intervals has been defined. The table shows the breakpoints that define these intervals for each of the nine (thirty) cells. The first column is the cell number. The following columns show the four breakpoints; first the number of seats and then the frequency corresponding to this seat volume. Figures 4.2a and 4.2b plot the Demand-Frequency curves for two of the cells in the nine-cell case.

4.2.7 Aircraft Load Factors Table

This table has two purposes. One is to provide the Model with information on how the load factor on each aircraft type changes in each cell. It really represents changes in load factor with respect to distance. In this study, two categories of aircraft have been considered regarding load factors: aircraft with more than 200 seats and aircraft with 200 seats or less. All the aircraft in one category have been considered to have the same load factor on a particular cell. The load factor, again, changes with distance.

The second purpose of this table is to inhibit a particular aircraft type to be flown on a cell. This is done by inputting a zero load factor, which the Model recognizes as a signal not to allow the aircraft to fly in that cell. In the present case, short range aircraft have been inhibited to fly in cells with distance attributes larger than the aircraft range. Also, large aircraft such as the B747, are not allowed to fly in very short range cells. While this is physically possible, as opposed to the case of short range aircraft in long range

Figure 4.2a   Demand-Frequency Curve for Cell No. 1 (Nine-Cell Case)

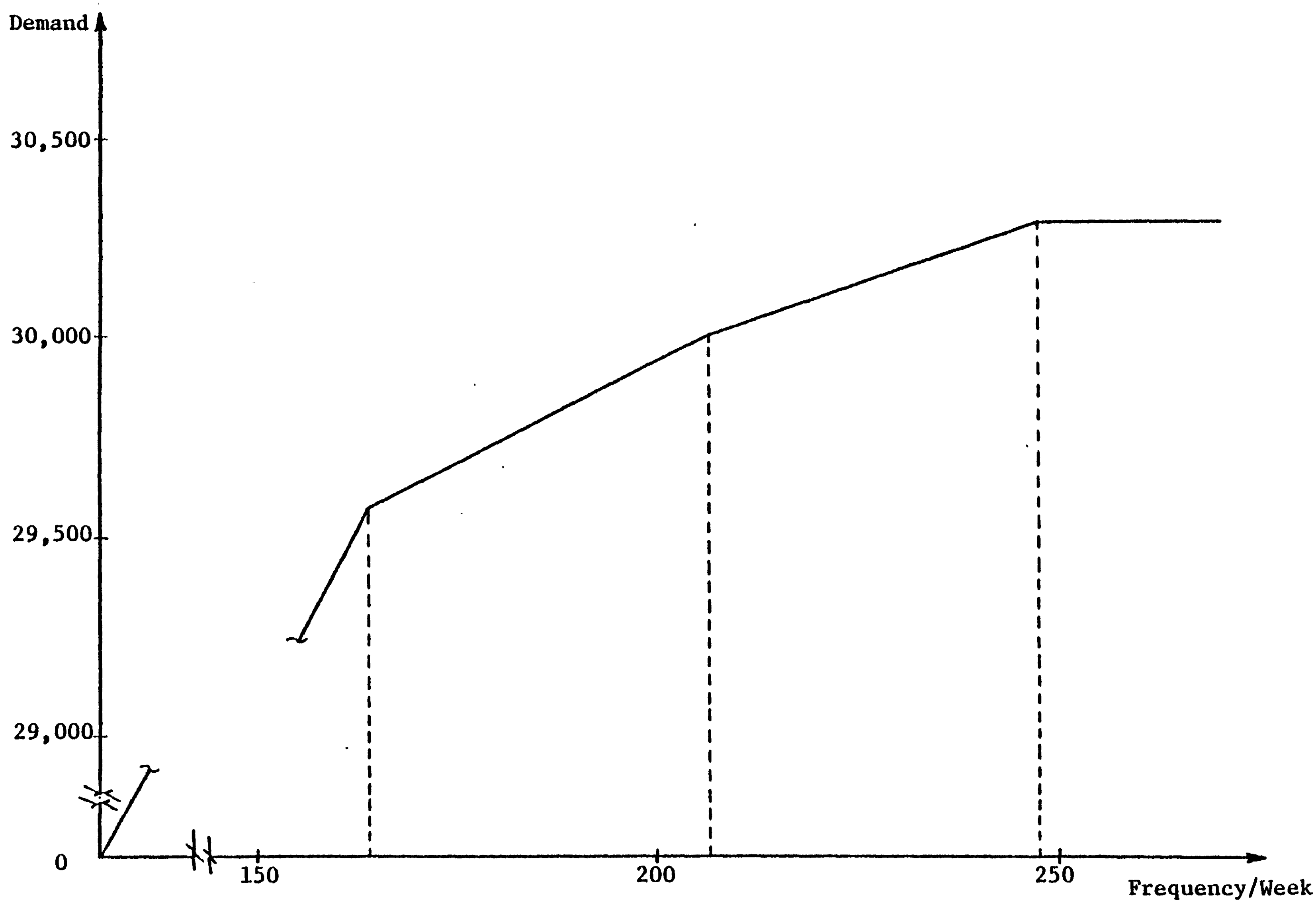
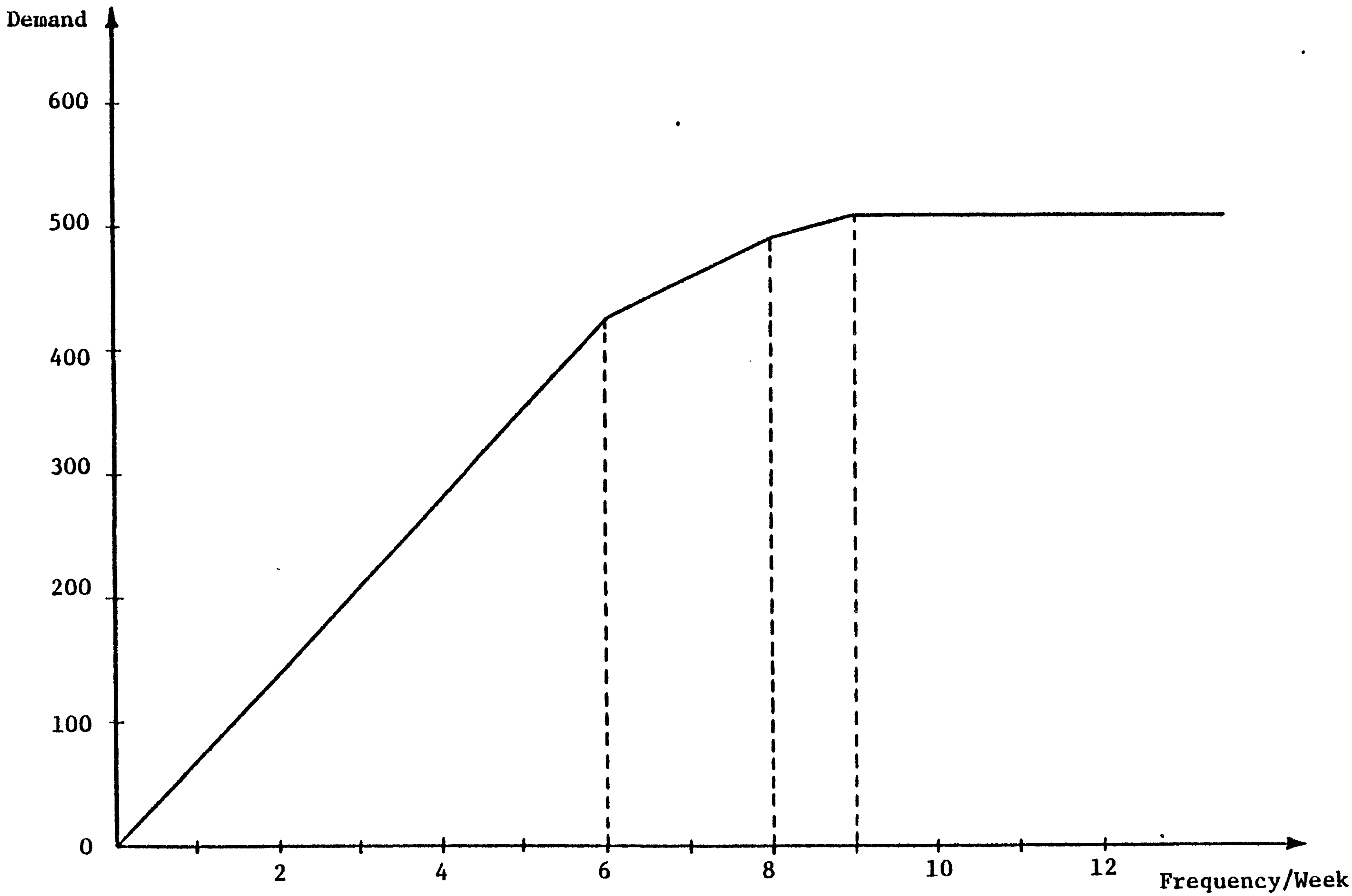


Figure 4.2b Demand-Frequency Curve for Cell No. 4 (Nine-Cell Case)



routes, it is not done in reality.

4.2.8 Aircraft Fuel Consumption Table

This table provides the Model with information on the average fuel consumption (gallons) by each aircraft type on each cell. This data is used by the Model to calculate the cost incurred in fuel consumption. The price per gallon of fuel has been provided in the Parameters Table (Section 4.2.2).

4.2.9 Minimum and Maximum Fleet Count by Type by Year Table

The purpose of this table is to set upper and lower bounds on the number of aircraft. The Model has the capability of acquiring and retiring aircraft during the planning period according to the efficiency of the different aircraft types. It is therefore necessary to set these bounds to avoid the retirement of all less efficient aircraft and the purchase of more efficient ones. Neither would the manufacturers be in condition to supply so many new aircraft, nor would the airlines be in the financial position to buy them.

The maximum fleet table shows possible production rates while the minimum fleet table tries to reflect known or possible retirements and acquisitions according to the capability of the airlines to replace their old and less efficient aircraft. Taking the B727-200 as an example, the minimum fleet table in cases A and B shows a steady but slow decrease in number of aircraft. In case C a relatively faster rate is allowed. If the Model were not restricted in this case, it would phase out the B727-200 at a much faster rate; a rate that would not match the real world conditions. In the case of the B707 and the DC8, the maximum fleet count drops to zero at early stages of the planning period. This is done because it is known that these two types are to be phased out due to noise restrictions. It is from this table that the Model builds the inventory and continuity of aircraft constraints.

4.2.10 Utilization Table

The utilization table provides the block hours per day that an aircraft can be used according to the number of years it has been operating. Up to twenty years of operation have been considered. The present case assumes a constant utilization throughout the life of the airplane. Only in the first year, when the aircraft has been introduced, a much lower utilization is assumed for all types.

The actual input files for the nine and thirty-cell cases are presented in Appendix B.1.

4.3 Outputs

This section describes the outputs from the Cell Fleet Planning Model, and presents the results obtained for this case study, for both the nine-cell and thirty-cell scenarios. Chapter 5 analyzes these results.

The postprocessor generates automatically an output report which contains information on aircraft inventory, acquisitions, and retirements, on operating and financial statistics, and statistics on departures by cell. A table containing detailed information is also presented for each cell. All the above data is given on a yearly basis for the whole planning period.

The output tables are now described.

4.3.1 Table 1-1: Aircraft Inventory

This table presents the number of aircraft for each type that exist on inventories on each year of the planning period. Along with the Acquisition and Retirement Tables it is the most important result, since it shows the solution to the fleet planning problem that was formulated. The amount of aircraft listed for each year is the result of adding the acquisitions and subtracting the retirements to the previous year inventory of that aircraft type. Aircraft acquisitions and retirements are a decision of the Model as a direct consequence of the optimal solution to the Linear Programming problem.

The "total" figure that appears at the bottom of the table is just the aggregation of all aircraft types for each individual year.

4.3.2 Table 1-2: Aircraft Acquisition

This table shows the number of aircraft for each type that the Model has decided to purchase on each year of the planning period. In the first period, 1982, results are all zero since the Model was not allowed to purchase any aircraft. The same is true for retirements. This was done by setting the minimum equal to the maximum for all aircraft types for 1982 in the Minimum and Maximum Fleet Count input table .

4.3.3 Table 1-3: Aircraft Retirement

This table presents the number of retirements decided by the Model for each aircraft type throughout the planning period. Aircraft retirements can either be forced by the user or phased-out by the model because of economic obsolescence.

4.3.4 Table 2: Percent Departures by Cell

Table 2 shows the percentage of total departures that has been allocated to each of the nine/thirty cells in each year. These results are interesting since they allow us to determine which cells (and therefore what route-segment characteristics) hold larger concentrations of traffic. The information is valuable for illustrating activity in each cell.

4.3.5 Table 3: Operating Statistics

This table is the product of processing the optimal Linear Programming solution values for frequency, aircraft, and demand, to calculate on a yearly basis: the number of active aircraft, available seat miles (ASM's), revenue passenger miles (RPM's), load factors, total frequency, total block hours, total aircraft miles, fuel consumption, seat volume, and average number of seats per departure. These parameters are the most commonly used industry performance measures in air transportation operations analysis, and therefore provide important information. Furthermore, many air transportation forecasts are based on some of these parameters such as ASM's and RPM's. This table will permit the comparison with those forecasts.

4.3.6 Table 4: Financial Statistics Report

This table provides information on revenues and costs incurred during the planning period. Costs are divided into reservations, food, commissions, overhead, block hours, fuel consumption, departure and ownership costs. Some revenues and costs appear as zeros in the actual results because they were not considered as inputs to the System Costs input table.

The bottom line of this table shows the net profit or loss (revenues minus costs) for each year.

4.3.7 Table 5: Aircraft Activity for Each Year for Each Cell

There is one of these tables for each cell and for every year in the planning period. This table contains detailed information on each cell. It shows the attributes of the cell: frequency, distance, and seat volume, the number of segments, and the total number of passengers carried in the cell. It also provides detailed data for each aircraft type the Model has chosen to fly in the cell. Daily frequency, total available seats, available seat miles. load factor, block hours, fuel consumption, revenues, costs, and operating results for each aircraft type are presented. The aircraft types which show zero for all these parameters have not been chosen by the Model to operate in this particular cell.

The actual results of the Cell Fleet Planning Model for the nine-cell and thirty-cell cases are presented next. A sample of the tables containing the detailed information for each cell (Table 5) for the nine-cell case is presented in Appendix B.

Appendix C provides some statistics on the computer time and costs incurred to run the Cell Fleet Planning Model for this case study.

OUTPUT TABLES FOR THE NINE-CELL CASE

Case A[3]:

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3 In this case the Model has the freedom to ground its inventory aircraft.

AIRCRAFT INVENTORY

TABLE 1-1

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	30.	30.	32.	33.	33.	33.	33.	33.	6.	6.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	30.	60.	100.	160.
B150	0.	0.	0.	0.	0.	0.	30.	60.	90.	120.
B707	74.	74.	0.	0.	0.	0.	0.	0.	0.	0.
B727-1	340.	113.	3.	3.	3.	0.	0.	0.	0.	0.
B727-2	790.	815.	815.	815.	814.	793.	768.	737.	704.	704.
B737-1	15.	5.	5.	5.	5.	3.	3.	0.	0.	0.
B737-2	264.	315.	450.	450.	450.	450.	450.	450.	450.	450.
B737-3	0.	10.	240.	347.	347.	347.	347.	347.	347.	347.
B747	102.	103.	105.	105.	105.	105.	105.	105.	105.	105.
B747-3	0.	5.	100.	200.	300.	314.	314.	314.	314.	314.
B747SP	15.	11.	11.	11.	11.	11.	3.	0.	0.	0.
B757	0.	44.	44.	44.	44.	44.	44.	44.	44.	44.
B757-2	10.	140.	380.	520.	598.	682.	706.	706.	706.	706.
B767-2	20.	70.	70.	70.	70.	90.	100.	116.	116.	116.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	44.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	20.	40.	60.	77.	77.	67.	57.	57.	57.	57.
DC9-10	3.	3.	3.	0.	0.	0.	0.	0.	0.	0.
DC9-30	317.	359.	459.	539.	619.	799.	879.	959.	913.	913.
DC9-50	55.	155.	257.	257.	257.	215.	215.	202.	202.	202.
DC9-80	43.	200.	350.	430.	430.	430.	430.	430.	430.	430.
DC10-10	117.	111.	111.	111.	111.	111.	111.	111.	111.	111.
DC10-30	23.	23.	12.	12.	12.	12.	12.	0.	0.	0.
DC10-40	22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
L1011	105.	104.	104.	104.	104.	104.	104.	104.	104.	104.
L1011-5	15.	15.	15.	15.	15.	15.	15.	15.	0.	0.
F100	0.	0.	0.	0.	0.	100.	200.	300.	400.	500.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	100.
TOTAL	2424.	2767.	3648.	4170.	4427.	4747.	4978.	5172.	5220.	5510.

AIRCRAFT ACQUISITION

TABLE 1-2

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	0.	0.	2.	1.	0.	0.	0.	0.	0.	0.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	30.	30.	40.	60.
B150	0.	0.	0.	0.	0.	0.	30.	30.	30.	30.
B707	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B727-1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B727-2	0.	25.	0.	0.	0.	0.	0.	0.	0.	0.
B737-1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B737-2	0.	51.	135.	0.	0.	0.	0.	0.	0.	0.
B737-3	0.	10.	230.	107.	0.	0.	0.	0.	0.	0.
B747	0.	1.	2.	0.	0.	0.	0.	0.	0.	0.
B747-3	0.	5.	95.	100.	100.	14.	0.	0.	0.	0.
B747SP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757	0.	44.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	0.	130.	240.	140.	78.	84.	24.	0.	0.	0.
B767-2	0.	50.	0.	0.	0.	20.	10.	16.	0.	0.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	0.	20.	20.	17.	0.	0.	0.	0.	0.	0.
DC9-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC9-30	0.	42.	100.	80.	80.	180.	80.	80.	18.	0.
DC9-50	0.	100.	102.	0.	0.	0.	0.	0.	0.	0.
DC9-80	0.	157.	150.	80.	0.	0.	0.	0.	0.	0.
DC10-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011-5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
F100	0.	0.	0.	0.	0.	100.	100.	100.	100.	100.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	100.
TOTAL	0.	635.	1076.	525.	258.	397.	274.	256.	188.	290.

AIRCRAFT RETIREMENT TABLE 1-3

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	0.	0.	0.	0.	0.	0.	0.	0.	27.	0.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B707	0.	0.	74.	0.	0.	0.	0.	0.	0.	0.
B727-1	0.	227.	110.	0.	0.	3.	0.	0.	0.	0.
B727-2	0.	0.	0.	0.	1.	21.	25.	31.	33.	0.
B737-1	0.	10.	0.	0.	0.	2.	0.	3.	0.	0.
B737-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B737-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747SP	0.	4.	0.	0.	0.	0.	8.	3.	0.	0.
B757	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	0.	44.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	0.	0.	0.	0.	0.	10.	10.	0.	0.	0.
DC9-10	0.	0.	0.	3.	0.	0.	0.	0.	0.	0.
DC9-30	0.	0.	0.	0.	0.	0.	0.	0.	64.	0.
DC9-50	0.	0.	0.	0.	0.	42.	0.	13.	0.	0.
DC9-80	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-10	0.	6.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-30	0.	0.	11.	0.	0.	0.	0.	12.	0.	0.
DC10-40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.
L1011-5	0.	0.	0.	0.	0.	0.	0.	0.	15.	0.
F100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	292.	195.	3.	1.	78.	43.	62.	139.	0.

PERCENT DEPARTURES BY CELL

TABLE 2

CELL	1982	1983	1984	1985	1986	1987	1938	1989	1990	1991
1	6.1	6.0	5.8	5.7	5.7	5.5	5.5	5.5	5.6	5.8
2	9.0	7.2	6.9	6.8	6.9	6.6	6.6	7.3	7.6	7.4
3	0.7	0.6	0.6	0.6	0.8	0.8	0.8	0.7	0.7	0.8
4	0.0	17.5	16.8	16.6	16.8	20.5	22.3	22.1	21.9	21.0
5	9.2	7.3	10.5	10.4	10.2	9.6	9.3	9.2	9.2	9.9
6	7.5	7.0	7.2	7.4	7.5	7.6	7.5	7.8	7.9	6.2
7	53.8	43.1	41.3	40.8	39.9	37.7	36.6	36.2	36.0	38.6
8	10.0	8.0	7.8	8.8	9.3	8.9	8.7	8.5	8.4	7.4
9	3.7	3.2	3.0	3.0	2.9	2.8	2.7	2.6	2.6	2.8
TOTALS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

OPERATING STATISTICS (DAILY TOTALS) TABLE 3

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
ACTIVE AIRCRAFT	2424.	2767.	3648.	4170.	4427.	4747.	4978.	5172.	5220.	5510.
ASM'S (MILLIONS)	1170.	1235.	1318.	1417.	1589.	1648.	1670.	1690.	1709.	1710.
RPM'S (MILLIONS)	733.	774.	807.	822.	857.	880.	898.	917.	935.	936.
LOAD FACTORS	63.	63.	61.	58.	54.	53.	54.	54.	55.	55.
FREQUENCY	10509.	12863.	13661.	14096.	14619.	15505.	16041.	16360.	16554.	15055.
BLOCK HOURS	17758.	19789.	21372.	21999.	22969.	23872.	24352.	24821.	25062.	22945.
AIRCRAFT MILES (000'S)	6600.	7102.	7725.	7946.	8325.	8584.	8706.	8865.	8942.	8218.
AVERAGE STAGE LENGTH	747.	703.	710.	716.	728.	730.	732.	738.	743.	756.
FUEL BURN (GALLONS)	22054240.	22420240.	21481056.	21534960.	23654816.	24416480.	24566720.	24784240.	24843408.	23943840.
SEATS	1565594.	1800501.	1867907.	1937129.	2028757.	2130814.	2189041.	2224526.	2257655.	2255333.
AVERAGE SEATS/DEPARTURE	149.	140.	137.	137.	139.	137.	136.	136.	136.	150.

TABLE 4
FINANCIAL STATISTICS REPORT
(000 DOLLARS PER DAY)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
REVENUES										
PASSENGER	154907.	169107.	173927.	183276.	192224.	197058.	198871.	203260.	206125.	205303.
OTHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	154907.	169107.	173927.	183276.	192224.	197058.	198871.	203260.	206125.	205303.
COSTS										
PAX RESERVATION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FOOD LIABILITY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAX COMMISSION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OVERHEAD	40561.	41206.	35107.	33314.	33742.	35647.	36979.	38939.	40675.	38006.
BLOCK HOUR	63037.	64925.	55391.	51338.	49505.	51028.	51602.	52845.	53526.	46561.
FUEL	18084.	17488.	14822.	15290.	17978.	20266.	22356.	25032.	27825.	29451.
DEPARTURE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OWNERSHIP	27776.	37075.	55077.	66190.	70240.	74828.	77414.	79486.	80076.	80232.
TOTAL	149459.	160694.	160397.	166132.	171464.	181768.	188351.	196302.	202101.	194250.
NET P & L	5448.	8412.	13530.	17144.	20760.	15290.	10520.	6958.	4023.	11053.

Case B[4]:

[4] i) Same input data as Case A.

ii) The Model is not allowed to ground its inventory aircraft. It is forced to utilize them.

AIRCRAFT INVENTORY

TABLE 1-1

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	30.	30.	32.	33.	33.	33.	33.	33.	6.	6.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B707	74.	74.	0.	0.	0.	0.	0.	0.	0.	0.
B727-1	340.	113.	3.	3.	3.	0.	0.	0.	0.	0.
B727-2	790.	813.	813.	813.	812.	791.	766.	735.	702.	665.
B737-1	15.	5.	5.	5.	5.	3.	3.	0.	0.	0.
B737-2	264.	315.	375.	375.	375.	375.	375.	375.	375.	488.
B737-3	0.	10.	23.	23.	30.	40.	60.	80.	100.	120.
B747	102.	103.	105.	105.	105.	105.	105.	105.	105.	105.
B747-3	0.	5.	100.	200.	220.	220.	220.	220.	220.	220.
B747SP	15.	11.	11.	11.	11.	11.	3.	0.	0.	0.
B757	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	10.	40.	40.	40.	40.	60.	80.	100.	120.	130.
B767-2	20.	40.	40.	50.	70.	90.	100.	116.	116.	116.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	44.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	20.	20.	20.	20.	20.	10.	0.	0.	0.	0.
DC9-10	3.	3.	3.	0.	0.	0.	0.	0.	0.	0.
DC9-30	317.	359.	459.	539.	619.	619.	583.	570.	555.	555.
DC9-50	55.	155.	155.	155.	155.	113.	113.	100.	100.	100.
DC9-80	43.	200.	200.	200.	200.	200.	200.	200.	200.	200.
DC10-10	117.	111.	111.	111.	111.	111.	111.	111.	111.	111.
DC10-30	23.	23.	12.	12.	12.	12.	12.	0.	0.	0.
DC10-40	22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
L1011	105.	104.	104.	104.	104.	104.	104.	104.	104.	104.
L1011-5	15.	15.	15.	15.	15.	15.	15.	15.	0.	0.
F100	0.	0.	0.	0.	0.	100.	180.	212.	363.	500.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	100.
TOTAL	2424.	2571.	2648.	2836.	2962.	3034.	3085.	3098.	3199.	3542.

AIRCRAFT ACQUISITION

TABLE 1-2

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	0.	0.	2.	1.	0.	0.	0.	0.	0.	0.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B707	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B727-1	0.	0.	C.	0.	0.	0.	0.	0.	0.	0.
B727-2	0.	23.	0.	0.	0.	0.	0.	0.	0.	0.
B737-1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B737-2	0.	51.	60.	0.	0.	0.	0.	0.	0.	113.
B737-3	0.	10.	13.	0.	7.	10.	20.	20.	20.	20.
B747	0.	1.	2.	0.	0.	0.	0.	0.	0.	0.
B747-3	0.	5.	95.	100.	20.	0.	0.	0.	0.	0.
B747SP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	0.	30.	0.	0.	0.	20.	20.	20.	20.	10.
B767-2	0.	20.	0.	10.	20.	20.	10.	16.	0.	0.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC9-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC9-30	0.	42.	100.	80.	80.	0.	0.	0.	0.	0.
DC9-50	0.	100.	0.	0.	0.	0.	0.	0.	0.	0.
DC9-80	0.	157.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011-5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
F100	0.	0.	0.	0.	0.	100.	80.	32.	151.	137.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	100.
TOTAL	0.	439.	272.	191.	127.	150.	130.	88.	191.	380.

AIRCRAFT RETIREMENT

TABLE 1-3

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	0.	0.	0.	0.	0.	0.	0.	0.	27.	0.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B707	0.	0.	74.	0.	0.	0.	0.	0.	0.	0.
B727-1	0.	227.	110.	0.	0.	3.	0.	0.	0.	0.
B727-2	0.	0.	0.	0.	1.	21.	25.	31.	33.	37.
B737-1	0.	10.	0.	0.	0.	2.	0.	3.	0.	0.
B737-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B737-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747SP	0.	4.	0.	0.	0.	0.	8.	3.	0.	0.
B757	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	0.	44.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	0.	0.	0.	0.	0.	10.	10.	0.	0.	0.
DC9-10	0.	0.	0.	3.	0.	0.	0.	0.	0.	0.
DC9-30	0.	0.	0.	0.	0.	0.	36.	13.	15.	0.
DC9-50	0.	0.	0.	0.	0.	42.	0.	13.	0.	0.
DC9-80	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-10	0.	6.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-30	0.	0.	11.	0.	0.	0.	0.	12.	0.	0.
DC10-40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011	0.	1.	0.	0.	0.	0.	0.	0.	0.	0.
L1011-5	0.	0.	0.	0.	0.	0.	0.	0.	15.	0.
F100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	292.	195.	3.	1.	78.	79.	75.	90.	37.

TABLE 2

PERCENT DEPARTURES BY CELL

CELL	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	6.1	6.5	6.0	5.8	5.4	5.4	5.3	5.3	5.2	5.5
2	9.0	7.7	7.1	6.9	6.5	6.4	6.3	6.3	6.2	6.6
3	0.7	0.7	0.6	0.8	0.8	0.9	0.9	0.9	0.9	0.9
4	0.0	11.4	17.3	16.8	21.1	20.9	22.9	23.0	22.8	21.3
5	9.2	7.9	8.5	9.0	8.9	9.8	9.6	9.6	9.5	10.0
6	7.5	7.5	6.9	8.3	7.8	7.8	7.6	7.6	7.5	6.3
7	53.8	46.3	42.6	41.3	38.8	38.5	37.6	37.6	37.3	39.2
8	10.0	8.6	7.9	7.7	7.2	7.1	7.0	7.0	7.8	7.3
9	3.7	3.4	3.1	3.4	3.5	3.1	2.9	2.8	2.7	2.9
TOTALS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

OPERATING STATISTICS (DAILY TOTALS) TABLE 3

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
ACTIVE AIRCRAFT	2424.	2571.	2648.	2836.	2962.	3034.	3085.	3098.	3199.	3542.
ASM'S (MILLIONS)	1170.	1246.	1399.	1629.	1696.	1718.	1715.	1713.	1718.	1742.
RPM'S (MILLIONS)	733.	766.	787.	827.	848.	869.	883.	900.	924.	931.
LOAD FACTORS	63.	62.	56.	51.	50.	51.	51.	53.	54.	53.
FREQUENCY	10509.	12032.	13093.	13756.	14649.	14844.	15253.	15309.	15644.	14730.
BLOCK HOURS	17758.	19158.	20197.	21764.	22685.	23079.	23305.	23293.	23717.	22533.
AIRCRAFT MILES (000'S)	6600.	6968.	7258.	7909.	8178.	8338.	8361.	8343.	8484.	8094.
AVERAGE STAGE LENGTH	747.	724.	710.	729.	730.	739.	741.	745.	749.	762.
FUEL BURN (GALLONS)	22054240.	22815920.	24468800.	27611904.	28602464.	28846800.	28664080.	28450368.	28335088.	27968624.
SEATS	1565594.	1736827.	1985239.	2155707.	2264465.	2283186.	2318706.	2293998.	2247302.	2308130.
AVERAGE SEATS/DEPARTURE	149.	144.	152.	157.	155.	154.	152.	150.	144.	157.

TABLE 4
FINANCIAL STATISTICS REPORT
(000 DOLLARS PER DAY)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
REVENUES										
PASSENGER	154907.	166719.	169309.	182555.	189337.	193358.	194472.	198320.	202705.	203341.
OTHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	154907.	166719.	169309.	182555.	189337.	193358.	194472.	198320.	202705.	203341.
COSTS										
PAX RESERVATION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FOOD LIABILITY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAX COMMISSION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OVERHEAD	40561.	41959.	39142.	42101.	44331.	45986.	46620.	47852.	49305.	47856.
BLOCK HOUR	63037.	66121.	61401.	64598.	66924.	68029.	67156.	66969.	66875.	61310.
FUEL	18084.	17796.	16883.	19604.	21738.	23943.	26084.	28735.	31735.	34401.
DEPARTURE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OWNERSHIP	27776.	33171.	39218.	44938.	44241.	45372.	46297.	46785.	47193.	47873.
TOTAL	149459.	159047.	156644.	171242.	177234.	183330.	186157.	190342.	195108.	191440.
NET P & L	5448.	7672.	12665.	11313.	12103.	10029.	8316.	7979.	7596.	11901.

Case C[5]:

[5] i) More constrained maximums and lower minimums for number of aircraft in each year than in cases A and B.

ii) The Model has the freedom to ground its inventory aircraft as in case A.

AIRCRAFT INVENTORY

TABLE 1-1

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	30.	37.	37.	37.	37.	37.	37.	37.	10.	10.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	30.	60.	100.	160.
B150	0.	0.	0.	0.	0.	0.	30.	60.	90.	120.
B707	74.	74.	0.	0.	0.	0.	0.	0.	0.	0.
B727-1	340.	200.	3.	3.	3.	0.	0.	0.	0.	0.
B727-2	790.	815.	815.	775.	725.	675.	625.	575.	525.	525.
B737-1	15.	5.	5.	5.	5.	3.	3.	0.	0.	0.
B737-2	264.	315.	450.	600.	603.	603.	603.	603.	603.	603.
B737-3	0.	10.	150.	350.	350.	350.	350.	350.	350.	350.
B747	102.	103.	105.	105.	105.	105.	105.	105.	105.	105.
B747-3	0.	5.	100.	200.	300.	314.	314.	314.	314.	314.
B747SP	15.	11.	11.	11.	11.	11.	3.	0.	0.	0.
B757	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	10.	20.	220.	420.	620.	671.	702.	702.	702.	702.
B767-2	20.	60.	60.	60.	70.	90.	100.	100.	100.	100.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	44.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	20.	45.	60.	77.	77.	67.	57.	57.	57.	57.
DC9-10	3.	3.	3.	0.	0.	0.	0.	0.	0.	0.
DC9-30	317.	359.	400.	400.	400.	400.	400.	400.	400.	203.
DC9-50	55.	155.	257.	257.	257.	215.	215.	202.	202.	202.
DC9-80	43.	80.	280.	480.	480.	480.	480.	480.	480.	480.
DC10-10	117.	126.	120.	120.	120.	120.	120.	120.	120.	120.
DC10-30	23.	23.	12.	12.	12.	12.	12.	0.	0.	0.
DC10-40	22.	22.	22.	22.	22.	22.	22.	22.	22.	22.
L1011	105.	105.	104.	100.	95.	90.	85.	80.	75.	70.
L1011-5	15.	15.	15.	15.	15.	15.	15.	15.	0.	0.
F100	0.	0.	0.	0.	0.	100.	200.	300.	400.	500.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	100.
TOTAL	2424.	2588.	3229.	4049.	4307.	4379.	4508.	4582.	4655.	4743.

AIRCRAFT ACQUISITION TABLE 1-2

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	0.	7.	0.	0.	0.	0.	0.	0.	0.	0.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	30.	30.	40.	60.
B150	0.	0.	0.	0.	0.	0.	30.	30.	30.	30.
B707	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B727-1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B727-2	0.	25.	0.	0.	0.	0.	0.	0.	0.	0.
B737-1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B737-2	0.	51.	135.	150.	3.	0.	0.	0.	0.	0.
B737-3	0.	10.	140.	200.	0.	0.	0.	0.	0.	0.
B747	0.	1.	2.	0.	0.	0.	0.	0.	0.	0.
B747-3	0.	5.	95.	100.	100.	14.	0.	0.	0.	0.
B747SP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	0.	10.	200.	200.	200.	51.	31.	0.	0.	0.
B767-2	0.	40.	0.	0.	10.	20.	10.	0.	0.	0.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	0.	25.	15.	17.	0.	0.	0.	0.	0.	0.
DC9-10	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC9-30	0.	42.	41.	0.	0.	0.	0.	0.	0.	0.
DC9-50	0.	100.	102.	0.	0.	0.	0.	0.	0.	0.
DC9-80	0.	37.	200.	200.	0.	0.	0.	0.	0.	0.
DC10-10	0.	9.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-30	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011-5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
F100	0.	0.	0.	0.	0.	100.	100.	100.	100.	100.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	100.
TOTAL	0.	362.	930.	867.	313.	184.	201.	160.	170.	290.

AIRCRAFT RETIREMENT

TABLE 1-3

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A300-B	0.	0.	0.	0.	0.	0.	0.	0.	27.	0.
A300-600	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B707	0.	0.	74.	0.	0.	0.	0.	0.	0.	0.
B727-1	0.	140.	197.	0.	0.	3.	0.	0.	0.	0.
B727-2	0.	0.	0.	40.	50.	50.	50.	50.	50.	0.
B737-1	0.	10.	0.	0.	0.	2.	0.	3.	0.	0.
B737-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B737-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B747SP	0.	4.	0.	0.	0.	0.	8.	3.	0.	0.
B757	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B757-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC8	0.	44.	0.	0.	0.	0.	0.	0.	0.	0.
DC8-73	0.	0.	0.	0.	0.	10.	10.	0.	0.	0.
DC9-10	0.	0.	0.	3.	0.	0.	0.	0.	0.	0.
DC9-30	0.	0.	0.	0.	0.	0.	0.	0.	0.	197.
DC9-50	0.	0.	0.	0.	0.	42.	0.	13.	0.	0.
DC9-80	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DC10-10	0.	0.	6.	0.	0.	0.	0.	0.	0.	0.
DC10-30	0.	0.	11.	0.	0.	0.	0.	12.	0.	0.
DC10-40	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
L1011	0.	0.	1.	4.	5.	5.	5.	5.	5.	5.
L1011-5	0.	0.	0.	0.	0.	0.	0.	0.	15.	0.
F100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TA11	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	0.	198.	289.	47.	55.	112.	73.	86.	97.	202.

TABLE 2

PERCENT DEPARTURES BY CELL

CELL	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	6.1	6.6	5.8	5.7	5.8	5.7	5.6	5.6	5.8	5.7
2	9.0	7.9	6.9	6.8	6.9	6.8	6.8	7.2	7.8	7.4
3	0.7	0.7	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8
4	0.0	9.4	16.9	16.5	16.3	18.8	20.4	22.2	20.1	20.8
5	9.2	8.1	10.5	10.4	10.3	9.9	9.6	9.3	9.5	9.8
6	7.5	7.6	7.1	7.5	7.5	7.6	7.6	7.3	7.5	6.8
7	53.8	47.4	41.4	40.6	40.2	38.6	37.6	36.4	37.0	38.3
8	10.0	8.8	7.8	9.0	9.3	9.1	8.9	8.5	8.8	7.6
9	3.7	3.5	3.0	3.0	2.9	2.8	2.8	2.7	2.7	2.8
TOTALS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

OPERATING STATISTICS (DAILY TOTALS) TABLE 3

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
ACTIVE AIRCRAFT	2424.	2588.	3229.	4049.	4307.	4379.	4508.	4582.	4655.	4743.
ASM'S (MILLIONS)	1170.	1218.	1315.	1420.	1590.	1647.	1669.	1692.	1703.	1714.
RPM'S (MILLIONS)	733.	764.	805.	823.	856.	878.	896.	915.	932.	939.
LOAD FACTORS	63.	63.	61.	58.	54.	53.	54.	54.	55.	55.
FREQUENCY	10509.	11784.	13609.	14187.	14470.	15139.	15614.	16197.	16058.	15294.
BLOCK HOURS	17758.	18970.	21285.	22135.	22806.	23554.	23979.	24563.	24586.	23308.
AIRCRAFT MILES (OOO'S)	6600.	6928.	7693.	7994.	8276.	8505.	8613.	8774.	8813.	8347.
AVERAGE STAGE LENGTH	747.	731.	710.	716.	730.	734.	736.	738.	747.	755.
FUEL BURN (GALLONS)	22054240.	22675008.	22598448.	21893376.	23562048.	24260944.	24377376.	24606432.	24595952.	24106288.
SEATS	1565594.	1694708.	1869479.	1949397.	2034246.	2124372.	2184285.	2245364.	2230368.	2262887.
AVERAGE SEATS/DEPARTURE	149.	144.	137.	137.	141.	140.	140.	139.	139.	148.

TABLE 4
FINANCIAL STATISTICS REPORT
(000 DOLLARS PER DAY)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
REVENUES										
PASSENGER	154907.	165946.	173493.	183378.	191951.	196514.	198332.	202803.	205250.	206041.
OTHER	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL	154907.	165946.	173493.	183378.	191951.	196514.	198332.	202803.	205250.	206041.
COSTS										
PAX RESERVATION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FOOD LIABILITY	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
PAX COMMISSION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OVERHEAD	40561.	41642.	36006.	33678.	33607.	35434.	36736.	38730.	40216.	38366.
BLOCK HOUR	63037.	65598.	56420.	51812.	49306.	50732.	51288.	52607.	52885.	47081.
FUEL	18084.	17686.	15593.	15544.	17907.	20137.	22183.	24852.	27547.	29651.
DEPARTURE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
OWNERSHIP	27776.	32533.	48296.	63889.	69360.	71233.	72892.	73547.	73707.	75351.
TOTAL	149459.	157459.	156315.	164924.	170181.	177536.	183100.	189737.	194355.	190448.
NET P & L	5448.	8487.	17178.	18455.	21770.	18978.	15232.	13066.	10895.	15593.

OUPUT TABLES FOR THE THIRTY-CELL CASE[6]

[6] Same conditions as the nine-cell case B.

AIRCRAFT INVENTORY

TABLE 1-1

	1982	1983	1984	1985	1986
A300-B	30.	30.	32.	33.	33.
A300-600	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.
B707	74.	0.	0.	0.	0.
B727-1	340.	3.	3.	3.	3.
B727-2	790.	813.	813.	813.	812.
B737-1	15.	3.	3.	3.	3.
B737-2	264.	315.	356.	375.	375.
B737-3	0.	0.	10.	20.	30.
B747	102.	103.	105.	105.	105.
B747-3	0.	5.	58.	58.	58.
B747SP	15.	11.	11.	11.	11.
B757	0.	0.	0.	0.	0.
B757-2	10.	10.	20.	30.	40.
B767-2	20.	31.	40.	50.	70.
B767-3	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.
DC8	44.	0.	0.	0.	0.
DC8-73	20.	20.	20.	20.	20.
DC9-10	3.	3.	0.	0.	0.
DC9-30	317.	321.	321.	315.	307.
DC9-50	55.	55.	55.	55.	55.
DC9-80	43.	48.	65.	75.	88.
DC10-10	117.	111.	111.	111.	111.
DC10-30	23.	23.	12.	12.	12.
DC10-40	22.	22.	22.	22.	22.
L1011	105.	104.	104.	104.	104.
L1011-5	15.	15.	15.	15.	15.
F100	0.	0.	0.	0.	0.
TA11	0.	0.	0.	0.	0.
TOTAL	2424.	2046.	2176.	2230.	2274.

AIRCRAFT ACQUISITION

TABLE 1-2

	1982	1983	1984	1985	1986
A300-B	0.	0.	2.	1.	0.
A300-600	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.
B707	0.	0.	0.	0.	0.
B727-1	0.	0.	0.	0.	0.
B727-2	0.	23.	0.	0.	0.
B737-1	0.	0.	0.	0.	0.
B737-2	0.	51.	41.	19.	0.
B737-3	0.	0.	10.	10.	10.
B747	0.	1.	2.	0.	0.
B747-3	0.	5.	53.	0.	0.
B747SP	0.	0.	0.	0.	0.
B757	0.	0.	0.	0.	0.
B757-2	0.	0.	10.	10.	10.
B767-2	0.	11.	9.	10.	20.
B767-3	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.
DC8	0.	0.	0.	0.	0.
DC8-73	0.	0.	0.	0.	0.
DC9-10	0.	0.	0.	0.	0.
DC9-30	0.	4.	0.	0.	0.
DC9-50	0.	0.	0.	0.	0.
DC9-80	0.	5.	17.	10.	13.
DC10-10	0.	0.	0.	0.	0.
DC10-30	0.	0.	0.	0.	0.
DC10-40	0.	0.	0.	0.	0.
L1011	0.	0.	0.	0.	0.
L1011-5	0.	0.	0.	0.	0.
F100	0.	0.	0.	0.	0.
TA11	0.	0.	0.	0.	0.
TOTAL	0.	100.	144.	60.	53.

AIRCRAFT RETIREMENT

TABLE 1-3

	1982	1983	1984	1985	1986
A300-B	0.	0.	0.	0.	0.
A300-600	0.	0.	0.	0.	0.
A320	0.	0.	0.	0.	0.
B150	0.	0.	0.	0.	0.
B707	0.	74.	0.	0.	0.
B727-1	0.	337.	0.	0.	0.
B727-2	0.	0.	0.	0.	1.
B737-1	0.	12.	0.	0.	0.
B737-2	0.	0.	0.	0.	0.
B737-3	0.	0.	0.	0.	0.
B747	0.	0.	0.	0.	0.
B747-3	0.	0.	0.	0.	0.
B747SP	0.	4.	0.	0.	0.
B757	0.	0.	0.	0.	0.
B757-2	0.	0.	0.	0.	0.
B767-2	0.	0.	0.	0.	0.
B767-3	0.	0.	0.	0.	0.
B767-XX	0.	0.	0.	0.	0.
DC8	0.	44.	0.	0.	0.
DC8-73	0.	0.	0.	0.	0.
DC9-10	0.	0.	3.	0.	0.
DC9-30	0.	0.	0.	6.	8.
DC9-50	0.	0.	0.	0.	0.
DC9-80	0.	0.	0.	0.	0.
DC10-10	0.	6.	0.	0.	0.
DC10-30	0.	0.	11.	0.	0.
DC10-40	0.	0.	0.	0.	0.
L1011	0.	1.	0.	0.	0.
L1011-5	0.	0.	0.	0.	0.
F100	0.	0.	0.	0.	0.
TA11	0.	0.	0.	0.	0.
TOTAL	0.	478.	14.	6.	9.

PERCENT DEPARTURES BY CELL

TABLE 2

CELL	1982	1983	1984	1985	1986
1	0.0	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.1	0.1
3	0.8	1.1	1.0	1.0	1.0
4	0.3	0.4	0.3	0.3	0.3
5	1.4	1.9	1.8	1.8	1.8
6	0.6	0.8	0.7	0.7	0.7
7	1.7	2.3	2.1	2.1	2.1
8	0.4	0.6	0.5	0.5	0.5
9	57.8	41.1	47.1	47.6	47.3
10	1.1	1.5	1.4	1.4	1.4
11	0.7	1.0	0.9	0.9	0.9
12	1.4	1.9	1.7	1.7	1.7
13	5.5	7.7	6.9	6.9	6.9
14	1.2	1.6	1.4	1.4	1.4
15	0.9	1.2	1.1	1.1	1.1
16	1.1	1.6	1.4	1.4	1.4
17	3.7	5.1	4.6	4.6	4.6
18	1.4	2.0	1.8	1.8	1.8
19	3.3	4.6	4.1	4.1	4.1
20	1.1	1.6	1.4	1.4	1.4
21	0.9	1.3	1.2	1.2	1.2
22	0.4	0.5	0.5	0.5	0.5
23	0.4	0.6	0.5	0.5	0.5
24	1.8	2.5	2.3	2.3	2.3
25	0.3	0.4	0.4	0.4	0.4
26	2.2	3.0	2.7	2.7	2.7
27	0.3	0.4	0.4	0.4	0.4
28	3.3	4.6	4.1	4.1	4.1
29	2.1	3.0	2.7	2.7	2.7
30	3.6	5.0	4.5	4.5	4.5
TOTALS	100.0	100.0	100.0	100.0	100.0

OPERATING STATISTICS (DAILY TOTALS) TABLE 3

	1982	1983	1984	1985	1986
ACTIVE AIRCRAFT	2424.	2046.	2176.	2230.	2274.
ASM'S (MILLIONS)	963.	926.	1022.	1037.	1052.
RPM'S (MILLIONS)	430.	437.	446.	455.	464.
LOAD FACTORS	45.	47.	44.	44.	44.
FREQUENCY	13622.	11679.	12568.	12878.	13099.
BLOCK HOURS	17758.	15697.	16742.	17150.	17466.
AIRCRAFT MILES (000'S)	5536.	5118.	5365.	5475.	5568.
AVERAGE STAGE LENGTH	697.	696.	694.	692.	690.
FUEL BURN (GALLONS)	17072432.	15692065.	18006704.	18228832.	18435216.
SEATS	2097862.	1879389.	2075070.	2136279.	2200217.
AVERAGE SEATS/DEPARTURE	154.	161.	165.	166.	168.

TABLE 4
FINANCIAL STATISTICS REPORT
(000 DOLLARS PER DAY)

	1982	1983	1984	1985	1986
REVENUES					
PASSENGER	99946.	104249.	105029.	111053.	114884.
OTHER	0.	0.	0.	0.	0.
TOTAL	99946.	104249.	105029.	111053.	114884.
COSTS					
PAX RESERVATION	0.	0.	0.	0.	0.
FOOD LIABILITY	0.	0.	0.	0.	0.
PAX COMMISSION	0.	0.	0.	0.	0.
OVERHEAD	32886.	30467.	29535.	31048.	32318.
BLOCK HOUR	51772.	48694.	46646.	49154.	50625.
FUEL	13999.	12240.	12425.	12942.	14011.
DEPARTURE	0.	0.	0.	0.	0.
OWNERSHIP	92584.	96032.	107899.	110883.	104539.
TOTAL	191241.	187432.	196505.	204028.	201492.
NET P & L	-91295.	-83183.	-91476.	-92975.	-86608.

CHAPTER 5.

ANALYSIS OF RESULTS

This Chapter analyzes the Cell Fleet Planning Model results obtained for the cases presented in Chapter 4. Fleet composition, trends in fleet and network structures, and operating statistics are analyzed. In Section 5.2, results for the nine-cell and thirty-cell cases are compared. Section 5.3 performs a comparison of the Model results with the airline industry's historical fleet composition and trends studied in Chapter 3. Finally, Section 5.4 compares the results here obtained against the forecasts of manufacturers such as Boeing and McDonnell Douglas, and the Federal Aviation Administration (FAA) forecasts.

5.1 Analysis of Results for the Nine-Cell Cases

5.1.1 Nine Cells, Case A

In studying the Aircraft Inventory, Aircraft Acquisition, and Aircraft Retirement output tables for case A in Chapter 4, it is interesting to note the preference of the Model for acquiring some specific aircraft types. Most of these types correspond to new aircraft, which is a logical decision since these aircraft are more efficient. Among the new aircraft purchased are the A320, B150, and F100 at late stages of the planning period (1987-88) when these aircraft types would be available. As mentioned earlier, the B150 would be a 150-seat aircraft launched by Boeing in 1988. Other new aircraft chosen by the Model, this time starting early in the planning term, are the B737-300, B747-300, B757-200, B767-200, and the DC9-80 or MD-80. These aircraft are already in use with exception of the 737-300 which will be put in service shortly.[1]

Some relatively older aircraft: B737-200's, DC9-30's, and DC9-50's, have also been picked by the Model. This perhaps, has more significance as related to the aircraft generic group or size then to the particular aircraft types. Let us, therefore, aggregate the aircraft types into the generic groups introduced in Chapter 3, and plot these against the ten-year period being analyzed. This is done in Table 5.1 and Figure 5.1 respectively.

From Table 5.1, the most interesting result lies in the increase of the narrow-bodied,2-engine aircraft (737's, 757's, DC9's). This category of aircraft represented 29.2% of the total fleet in 1982 while for 1991 it appears as 70.3%. In 1982, the dominant group was the narrow-bodied,3-engine (727's) which accounted for 46.6%. In 1991, this group represents only 12.8% of the total fleet. Regarding other aircraft categories, the narrow-bodied, 4-engine aircraft group (707's and DC8's) and wide-bodied, 3-engine aircraft group (DC10's and L1011's) show a decrease throughout the planning period. By 1984, the narrow-bodied, 4-engine group appears limited to DC8-73's, having the rest of DC8's and the 707's been phased out by the end of 1983.

The two remaining groups, namely the wide-bodied, 4-engine and wide-bodied, 2-engine aircraft groups, show an increase with respect to their 1982 composition. The wide-bodied, 4-engine aircraft (747's) increase until 1986 in which they level off. This increase is due to the Model's decision of acquiring B747-300's during the first years of the

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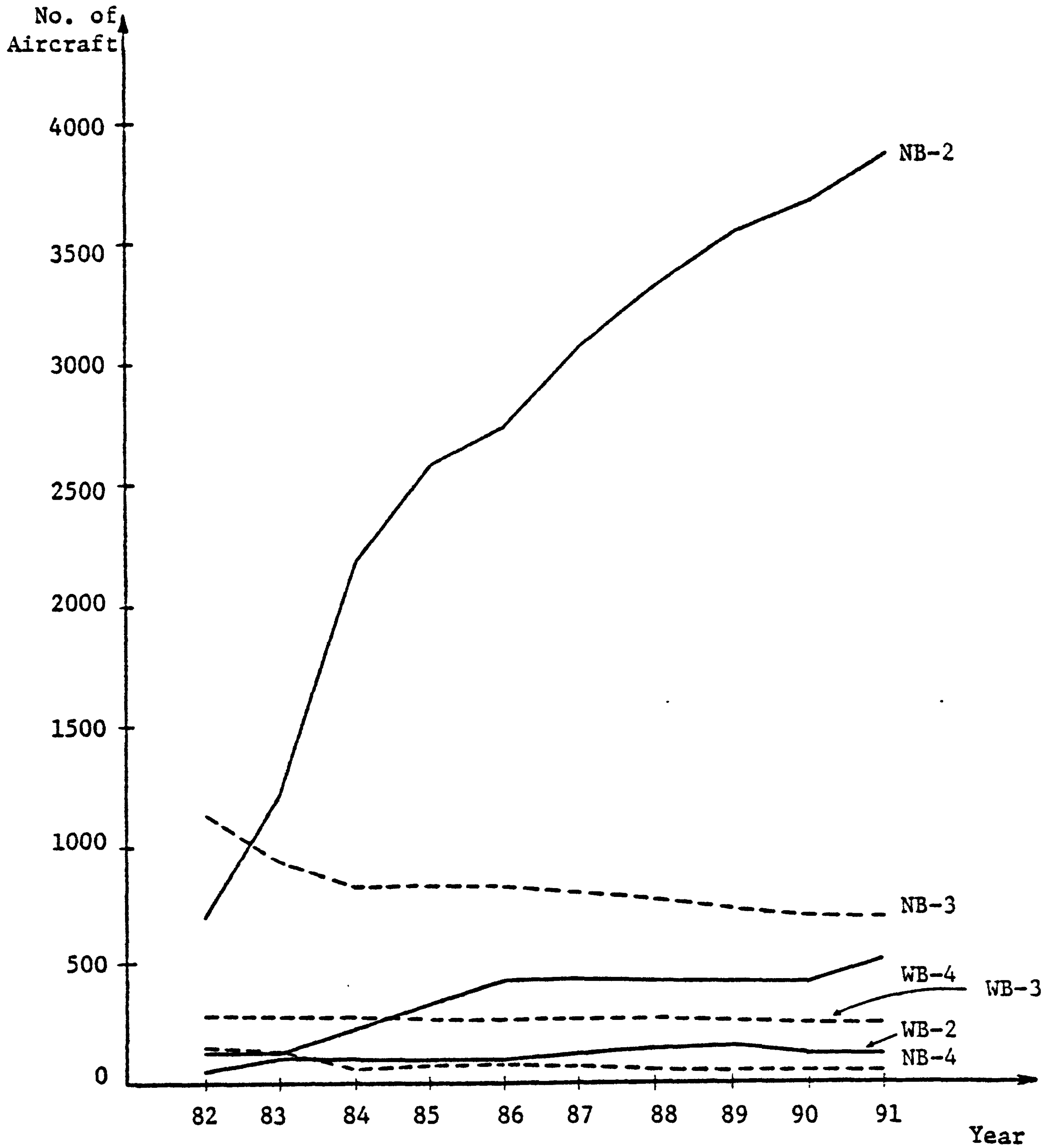
[1] The first B737-300 will be delivered to USAir on November 1984.

Table 5.1 Number of Aircraft per Generic Group for Case A

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	117	119	216	316	416	430	422	419	419	519
NB-4	138	114	60	77	77	67	57	57	57	57
WB-3	282	276	275	264	264	264	264	252	237	237
NB-3	1130	928	818	818	817	793	768	737	704	704
WB-2	50	100	102	103	103	123	133	149	122	122
NB-2	707	1231	2188	2592	2750	3070	3334	3558	3682	3872

Figure 5.1 Number of Aircraft per Generic Group (Case A)



planning period. In 1991, there is an increase in this group due to the purchase of one hundred TA11's. (The TA11 is a large-capacity, long-range aircraft by Airbus.) The increase in wide-bodied, 2-engine aircraft is due mainly to the purchase of B767-200's.

Regarding aircraft retirements, the highest amounts correspond to the B727-100, B727-200, and B707's. This decrease in 727's explains the decrease in the narrow-bodied, 3-engine aircraft category, plus the fact that the aircraft which may be the replacement for the B727, namely the B757, falls in the narrow-bodied, 2-engine aircraft category.

Aircraft types totally phased out at some point during the years considered are the B707, B727-100, B737-100, B747SP, DC8, DC9-10, DC10-30, and L1011-500. Some aircraft types were never chosen by the Model in this case. They are the A300-600, B767-300, and B767-XX.

In analyzing the percentage of departures in each cell throughout the ten-year planning period (output table 2), it can be seen that cells with a distance attribute greater than 900 miles, namely cell 3, cell 5, and cell 9, remain relatively constant. Cells with distance between 500 and 900 miles, namely cell 1, cell 2, cell 6, and cell 8, remain relatively constant in some cases and show a very slight decrease in others. The greatest change can be seen in the cells with a distance attribute between 300 and 500 miles as cell no. 7, and in the cells with less than 300 miles, as cell no. 4. Cell 7 accounted for 53.8% of the total departures in 1982, while it accounts for only 38.6% in 1991. Cell 4 shows the opposite trend. While it had no departures on 1982, it rose suddenly to 17.5% in 1983, and increased to 21% of the total number of departures in 1991. There is obviously a trend to increase the number of short haul segments. This is perfectly consistent, and helps to explain the decision of the Model to greatly increase its number of short range, small capacity aircraft, namely the narrow-bodied, 2-engine aircraft group.

An analysis can also be performed considering the number of frequencies by aircraft types throughout the planning period. The information on frequencies provided by the detailed cell outputs has been summarized in Table 5.2. Table 5.3 shows these frequencies aggregated into the six generic groups considered.

Table 5.3 reveals a very interesting result: the Model does not utilize part of its inventory fleet. In other words, the Model decides to ground some its aircraft. Furthermore, from 1986 to 1991 it only flies wide-bodied, 4-engine and narrow-bodied, 2-engine aircraft. The Model chooses these two aircraft groups as the optimal decision to serve the route network, large aircraft for long-haul and small aircraft for short-haul. By 1986 it has enough of these two types to be able to ground the other aircraft categories and satisfy the demand. These other aircraft remain in inventory either because their ownership cost has reached a zero level, that is, the aircraft is fully depreciated, or because they are forced to stay (Minimum Fleet Count by Type by Year input table).

Table 5.3 also explains the increase in the number of wide-bodied, 4-engine aircraft, and especially the large increase in the number of narrow-bodied, 2-engine aircraft, since the daily frequencies for these two aircraft types follow the same trend.

From Table 5.2, it can be seen that the Model shows a tendency to standardize aircraft types flown in each cell, and that the aircraft types most flown towards the end of the planning period are the B737-200, B737-300, B747-300, DC9-30, DC9-80, and F100. It is interesting to note

Table 5.2 Daily Frequencies per Aircraft Type per Cell (Case A)

Cell No.	1982	1983	1984	1985
1 (632 mi.)	727-2 (526) DC10-10 (191)	727-2 (559) L1011 (166)	A300B (142) 757 (193) 757-2 (140) 767-2 (91) DC9-80 (157)	757-2 (680) 767-2 (58)
2 (647 mi.)	A300B (130) 727-2 (649) 737-2 (415) DC10-10 (202) DC10-30 (89) L1011 (112)	A300B (130) 727-2 (797) 737-3 (42) 757 (189) 767-2 (275) L1011 (148)	737-3 (58) 757-2 (1507)	757-2 (1431) 767-2 (118)
3 (4345 mi.)	747 (96)	747 (94) 747-3 (5)	747-3 (93)	747-3 (97)
4 (161 mi.)		DC9-10 (26) DC9-30 (2084)	737-1 (49) 737-2 (1233) DC9-30 (848)	737-1 (49) 737-2 (1431) DC9-30 (672)

-(Daily frequencies are shown in parenthesis.)

Table 5.2 (cont.)

Cell No.	1986	1987	1988	1989
1	757-2 (768)	757-2 (792)	757-2 (817)	757-2 (843)
2	757-2 (1580)	757-2 (1599)	757-2 (1618)	737-3 (426) 757-2 (1373)
3	747-3 (136)	747-3 (149)	747-3 (147)	747-3 (145)
4	737-1 (49) 737-2 (935) DC9-30 (1271)	737-1 (30) 737-2 (827) DC9-30 (2079)	DC9-30 (3325)	DC9-30 (3359)

Table 5.2 (cont.)

Cell No.	1990	1991
1	757-2 (869)	757-2 (719) TA11 (124)
2	757-2 (1170) DC9-80 (689)	757-2 (1677)
3	747-3 (143)	747-3 (141)
4	DC9-30 (3392)	737-2 (3013) DC9-50 (42)

Table 5.2 (cont.)

Cell No.	1982	1983	1984	1985
5 (943 mi.)	737-2 (540) 757-2 (22) 767-2 (43) DC9-50 (175) DC9-80 (131) L1011 (279)	757-2 (469) 767-2 (22) DC9-50 (22) DC9-80 (609) L1011 (68)	737-3 (309) DC9-50 (529) DC9-80 (946)	757-2 (50) DC9-50 (424) DC9-80 (1310)
6 (545 mi.)	727-2 (277) DC9-30 (1012) DC10-30 (43)	727-2 (104) 737-2 (718) DC9-50 (701)	737-2 (1211) DC9-50 (429)	737-2 (1485) DC9-50 (201)
7 (313 mi.)	727-1 (2008) 737-1 (30) DC9-10 (19) DC9-30 (599) DC10-30 (31) DC10-40 (111)	727-1 (667) 727-2 (129) 737-1 (36) 737-2 (1197) DC9-30 (851)	737-2 (546) DC9-10 (19) DC9-30 (2403)	DC9-30 (3056)
8 (525 mi.)	727-2 (2370) 737-1 (55)	727-2 (2370) L1011 (6)	727-2 (1453) 737-3 (656) 767-2 (258)	737-3 (1759) 757 (227) 757-2 (106) 767-2 (154) DC9-50 (399)
9 (1967 mi.)	707 (78) 747 (49) 747SP (44) DC8 (67) DC8-73 (27) DC10-10 (57) L1011-5 (35)	707 (78) DC8-73 (54) DC10-10 (186) L1011 (27) L1011-5 (35)	747-3 (33) DC8-73 (82) DC10-10 (40) L1011 (195) L1011-5 (35)	747-3 (248) DC8-73 (104) L1011-5 (35)

Table 5.2 (cont.)

Cell No.	1986	1987	1988	1989
5	757-2 (188) DC9-50 (287) DC9-80 (1310)	757-2 (330) DC9-50 (144) DC9-80 (1310)	A320 (100) B150 (100) 757-2 (440) DC9-80 (1143)	A320 (201) B150 (201) 757-2 (663) DC9-50 (104) DC9-80 (615)
6	737-2 (1730)	737-2 (1130) DC9-30 (344) F100 (357)	737-2 (1108) DC9-30 (21) F100 (714)	737-2 (561) DC9-30 (294) F100 (1071)
7	DC9-30 (3148)	DC9-30 (3242)	DC9-30 (3339)	DC9-30 (3439)
8	737-3 (1759) 757 (227) 757-2 (19) DC9-50 (822)	737-3 (1759) 757-2 (182) DC9-50 (836)	737-3 (1759) 757-2 (82) DC9-50 (669) DC9-80 (259)	737-3 (1247) DC9-50 (335) DC9-80 (1079)
9	747-3 (392)	747-3 (396)	747-3 (399)	747-3 (403)

Table 5.2 (cont.)

Cell No.	1990		1991	
5	A320	(335)	A320	(536)
	B150	(301)	B150	(402)
	757-2	(800)	DC9-80	(462)
	DC9-80	(348)	TA11	(385)
6	737-2	(514)	737-3	(1403)
	F100	(1429)	F100	(3)
7	DC9-30	(3543)	737-2	(1034)
			F100	(2615)
8	737-3	(1759)	737-3	(300)
	757	(189)	757-2	(810)
	DC9-80	(666)	DC9-80	(981)
9	747-3	(407)	747-3	(412)

Table 5.3 Total Daily Frequencies per Generic Group for Case A

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	189	99	126	345	528	545	546	548	550	1062
NB-4	172	132	82	104	0	0	0	0	0	0
WB-3	959	636	270	35	0	0	0	0	0	0
NB-3	5830	4626	1453	0	0	0	0	0	0	0
WB-2	173	427	491	330	0	0	0	0	0	0
NB-2	2998	6944	11233	13280	14093	14961	15494	15811	16004	13997

that aircraft types such as the B767-200's and A300B's are not listed. Table 5.2 also shows how the composition of aircraft types used in each cell varies along the ten-year period.

Analyzing the operating statistics, output table 3 (case A) in Chapter 4, a steady and constant increase in ASM's (available seat miles) and RPM's (revenue passenger miles) can be seen. These figures appear to be very reasonable and are in the same range as those of other forecasts, as described in Section 5.4. Load factors show a decrease from their 63% starting point, but level off at approximately 55% in the second half of the planning period. Total frequency, block hours, and aircraft miles show a smooth, steady increase through most of the ten-year period. The average stage length drops in the second year and then gradually increases until it reaches approximately its starting level. The average number of seats per departure decreases through most of the period. This is consistent with the result that the dominant aircraft category is by far the small capacity narrow-bodied, 2-engine aircraft group.

5.1.2 Nine Cells, Case B

In this case, the Model has been forced to ultilize its inventory aircraft by modifying the Fleet Utilization Constraint from a less than or equal relationship to an equality, as described in Chapter 4. Analyzing the output tables for aircraft inventory, acquisition, and retirement, and comparing them to case A, it is clear that case B presents a lesser number of inventory aircraft throughout the entire planning period (with exception of the first year). This is due to fewer purchases of aircraft since the Model is now using the aircraft it already possesses before buying any more. It must be recalled that the same input data as in case A has been used. This means that the same constraints regarding maximum and minimum number of aircraft per each type on each year apply for case B.

In the present case, approximately the same aircraft types as in case A have been purchased, namely, B737-200's, B737-300's, B747-300's, B757-200's, B767-200's, DC9-30's, DC9-50's, DC9-80's, F100's. This time, A320's and B150's were not chosen, but the major difference lies in the number of purchases for each of these types, which is much smaller for case B than for case A.

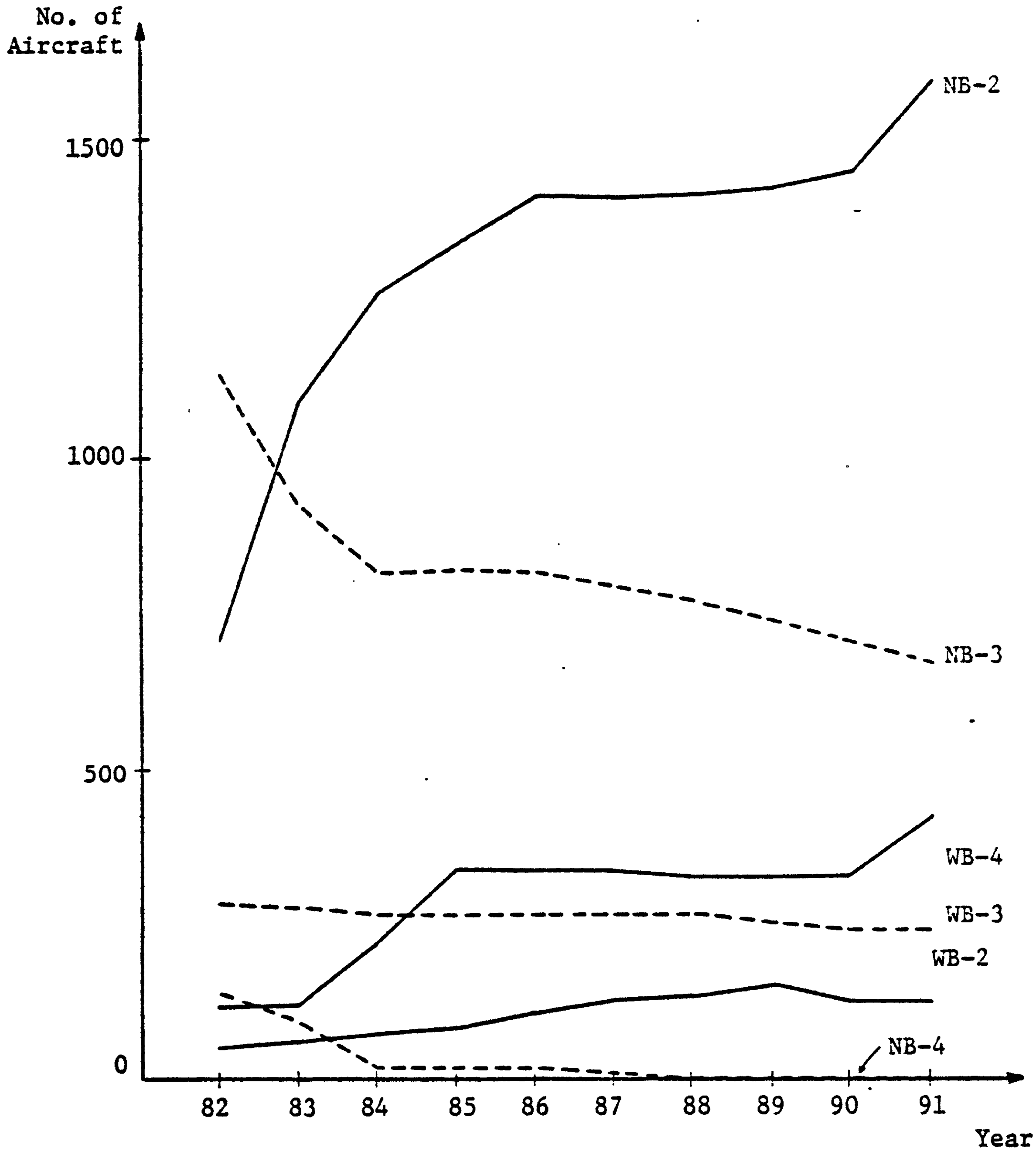
Table 5.4 aggregates the aircraft types into the generic groups and Figure 5.2 plots the number of aircraft in each of these groups through the ten years analyzed. From Table 5.4 it can be seen that the narrow-bodied, 2-engine aircraft group is the one that shows the largest increase and, starting in the second year, becomes the dominant aircraft group. It rises from 707 aircraft in 1982 to 1,593 in 1991, and from 29.2% to 45.0% of the total fleet over the same period of time. It, therefore, shows a similar trend to that of case A, but at a much smoother pace. The total number of narrow-bodied, 2-engine aircraft in case B for 1991 is less than half than in case A (1,593 against 3,872). Narrow-bodied, 3-engine aircraft (727's) decreased from 46.6% to 18.8% of the total fleet.

Narrow-bodied, 4-engine aircraft (707's, DC8's) decrease until 1988 when they are phased out. The wide-bodied, 3-engine aircraft category decreases slightly between 1982 and 1991, while the wide-bodied, 4-engine and wide-bodied, 2-engine aircraft groups show an increase due to the purchase of B747-300's and B767-200's. Compared to case A, the wide-bodied, 3-engine (DC10's, L1011's) and the wide-bodied, 2-engine groups

Table 5.4 Number of Aircraft per Generic Group for Case B

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	117	119	216	336	336	336	328	325	325	425
NB-4	138	94	20	20	20	10	0	0	0	0
WB-3	282	275	264	264	264	264	264	252	237	237
NB-3	1130	926	816	816	815	791	766	735	702	665
WB-2	50	70	72	83	103	123	133	149	122	122
NB-2	707	1084	1260	1337	1424	1410	1414	1425	1450	1593

Figure 5.2 Number of Aircraft per Generic Group (Case B)



(A300's, 767's) reach the same levels in 1991. The wide-bodied, 4-engine and narrow-bodied, 3-engine aircraft categories reach lower levels.

Regarding aircraft retirements, the most retired aircraft types are the B707, B727-100, and DC8 at early stages of the planning period, and the B727-200, DC8-73, DC9-30, and DC9-50 later in the period. These retirements explain the reduction in the narrow-bodied, 4-engine and narrow-bodied, 3-engine aircraft groups. Aircraft types totally phased out during the ten year period are the B707, B727-100, B737-100, B747SP, DC8, DC8-73, DC9-10, DC10-30, and L1011-500. Types never purchased by the Model are the A300-600, A320, B150, B767-300, and the B767-XX.

As in the previous case, an analysis of the frequencies per aircraft type is considered. In order to do so, tables 5.5 and 5.6 have been created. Table 5.5 presents the number of frequencies per aircraft type, and Table 5.6 aggregates these frequencies into the six generic groups.

Table 5.6 shows that, with exception of the narrow-bodied, 4-engine aircraft group, which is phased out in 1988, all the categories are utilized through the entire period. Comparing Table 5.6 to Table 5.4 (number of aircraft per generic group) it can be seen that the trends match in both cases for all the aircraft groups. In studying closely Table 5.5 it is seen that the only aircraft type in inventory not flown at the end of the planning period, that is in 1991, is the DC9-30. The reason why the Model keeps it in inventory, and at a number above the minimum established, is that the DC9-30 is by then fully depreciated and, therefore, does not incur ownership cost. From the Model's point of view, there is no cost in keeping this aircraft type grounded.

The percentage of departures by cell by year (output table 2 in

Table 5.5 Daily Frequencies per Aircraft Type per Cell (Case B)

Cell No.	1982	1983	1984	1985
1 (632 mi.)	727-2 (526) DC10-10 (191)	727-2 (509) DC10-10 (215)	727-2 (492) DC10-10 (240)	727-2 (473) DC10-10 (266)
2 (647 mi.)	A300B (130) 727-2 (649) 737-2 (415) DC10-10 (202) DC10-30 (89) L1011 (112)	A300B (130) 727-2 (605) 737-3 (42) 767-2 (173) DC9-50 (328) DC10-10 (16) DC10-30 (145) DC10-40 (39) L1011 (102)	A300B (138) 727-2 (418) 737-2 (523) DC10-10 (234) L1011 (251)	A300B (143) 727-2 (57) 737-2 (722) DC8-73 (65) DC10-10 (185) L1011 (293) L1011-5 (84)
3 (4345 mi.)	747 (96)	747 (94) 747-3 (5)	747-3 (93)	747-3 (141)
4 (161 mi.)		737-1 (49) 737-2 (639) DC9-30 (591)	737-1 (49) 737-2 (115) 757-2 (405) DC9-30 (1317) DC9-50 (244)	737-1 (49) 737-2 (383) 757-2 (405) DC9-30 (1315)

-(Daily frequencies are shown in parenthesis.)

Table 5.5 (cont.)

Cell No.	1986	1987	1988	1989
1	727-2 (454) DC10-10 (292)	727-2 (433) DC10-10 (320)	727-2 (412) DC10-10 (349)	727-2 (390) DC10-10 (379)
2	A300B (143) 727-2 (260) 737-2 (532) DC8-73 (65) DC10-10 (136) L1011 (313) L1011-5 (84)	A300B (143) 727-2 (422) 737-2 (390) DC8-73 (33) DC10-10 (87) L1011 (360) L1011-5 (84)	A300B (143) 727-2 (727) 737-2 (121) DC10-10 (117) L1011 (311) L1011-5 (84)	A300B (143) 727-2 (846) DC10-10 (56) L1011 (359) L1011-5 (84)
3	747-3 (141)	747-3 (164)	747-3 (164)	747-3 (164)
4	737-1 (49) 737-2 (415) 757-2 (405) DC9-30 (2036)	737-1 (30) 757-2 (608) DC9-30 (2298)	737-1 (30) 757-2 (811) DC9-30 (1869) DC9-50 (616)	737-2 (1783) 757-2 (663) DC9-30 (912)

Table 5.5 (cont.)

Cell No.	1990	1991
1	727-2 (366) DC10-10 (410)	727-2 (104) 737-3 (136) 767-2 (149) DC10-10 (396)
2	A300B (26) 727-2 (833) DC10-10 (98) DC10-40 (66) L1011 (451)	A300B (26) 737-3 (363) 757-2 (246) 767-2 (357) L1011 (467)
3	747-3 (164)	747-3 (162)
4	737-2 (1430) DC9-30 (1962)	737-2 (2094) DC9-50 (961)

Table 5.5 (cont.)

Cell No.	1982	1983	1984	1985
5 (943 mi.)	737-2 (540) 757-2 (22) 767-2 (43) DC9-50 (175) DC9-80 (131) L1011 (279)	757-2 (134) DC9-50 (238) DC9-80 (609) L1011 (209)	737-3 (76) 767-2 (134) DC9-50 (411) DC9-80 (609) L1011 (157)	737-2 (50) 737-3 (76) 767-2 (167) DC9-50 (492) DC9-80 (609) L1011 (135)
6 (545 mi.)	727-2 (277) DC9-30 (1012) DC10-30 (43)	727-2 (304) 737-2 (1219)	727-2 (343) 737-2 (1165)	737-2 (729) DC9-30 (1139)
7 (313 mi.)	727-1 (2008) 737-1 (30) DC9-10 (19) DC9-30 (599) DC10-30 (31) DC10-40 (111)	727-1 (667) 727-2 (229) DC9-10 (19) DC9-30 (1932) DC10-40 (34)	727-1 (18) 727-2 (628) DC9-10 (19) DC9-30 (2063) DC10-30 (128) DC10-40 (111)	727-1 (18) 727-2 (1880) DC9-30 (920) DC10-30 (128) DC10-40 (111)
8 (525 mi.)	727-2 (2370) 737-1 (55)	727-2 (2369) DC10-40 (7)	727-2 (2292) DC10-10 (37)	727-2 (2217) DC10-10 (65)
9 (1967 mi.)	707 (78) 747 (49) 747SP (44) DC8 (67) DC8-73 (27) DC10-10 (57) L1011-5 (35)	707 (78) 747 (54) 747SP (32) DC8-73 (27) DC10-10 (114) L1011 (40) L1011-5 (35)	747 (251) 747-3 (33) 747SP (32) DC8-73 (27) L1011 (6) L1011-5 (35)	747 (251) 747-3 (159) 747SP (32)

Table 5.5 (cont.)

Cell No.	1986	1987	1988	1989
5	737-2 (51) 737-3 (98) 767-2 (234) DC9-50 (492) DC9-80 (609) L1011 (120)	737-2 (287) 737-3 (130) 767-2 (301) DC9-50 (359) DC9-80 (609) L1011 (83)	737-2 (369) 737-3 (196) 767-2 (335) DC9-50 (155) DC9-80 (609) L1011 (121)	737-2 (9) 737-3 (261) 757-2 (116) 767-2 (388) DC9-50 (317) DC9-80 (609) L1011 (84)
6	737-2 (930) DC9-30 (920)	727-2 (32) 737-2 (946) DC9-30 (495) F100 (357)	727-2 (34) 737-2 (1135) F100 (645)	727-2 (104) 737-2 (933) F100 (757)
7	727-2 (1662) DC9-30 (1246) DC10-30 (128) DC10-40 (111)	727-2 (1324) DC9-30 (1679) DC10-30 (128) DC10-40 (111)	727-2 (750) DC9-30 (2478) DC10-40 (111)	727-2 (354) DC9-30 (3085)
8	727-2 (2144) DC10-10 (93)	727-2 (2072) DC10-10 (119)	727-2 (2008) DC10-10 (49) DC10-30 (91)	727-2 (1939) DC10-10 (87) DC10-40 (79)
9	747 (251) 747-3 (203) 747SP (32)	747 (251) 747-3 (157) 747SP (32)	747 (251) 747-3 (157) 747SP (9)	747 (251) 747-3 (157)

Table 5.5 (cont.)

Cell No.	1990	1991
5	727-2 (175) 737-3 (50) 757-2 (402) 767-2 (388) DC9-50 (147) DC9-80 (609) L1011 (13)	737-2 (444) 757-2 (245) DC9-80 (609) TA11 (478)
6	737-2 (1121) DC9-50 (255) F100 (401)	727-2 (743) F100 (663)
7	DC9-30 (2227) F100 (1316)	727-2 (1004) 737-2 (998) F100 (1647)
8	727-2 (1890) 737-3 (429)	727-2 (1808) DC10-10 (135) DC10-40 (79)
9	747 (251) 747-3 (157)	747 (251) 747-3 (161)

<u>Table 5.6</u> Total Daily Frequencies per Generic Group for Case B

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	189	185	409	583	627	604	581	572	572	1052
NB-4	172	105	27	65	65	33	0	0	0	0
WB-3	959	956	1119	1267	1277	1292	1233	1128	1038	1077
NB-3	5830	4683	4191	4645	4520	4283	3931	3633	3264	3659
WB-2	173	303	272	310	377	444	478	531	414	383
NB-2	2998	5800	6996	6889	7783	8188	9034	9445	10349	8406

Chapter 4) is very similar to that of case A. With slight differences in the figures throughout the ten years, the trends and changes are the same as the ones described for case A in the previous section. The same can be stated regarding the operating statistics. ASM's are slightly higher in case B than in case A, and the opposite is true for RPM's. Frequencies, block hours, and aircraft miles are slightly lower for the present case than for case A; and the fuel burn or fuel consumption is higher in case B. This occurs since more frequencies with older aircraft and less with new and more efficient aircraft are flown than in case A.

5.1.3 Nine Cells, Case C

In this third case, the difference lies in the Maximum and Minimum Fleet Count by Type by Year input data. The Cell Fleet Planning Model has been brought back to its original Fleet Utilization Constraint presented in Section 2.3.2.5.

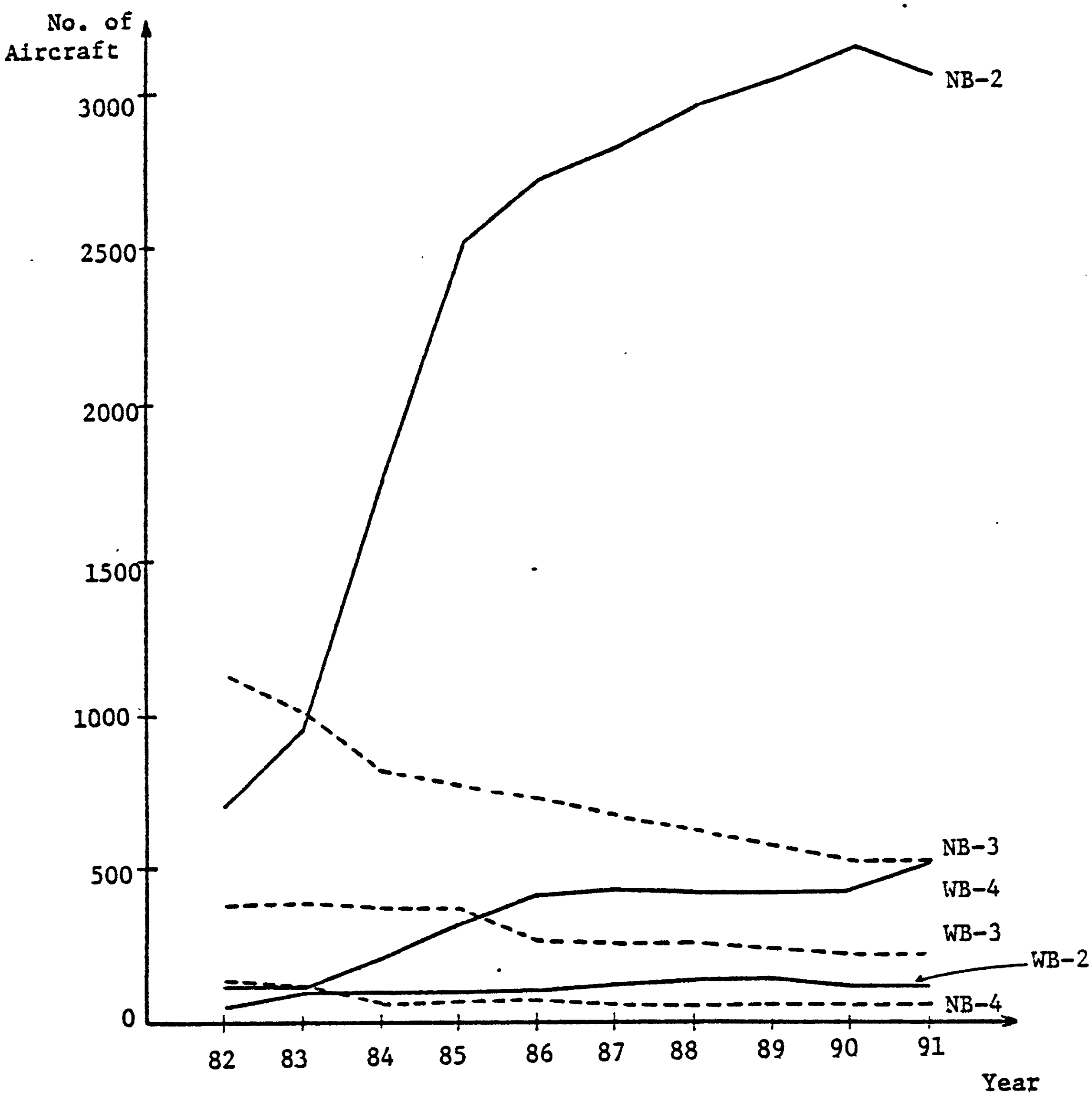
The Aircraft Inventory and Aircraft Acquisition output tables show basically the same trends as in cases A and B regarding the aircraft types that increased and those that decreased in size. Aircraft purchased are mostly new types: A320, B150, B737-300, B747-300, B757-200, B767-200, DC9-80, and F100. Other types purchased are the B737-200, DC9-30 and DC9-50. Comparing case C to the two previous cases, it shows a lesser number of aircraft than case A and a greater number than case B throughout the entire ten-year period. Nevertheless, it is much closer to case A than it is to case B.

Table 5.7 shows the number of aircraft per year aggregated into the generic groups, and Figure 5.3 presents a plot for these figures. They show again the narrow-bodied, 2-engine aircraft as the leading aircraft

Table 5.7 Number of Aircraft per Generic Group for Case C

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	117	119	216	316	416	430	422	419	419	519
NB-4	138	119	60	77	77	67	57	57	57	57
WB-3	282	291	273	269	264	259	254	237	217	212
NB-3	1130	1015	818	778	728	675	625	575	525	525
WB-2	50	97	97	97	107	127	137	137	110	110
NB-2	707	947	1765	2512	2715	2822	2953	3037	3137	3040

Figure 5.3 Number of Aircraft per Generic Group (Case C)



category. In the present case the narrow-bodied, 2-engine aircraft group increases from 29.2% in 1982 to 64.1% of the total fleet in 1991. The narrow-bodied, 3-engine aircraft decrease from 46.6% to 11.1% over the same period of time. In case C, the total number of narrow-bodied, 2-engine aircraft reaches 3,040 in 1991 against 3,872 of case A and 1,593 of case B.

Aircraft types retired during the planning period in this case are the B707, B727-100, B727-200, B737-100, B747SP, DC8, DC8-73, DC9-30, DC9-50, DC10-10, DC10-30, L1011, and L1011-500. In case C the Model chooses to retire more aircraft than in cases A and B. Overall, case C is very similar to case A, but it has fewer acquisitions and more retirements of aircraft; this is a consequence of the reduced number of aircraft per type in the input data.

As in the previous cases, tables containing the number of daily frequencies for each aircraft type on each cell and the aggregation of these into the six generic groups considered have been created. They are Table 5.8 and Table 5.9 repectively. Looking at Table 5.9, it can be seen that the same phenomenon which ocurred in case A is repeated in case C. That is, the Model is grounding part of its inventory aircraft fleet, and from 1986 to 1990, only the wide-bodied, 4-engine and narrow-bodied, 2-engine aircraft are used. Furthermore, Table 5.3 (case A) and Table 5.9 (case C) are very similar. In looking also at Table 5.8, it is seen that the distribution of aircraft types and frequencies is also alike. It is then clear that the major difference between case A and case C lies in the higher retirements of aircraft grounded by the Model in case C.

The percentage of departures by cell from 1982 to 1991 (output table 2) is very similar to that of the two preceeding cases. Trends and

Table 5.8 Daily Frequencies per Aircraft Type per Cell (Case C)

Cell No.	1982	1983	1984	1985
1 (632 mi.)	727-2 (526) DC10-10 (191)	727-2 (513) DC10-10 (153) DC10-30 (43) DC10-40 (16)	727-2 (410) 767-2 (222) L1011 (99)	A300B (136) 737-3 (180) 757-2 (295) 767-2 (128)
2 (647 mi.)	A300B (130) 727-2 (649) 737-2 (415) DC10-10 (202) DC10-30 (89) L1011 (112)	A300B (160) 727-2 (741) 737-2 (303) 737-3 (32) DC10-30 (103) L1011 (241)	A300B (160) 727-2 (411) 757-2 (952) 767-2 (42)	A300B (28) 757-2 (1521)
3 (4345 mi.)	747 (96)	747 (94) 747-3 (5)	747-3 (93)	747-3 (97)
4 (161 mi.)		DC9-10 (26) DC9-30 (1005)	737-1 (49) 737-2 (1769) DC9-30 (312)	737-2 (2152)

-(Daily frequencies are shown in parenthesis.)

Table 5.8 (cont.)

Cell No.	1986	1987	1988	1989
1	757-2 (768)	757-2 (792)	757-2 (817)	757-2 (843)
2	757-2 (1580)	757-2 (1599)	757-2 (1618)	737-3 (317) 757-2 (1413) DC9-80 (38)
3	747-3 (136)	747-3 (149)	747-3 (147)	747-3 (145)
4	737-2 (2173)	737-2 (2239) DC9-50 (383)	737-2 (2774) DC9-50 (190)	737-2 (2860) DC9-30 (499)

Table 5.8 (cont.)

Cell No.	1990	1991
1	757-2 (869)	757-2 (719) TA11 (124)
2	757-2 (1153) DC9-80 (712)	757-2 (1677)
3	747-3 (143)	747-3 (141)
4	737-2 (1515) DC9-30 (1509)	737-2 (3054)

Table 5.8 (cont.)

Cell No.	1982	1983	1984	1985
5 (943 mi.)	737-2 (540) 757-2 (22) 767-2 (43) DC9-50 (175) DC9-80 (131) L1011 (279)	757-2 (67) 767-2 (201) DC9-50 (492) DC9-80 (243) L1011 (178)	727-2 (56) 737-3 (489) DC9-50 (378) DC9-80 (852)	757-2 (6) DC9-50 (318) DC9-80 (1461)
6 (545 mi.)	727-2 (277) DC9-30 (1012) DC10-30 (43)	727-2 (309) 737-1 (24) 737-2 (1184)	737-2 (947) DC9-50 (654)	737-2 (1593) DC9-50 (109)
7 (313 mi.)	727-1 (2008) 737-1 (30) DC9-10 (19) DC9-30 (599) DC10-30 (31) DC10-40 (111)	727-1 (1181) DC9-30 (1624) DC10-40 (75)	737-2 (546) DC9-10 (19) DC9-30 (2403)	737-1 (36) 737-2 (392) DC9-30 (2629)
8 (525 mi.)	727-2 (2370) 737-1 (55)	727-2 (2369) DC10-40 (7)	727-2 (2363)	727-2 (337) 737-3 (1562) 767-2 (161) DC9-50 (660)
9 (1967 mi.)	707 (78) 747 (49) 747SP (44) DC8 (67) DC8-73 (27) DC10-10 (57) L1011-5 (35)	707 (78) 747SP (32) DC8-73 (61) DC10-10 (174) L1011-5 (35)	747-3 (33) DC8-73 (82) DC10-10 (80) L1011 (154) L1011-5 (35)	747-3 (248) DC8-73 (104) L1011-5 (35)

Table 5.8 (cont.)

Cell No.	1986	1987	1988	1989
5	757-2 (143) DC9-50 (180) DC9-80 (1461)	757-2 (285) DC9-50 (38) DC9-80 (1461)	A320 (100) B150 (100) 757-2 (440) DC9-80 (1143)	A320 (201) B150 (201) 757-2 (619) DC9-80 (763)
6	737-2 (1535) DC9-50 (166)	737-2 (1429) F100 (357)	737-2 (1327) F100 (486)	737-2 (1522) F100 (272)
7	737-1 (36) 737-2 (483) DC9-30 (2692)	737-1 (21) 737-2 (592) DC9-30 (2629)	737-1 (21) 737-2 (354) DC9-30 (2629) F100 (335)	DC9-30 (2268) F100 (1172)
8	737-3 (1774) 757-2 (201) DC9-50 (814)	737-3 (1774) 757-2 (192) DC9-50 (805)	737-3 (1774) 757-2 (62) DC9-50 (404) DC9-80 (494)	737-3 (1392) DC9-50 (231) DC9-80 (1038)
9	747-3 (392)	747-3 (396)	747-3 (399)	747-3 (403)

Table 5.8 (cont.)

Cell No.	1990	1991
5	A320 (335) B150 (301) 757-2 (800) DC9-80 (348)	A320 (536) B150 (402) DC9-80 (462) TA11 (385)
6	737-2 (1716) F100 (61)	737-2 (728) 737-3 (830)
7	DC9-30 (1536) F100 (2006)	737-2 (1030) F100 (2619)
8	737-3 (1774) DC9-80 (873)	737-3 (910) 757-2 (790) DC9-80 (477)
9	747-3 (407)	747-3 (412)

Table 5.9 Total Daily Frequencies per Generic Group for Case C

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	189	131	126	345	528	545	546	548	550	1062
NB-4	172	139	82	104	0	0	0	0	0	0
WB-3	959	1025	368	35	0	0	0	0	0	0
NB-3	5830	5113	3240	337	0	0	0	0	0	0
WB-2	173	361	424	453	0	0	0	0	0	0
NB-2	2998	5000	9370	12914	13943	14596	15068	15649	15508	14234

variations are practically those described for case A. The analogous situation is found in analyzing the operating statistics (output table 3 in Chapter 4).

5.2 Analysis of the Thirty-Cell Case and Comparison to the Nine-Cell Case

This case was run using the modified Fleet Utilization Constraint used in Case B for nine cells. The purpose of this thirty-cell run is to test the Model's behavior at a larger number of clusters than run until now. The question is: Does more cell detail yield very different results? The approach of case B was chosen because after analyzing the results for the three nine-cell cases, it is this author's opinion that the results for case B are the most realistic among the cases studied here. In the present case, the Cell Model was run for five years.

In analyzing the Aircraft Inventory, Aircraft Acquisition, and Aircraft Retirement output tables for the thirty-cell case, the most interesting result appears to be the decision of the Model to promptly retire the oldest and most inefficient aircraft types, which results in a decrease of the total number of aircraft from 1982 to 1983. The Model executes the maximum permissible number of retirements for B707's, B727-100's, B737-100's, B747SP's, DC8's, and DC10-10's in 1983. (The phase-out of DC8's is forced by the input data.) The aircraft types the model chose to acquire in this run were: the B737-200, B737-300, B747-300, B757-200, B767-200, and DC9-80. These aircraft types closely agree with the acquisitions in the nine-cell case.

Table 5.10 aggregates the aircraft into the six generic groups.

Table 5.10 Number of Aircraft per Generic Group for the Thirty-Cell Case.

	1982	1983	1984	1985	1986
WB-4	117	119	174	174	174
NB-4	138	20	20	20	20
WB-3	282	275	264	264	264
NB-3	1130	816	816	816	815
WB-3	50	61	72	83	103
NB-2	707	755	830	873	898

This table shows an increasing trend for the widebodied-4 engine, wide-bodied, 2-engine, and narrow-bodied, 2-engine aircraft groups, and a decreasing trend for the narrow-bodied, 4-engine; wide-bodied, 3-engine; and narrow-bodied, 3-engine aircraft categories. Comparing these figures with the first five years for case B (Table 5.4), similar trends are found. The major difference lies in the rate at which the wide-bodied, 4-engine (B747's) and the narrow-bodied, 2-engine aircraft increase. For the rest of the aircraft types, the figures are very similar, and in many cases, they are equal. As in previous cases, the narrow-bodied, 2-engine aircraft appears as the dominant group (39.5% of the total fleet in 1986).

Table 5.11 presents the aggregation of total daily frequencies for the thirty-cell case. A close correlation exists between the number of aircraft (Table 5.10) and daily frequency trends. Comparing daily frequencies for the thirty-cell and nine-cell cases for the first five years, the same direction in trends can be found, but the thirty-cell case presents a less pronounced rate of change.

Analyzing the operating statistics, it is seen that certain parameters such as active aircraft, available seat miles (ASM's), frequency, block hours, aircraft miles, fuel burn, and number of seats, drop on the second year and then increase steadily through the remaining years of the planning period. This drop is due to the large amount of retirements in the second year.

Comparing operating statistics for the nine-cell and thirty-cell cases, the greatest discrepancy lies in the number of ASM's and RPM's. The difference in load factors is a consequence of the change in ASM's and RPM's. For the first year, ASM's are equal to 963 millions in the

Table 5.11 Total Daily Frequencies per Generic Group for the Thirty-Cell Case.

	1982	1983	1984	1985	1986
WB-4	243	267	343	341	341
NB-4	674	106	106	106	106
WB-3	1683	1674	1946	1946	1940
NB-3	6442	4821	4933	5056	5030
WB-2	258	339	415	475	598
NB-2	4255	4471	4825	4953	5084

thirty-cell case and to 1170 millions in the nine-cell case. RPM's are 430 millions and 733 millions respectively. It is interesting to note that the change in ASM's is correlated with the change in aircraft miles and that the average stage length is smaller in the thirty-cell case.

In summary, the comparison between the nine-cell run and the thirty-cell run shows that the latter presents a smaller number of total aircraft, less ASM's as a consequence of less miles flown, less RPM's, and a smaller average stage length. In searching an explanation for the variation in results when increasing the number of cells from nine to thirty, one could conclude that it occurs because the clustering of OAG route segments into thirty cells, instead of nine, produces a different set of average attributes for the cells that represent the entire airline route network. It must be recalled that the cells, nine or thirty, are defined by obtaining the mean attributes of each cluster for each year considered; cells are then matched for all the years, and the attributes of matching cells are averaged to finally obtain the cells to be used in the Model. Obviously, some information is lost in these averaging processes that cause the nine cells and the thirty cells to produce a somewhat different representation of the system. The thirty-cell case gives a better representation as was discussed in Chapter 2 when analyzing the Within-Cluster Sum of Squares (WSS) plot. But there are some tradeoffs; the thirty-cell case involves a greater amount of input data, some of it assumed or forecasted. It is then a matter of confidence in this input data what will yield greater or less confidence in the results. If the input data is not reliable, introducing more assumptions (thirty-cell case) may produce less accuracy than the case having less input data and, therefore, less assumptions or forecasts (nine-cell case). In such case the effort of building a thirty-cell case would not be worthwhile. If the data is known to be good and reliable, a thirty-cell case should definitely yield more confident results than a nine-cell case.

5.3 Comparison of Cell Fleet Planning Model Results to Historical Data

This section compares the results obtained from the Cell Model against the recent historical data analyzed in Chapter 3. These two sets of data include the period 1982-83, and, therefore, allow the comparison. An analysis is also performed to see if trends developed during the period 1979-1983 matched the trends that appear in the Model's results.

Before proceeding with the above analysis, a comparison is shown between operating statistics for 1982 presented by the Civil Aeronautics Board (CAB) and these same statistics as given by results of the Model for the cases studied. Table 5.12 presents this comparison. The results of the Model are very much in the range of the CAB data. The CAB parameters were also used to calibrate the Model, and Table 5.12 allows one to state that a reasonably good calibration was obtained.

In Chapter 3, a plot showing the variation of the historical number of aircraft in each generic group through the years (Figure 3.1) was presented. In comparing it to Figures 5.1, 5.2, and 5.3 the majority of the trends coincide. In Figure 3.1 the narrow-bodied, 2-engine aircraft group was the group that showed the fastest increase. This is the case in the Cell Model results as well, but at a higher rate of increase for the latter. In 1981, the narrow-bodied, 3-engine aircraft category started a decreasing trend which is continued in the Model's results due to the retirement of B727's. The narrow-bodied, 4-engine aircraft (B707's,

Table 5.12 C.A.B. and Cell Model Operating Statistics for 1982

	C.A.B.	Cell Model Cases A,B,C
ASM's (millions)	1203	1170
RPM's (millions)	710	733
Load Factor	59%	63%
Frequency	13509	10509
Block Hours	17558	17758
Aircraft Miles	7303	6600

* Figures shown are daily totals.

DC8's) show a decreasing trend in the historical data which is matched in all the cases seen for the Cell Model. The wide-bodied, 2-engine aircraft is another category that shows the same trend in both cases, that is, a smooth increasing trend. Two aircraft groups show different trends historically and in the Model's results: the wide-bodied, 4-engine and the wide-bodied, 3-engine aircraft groups. Historically, since 1979, the number of wide-bodied, 4-engine aircraft remained relatively constant. In the Model's results, this category shows an increasing trend, although it becomes constant in the latter part of the planning period. The other category which shows some discrepancy, the widebodied-3 engine aircraft group, historically showed an increasing trend but appears decreasing slightly in the Cell Model's results.

Comparing the actual number of aircraft in each group in 1982 to the results of the model for 1982 (Table 3.3 against Tables 5.1, 5.4, and 5.7) is irrelevant since in the first year the model was not allowed any purchases or retirements of aircraft, and, therefore, the number of aircraft in 1982 shown by the Model only reflects the input data. It is interesting however, to compare the actual number of daily frequencies for 1982 and 1983 between the historical data (Table 3.6) and case A, case B, and case C for the Cell Model. Table 5.13 summarizes tables 3.6, 5.3, 5.6, and 5.9 (daily frequencies) for 1982 and 1983. This table shows, as does Table 5.12, a smaller number of frequencies in the results of the Model than in reality. This should be expected since the results of the Cell Fleet Planning Model are the optimal solution to a mathematical programming problem in which the profit objective is a simplification of the actual objectives of the industry. In other words, frequencies have been optimally allocated in each cell by the Model

Table 5.13 Comparison of Historical and Cell Model Daily Frequencies

	1982		1983			
	Historical	Cases A,B,C*	Historical	Case A	Case B	Case C
WB-4	234	189	227	99	185	131
NB-4	270	172	203	132	105	139
WB-3	852	959	844	636	956	1025
NB-3	5040	5830	4987	4626	4683	5113
WB-2	107	173	294	427	303	361
NB-2	5892	2998	6333	6944	5800	5000

* Daily frequencies are equal in Case A, Case B, and Case C in 1982.

without considering several other factors. In reality there are many other factors that dictate decisions, like the economy, politics, marketing factors, etc. It could then be more significant to look at trends followed by frequencies and compare these to historical trends. The analysis of Chapter 3 showed two aircraft groups with an increasing trend regarding their total number of frequencies: the narrow-bodied, 2-engine and the wide-bodied, 2-engine aircraft categories. It also showed two groups remaining relatively stable: the wide-bodied, 3-engine and wide-bodied, 4-engine aircraft groups, and two groups showing a decreasing trend: the narrow-bodied, 3-engine and narrow-bodied, 4-engine aircraft. In the Cell Model's results, trends vary in the cases studied. Comparing the historical trends with case A and case C, both of which have very similar trends, a coincidence is found regarding the narrow-bodied, 2-engine aircraft group and the narrow-bodied, 4-engine aircraft group. In both cases the narrow-bodied, 2-engine aircraft increase their total number of daily frequencies while the narrow-bodied, 4-engine aircraft reduce them (until it reaches zero in the Model's results). For the remaining four aircraft categories, there is discrepancy in their frequency trends. While the narrow-bodied, 3-engine aircraft group shows a decreasing trend in both cases, historically and in the Model, the trend is much faster in the latter.

Performing a comparison of historical trends with case B, a coincidence is found in four aircraft categories, namely, the narrow-bodied, 4-engine and narrow-bodied, 3-engine aircraft, which decrease, and the wide-bodied, 2-engine and narrow-bodied, 2-engine aircraft groups, which increase. In the Model's results, the wide-bodied, 4-engine and wide-bodied, 3-engine aircraft categories increase during the first years and then slightly decrease their daily frequencies, while in the historical data there is no sign of that increase.

5.4 Comparison to Other Forecasts

This section compares the Cell Fleet Planning Model results on number of aircraft and operating statistics to the forecasts of the Federal Aviation Administration and certain manufacturers. Before looking at each of these forecasts separately, a comparison of the industry's ASM and RPM forecasts, and ASM's and RPM's given by the Model's results is shown in Table 5.14. A comparison of ASM's and RPM's is relevant because they represent the supply and demand respectively that the fleet planning process is trying to match.

5.4.1 Federal Aviation Administration (FAA) Forecasts

Table 5.15 presents the FAA forecasts regarding the total number of aircraft per generic group.[12] The comparison of this table to the Model's results (case B) shows a coincidence in increasing and decreasing trends in each of the aircraft categories. Furthermore, some figures (e.g. wide-bodied, 3-engine and narrow-bodied, 3-engine aircraft groups in 1991) are very close. The greatest differences appear in the Cell Model's decision to include a larger number of wide-bodied, 4-engine and narrow-bodied, 2-engine aircraft, and a smaller number of wide-bodied, 2-engine aircraft than forecasted by the FAA. The FAA forecast also shows the narrow-bodied, 2-engine aircraft as becoming the dominant group. In 1991 it represents 43.5% of the total fleet against 45% shown by the Cell Model. The narrow-bodied, 3-engine aircraft accounts for 20.9% of the total fleet in 1991 in the FAA forecast, while the Model's

Table 5.14a   Revenue Passenger Miles (RPM) Forecasts (in billions)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Airbus	267	277	300	319	334	350	366	384	402	419
Boeing	261	270	293	314	321	338	364	394	416	433
Douglas	270	289	308	321	339	357	379	401	423	447
Pratt	262	272	283	285	295	315	341	368	384	417
Cell Model:										
Case A	268	283	295	300	313	321	328	335	341	342
Case B	268	280	287	302	310	317	322	329	337	340
Case C	268	279	294	300	312	320	327	334	340	343

Table 5.14b Available Seat Miles (ASM) Forecasts (in billions)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Airbus	438	450	484	506	526	547	567	591	614	635
Boeing	422	431	460	488	495	519	558	603	637	663
Douglas	455	481	502	519	537	559	586	614	640	668
Pratt	437	452	469	471	486	518	559	601	625	678
Cell Model:										
Case A	427	451	481	517	580	602	610	617	624	624
Case B	427	454	511	594	619	627	626	625	626	636
Case C	427	445	480	518	580	601	609	618	622	626

Table 5.15 F.A.A. Forecasts on the Number of Aircraft per Generic Group

	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	145	150	150	152	159	167	174	181	188
NB-4	202	181	162	127	95	86	86	86	86
WB-3	280	280	282	284	285	286	286	286	286
NB-3	1058	1018	947	872	801	731	682	644	604
WB-2	43	80	101	156	213	269	332	390	447
NB-2	777	828	856	933	1004	1073	1136	1196	1255

results show 18.8%.

With respect to other parameters, coincidences and discrepancies are found between the FAA forecasts and the Cell Fleet Planning Model results. The average stage length is very similar in both cases. (The FAA figures show an increase in average stage length from 762 miles to 798 miles in 1994.) Seating capacity and load factors are two parameters that differ in the FAA and Cell Model figures. The FAA forecasts the average seats to increase from 150 seats in 1982 to 193 seats in 1994. The results of the Cell Model show that the average seats vary betwen 149 and 157 between 1982 and 1991. Regarding load factors, the FAA forecasts a steady increase until 1988 when 63% is reached. In the Model results, load factor is approximately 54% towards the end of the planning period.

5.4.2 McDonnell Douglas Forecasts

The planning period for McDonnell Douglas forecasts extends fifteen years.[15] By 1997, Douglas forecasts that the dominant group will be what they call the Short Range-160 (SR-160) which includes the B727-200 and the DC9-80. According to Douglas the SR-160 category will account for 32% of the total fleet. In the Cell Model, the B727-200 and the DC9-80 are grouped in different categories, but adding the individual number of aircraft for these two types, it can be seen that they account for 24.4% of the total fleet in 1991. Another group that Douglas' forecasts show will increase is the Medium Range-200 (MR-200) which includes B707's, DC8's, B757-200's, and B767-200's. It can be said that this matches the trends shown by the Cell Model since, in its results, acquisitions of B757-200's and B767-200's are larger than the retirements of B707's and DC8's. Therefore, if the Cell Model were to group aircraft according to McDonnell Douglas' classification, the trend for the MR-200 would be similar.

The Short Range-110 (SR-110) aircraft group from Douglas aggregates BAC-111's, B727-100's, B737's (all types), Caravelles, DC9's (excepting the DC9-80), and F28's. This is the group with highest retirements in Douglas' forecast. The Cell Model runs have not considered aircraft types such as BAC-111's, Caravelles, and F28's, and it does retire a large amount of B727-100's, but the B737's and DC9's are among the highest increasing types in its results.

5.4.3 Boeing Forecasts

Boeing aggregates aircraft into four categories: low-bypass standard body, high-bypass standard body, 2-engine widebody, and 3- and 4-engine widebody; and extends its forecasts twelve years into the future.[6] The low-bypass standard body group includes aircraft types such as DC9's, B737-100's, B737-200's, B727's, DC8's and B707's among others not considered in the Cell Model runs. According to Boeing's forecast, this group will represent 32% of the total fleet in 1995. The high-bypass standard body, which will account for another 32%, is formed by DC8-70's, DC9-80's, B737-300's, and B757's. Therefore, the standard body aircraft will represent 64% of the total fleet in 1995. In the Cell Model results, the standard body (narrow-bodied) aircraft account for 63.7% of the total fleet in 1991, but the distribution of these aircraft in low-bypass and high-bypass is somewhat different. The Cell Model shows a larger number of DC9's and B737-200's which result in a higher percentage of low-bypass standard body aircraft.

Regarding the wide-bodied aircraft, the Cell Model shows a higher proportion of wide-bodied, 4-engine aircraft than of wide-bodied, 2-engine aircraft. Boeing's forecasts show a similar proportion of wide-bodied, 4-engine and wide-bodied, 2-engine aircraft in the latter part of the planning period.

5.4.4 Pratt & Whitney Forecasts

In table 5.16, Pratt & Whitney's forecasts for each of the aircraft types considered in the Cell Model runs have been aggregated into the six generic groups. Comparing these forecasts with the results obtained for case B (table 5.4), coincidences and discrepancies are found. Pratt's figures show the narrow-bodied, 2-engine aircraft group as the dominant category, as do the Cell Model's results. The number of aircraft for this category are in the same range. (The Cell Model's figures are slightly higher.) Both forecasts, the Cell Model's and Pratt's, also show the wide-bodied, 4-engine and wide-bodied, 2-engine groups increasing their number of aircraft. The difference lies in the rate at which they increase. The Cell Model shows a much greater increase in wide-bodied, 4-engine aircraft than Pratt. The opposite is true in the case of wide-bodied, 2-engine aircraft. In 1991, the number of wide-bodied, 4-engine aircraft is equal to 425 according to the Cell Model's results against 156 according to Pratt. In this same year, the Cell Model forecasts 122 wide-bodied, 2-engine aircraft against 359 forecasted by Pratt.

Regarding the narrow-bodied, 3-engine aircraft, both forecasts closely agree. They both show a steady decreasing trend in this aircraft group. In 1991, the Cell Model shows 665 narrow-bodied, 3-engine aircraft against 642 shown by Pratt. In the narrow-bodied, 4-engine category,

Table 5.16 Pratt & Whitney Forecasts by Aircraft Group

	1983	1984	1985	1986	1987	1988	1989	1990	1991
WB-4	116	118	118	121	128	136	143	150	156
NB-4	93	54	54	54	54	54	54	54	54
WB-3	270	270	270	270	270	270	270	270	270
NB-3	1059	1017	968	913	861	805	743	679	642
WB-2	80	93	106	127	160	201	242	295	359
NB-2	864	939	1021	1094	1170	1243	1335	1408	1458

-(Only aircraft types considered in the Cell Model runs have been aggregated.)

Pratt shows an initial reduction in number of aircraft in 1983 and then maintains the number constant throughout the entire planning period. The Cell Model reduces the number of narrow-bodied, 4-engine aircraft until 1988 when it phases out this group. In the wide-bodied, 3-engine aircraft category, Pratt shows a constant number, 270, from 1983 to 1991. In this group the Cell Model shows a slight decrease ranging from 282 in 1982 to 237 in 1991.

In summary, no major disagreement is found between the Cell Model's results and Pratt & Whitney forecasts, except for the number of wide-bodied, 4-engine and wide-bodied, 2-engine aircraft. In the case of this latter group, the Cell Model shows again a smaller number of aircraft than other forecasts.

CHAPTER 6.

CONCLUSIONS

The Cell Fleet Planning Model provides an option which is less macro than the Capacity Gap approach which consists in forecasting RPM's and ASM's, and not so micro as the Fleet Assignment and Schedule Evaluation fleet planning techniques. The aggregation of route segments into nine or thirty cells (as done in this study) greatly simplifies the problem in relation to the more micro approaches, and provides more accuracy than the approach of globally forecasting RPM's and ASM's.

From the results obtained for the different cases studied, the Cell Fleet Planning Model appears to be a valid fleet planning tool. The results seem to be reasonable and, in many cases, coincident with other industry and FAA forecasts. The cases studied in this thesis are only a very small portion of the possible scenarios. One of the advantages of this Model is its flexibility in the sense that it allows the analysis of many different cases. Any change in the input data represents a different scenario for the analyst to work with.

Another advantage of the Cell Model is that it allows different levels of detail in the analysis, that is, it can range from a more macroscopic to a more microscopic analysis, and viceversa. This is done by varying the number of cells. The larger the number of cells, the more detailed the analysis becomes. In the present case study, a run was executed for a thirty-cell case to test the Model, and, as described in Section 5.3, different values of ASM's and RPM's were obtained. While a larger number of cells provides a better representation of the system, it involves not only more effort, time, and cost, but also a greater number of assumptions in the inputs. We are then faced with the situation of having a more exact representation of how the system has been structured historically, and a greater uncertainty regarding the input data. This occurs, for example, when the number of cells is increased from nine to thirty as was done is this study. In the end, it is a decision the analyst has to make according to his requirements and available data. If he is confident about the accuracy of his data, a thirty-cell approach can give more reliable results. If not, a nine-cell approach can yield results as good and reliable as the thirty-cell case.

An important assumption is made in the Cell Fleet Planning Model regarding the composition and structure of the cells. It is assumed that the basic composition of the cells and, therefore, the basic structure of the route system, will be projected into the future throughout the entire planning period. A constant growth/reduction rate in the number of passengers and number of segments in each cell is considered for each year. In this case study, this growth/reduction rate is a projection of trends found in the cells for the historical period 1979-1983. Thus, the reliability of the results obtained is related to the accuracy of the above assumption. Further research on the cell forecasting problem would be necessary to verify this assumption. The application of econometric techniques could help in the forecasting of cells.

If indeed the cells retain their basic composition over the next ten years, results obtained for all the cases studied show a need for more narrow-bodied, 2-engine and less wide-bodied, 2-engine aircraft than predicted by the other forecasts mentioned in Section 5.4. The Cell Model has chosen more B737's, B757's, and DC9-80's than B767's and A300's as the optimal aircraft types to fly the route network. Other forecasts show a greater preference for the wide-bodied, 2-engine aircraft than the Cell Model in the cases presented. Further analyses of more scenarios would be necessary to confirm or reject this result.

Large aircraft on long-haul segments and small aircraft on short-haul segments appears to be the optimal allocation of aircraft. Given the freedom to ground aircraft (as done in the nine-cell cases A and C), the model uses only wide-bodied, 4-engine and narrow-bodied, 2-engine aircraft to serve the route network starting in 1986. In this year enough units of the above aircraft types have been acquired by the model to satisfy demand.

The results obtained in the cases studied show that the trend in the route network structure is directed toward shorter stage length segments, hence the need for more narrow-bodied, small-aircraft as opposed to wide-bodied, longer-range aircraft.

Many factors (the economy, politics, marketing factors, etc.) that in reality affect decisions on fleet planning are not considered in the Model thus causing some differences between the Model's results and what in fact occurs. The future inclusion of financial constraints to the Cell Model will, to a certain extent, narrow these differences. These financial constraints will create upper bounds in purchasing capabilities thus avoiding unrealistically large acquisitions of aircraft as seems to be the case in Case A and Case C.

Regarding the computer statistics, for the nine-cell cases (10 years and 31 aircraft types), the average CPU time for each run was 14 min. 5 sec. for a Linear Programming problem of 1201 rows and 4418 columns. For the thirty-cell case (5 years and 31 aircraft types), the average CPU time was 10 min. 16 sec. for 916 rows and 5958 columns.

APPENDIX A.1: HISTORICAL DAILY FREQUENCY FOR SELECTED AIRCRAFT TYPES PER CELL (NINE CELLS)[1]

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[1] In the following tables only the aircraft types considered in the Cell Model runs have been considered.

Daily Frequency = number of flights per day per aircraft type or aircraft group in the given cell on the given year

% of Total Cell Freq. = Percentage of total number of frequencies of that cell flown by each aircraft type or aircraft group on the given year

% of Total Type Freq. = Percentage of the total number of frequencies flown by the given aircraft type on the given year in that cell

Table A.1.1

YEAR: 1979 CELL NO. 1

ATTRIBUTES:
FREQUENCY = 24.3 DISTANCE = 818 MI. SEATS = 3956

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	2	0.2	5.3
B707	33	3.0	6.0
B727-100	104	9.4	5.3
B727-200	388	34.9	9.9
B737-100	79	7.1	11.8
B737-200	61	5.5	6.6
B747	46	4.2	21.5
DC8	4	0.4	5.0
DC8-60,70	17	1.6	7.8
DC9-10	26	2.4	5.9
DC9-30	39	3.6	2.2
DC9-50	54	4.9	11.2
DC10	139	12.5	32.1
L1011	69	6.2	19.6

WB-4	46	4.2
NB-4	54	4.6
WB-3	208	18.7
NB-3	493	44.3
WB-2	2	0.2
NB-2	262	23.5

Table A.1.2

YEAR: 1979 CELL NO. 2

ATTRIBUTES:

FREQUENCY = 15.3 DISTANCE = 533 MI. SEATS = 2079

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	13	0.6	34.2
B707	74	3.4	13.5
B727-100	300	13.6	15.2
B727-200	809	36.6	20.7
B737-100	20	0.9	3.0
B737-200	60	2.7	6.5
B747	19	0.9	9.2
DC8	22	1.0	27.5
DC8-60,70	52	2.4	23.5
DC9-10	81	3.7	18.0
DC9-30	238	10.8	13.4
DC9-50	90	4.1	18.7
DC10	89	4.1	20.7
L1011	110	5.0	31.2
WB-4	19	0.9	
NB-4	148	4.4	
WB-3	200	9.1	
NB-3	1109	50.2	
WB-2	13	0.6	
NB-2	490	22.2	

Table A.1.3

YEAR: 1979 CELL NO. 3

ATTRIBUTES:

FREQUENCY = 0.9 DISTANCE = 4367 MI. SEATS = 223

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	22	16.6	4.1
B747	69	51.5	32.5
B747SP	11	8.6	83.7
DC8-60,70	8	5.9	3.6
DC10	1	1.1	0.3
L1011	5	4.2	1.6
WB-4	80	60.1	
NB-4	30	22.5	
WB-3	6	5.3	
NB-3	0	0.0	
WB-2	0	0.0	
NB-2	0	0.0	

Table A.1.4

YEAR: 1979 CELL NO. 4

ATTRIBUTES:

FREQUENCY = 1.0 DISTANCE = 172 MI. SEATS = 61

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	21	1.1	3.9
B727-100	108	5.5	5.5
B727-200	121	6.1	3.1
B737-100	34	1.7	5.1
B737-200	195	9.9	20.9
B747	4	0.2	2.3
DC8	2	0.1	2.5
DC8-60,70	5	0.3	2.6
DC9-10	50	2.5	11.1
DC9-30	160	8.2	9.1
DC9-50	35	1.8	7.4
DC10	5	0.3	1.2
WB-4	4	0.2	
NB-4	28	1.5	
WB-3	5	0.3	
NB-3	229	11.6	
WB-2	0	0.0	
NB-2	476	24.1	

Table A.1.5

YEAR: 1979 CELL NO. 5

ATTRIBUTES:

FREQUENCY = 1.6 DISTANCE = 890 MI. SEATS = 197

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	5	0.4	13.2
B707	67	5.6	12.4
B727-100	355	29.1	18.0
B727-200	450	36.9	11.5
B737-100	20	1.6	3.0
B737-200	62	5.1	6.7
B747	18	1.5	8.5
B747SP	1	0.1	8.2
DC8	2	0.2	2.5
DC8-60,70	19	1.6	8.8
DC9-10	19	1.6	4.2
DC9-30	154	12.7	8.7
DC9-50	8	0.7	1.7
DC10	10	0.8	2.3
L1011	14	1.1	3.9

WB-4	19	1.6
NB-4	89	7.4
WB-3	24	1.9
NB-3	806	66.0
WB-2	5	0.4
NB-2	244	21.7

Table A.1.6

YEAR: 1979 CELL NO. 6

ATTRIBUTES:
FREQUENCY = 2.9 DISTANCE = 201 MI. SEATS = 223

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	1	0.0	2.6
B707	9	0.3	1.8
B727-100	219	7.5	11.1
B727-200	320	11.0	8.2
B737-100	147	5.0	21.8
B737-200	233	8.0	25.0
B747	5	0.2	2.3
DC9-10	97	3.3	21.6
DC9-30	369	12.7	20.8
DC9-50	76	2.6	15.7
DC10	4	0.1	0.9
L1011	12	0.4	3.4
WB-4	5	0.2	
NB-4	9	0.3	
WB-3	16	0.5	
NB-3	540	18.5	
WB-2	1	0.0	
NB-2	924	31.6	

Table A.1.7

YEAR: 1979 CELL NO. 7

ATTRIBUTES:

FREQUENCY = 5.6 DISTANCE = 341 MI. SEATS = 550

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	8	0.2	21.1
B707	80	2.3	14.7
B727-100	433	12.5	22.0
B727-200	714	20.5	18.2
B737-100	214	6.2	31.7
B737-200	216	6.2	23.2
B747	6	0.2	2.8
DC8	10	0.3	12.5
DC8-60,70	14	0.4	6.6
DC9-10	109	3.1	24.3
DC9-30	527	15.2	29.7
DC9-50	151	4.4	31.3
DC10	15	0.4	3.5
L1011	31	0.9	8.7
WB-4	6	0.2	
NB-4	105	3.0	
WB-3	46	1.3	
NB-3	1147	33.0	
WB-2	8	0.2	
NB-2	1219	35.1	

Table A.1.8

YEAR: 1979   CELL NO. 8

ATTRIBUTES:

FREQUENCY = 8.9   DISTANCE = 646 MI.   SEATS = 1132

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	9	0.3	23.7
B707	111	4.1	20.4
B727-100	350	12.8	17.8
B727-200	970	35.4	24.8
B737-100	159	5.8	23.6
B737-200	103	3.8	11.1
B747	14	0.5	6.8
DC8	9	0.3	11.2
DC8-60,70	62	2.3	28.2
DC9-10	67	2.5	15.0
DC9-30	283	10.4	16.0
DC9-50	67	2.5	14.0
DC10	109	4.0	25.2
L1011	74	2.7	20.9
WB-4	14	0.5	
NB-4	183	6.7	
WB-3	183	6.7	
NB-3	1320	48.2	
WB-2	9	0.3	
NB-2	682	25.0	

Table A.1.9

YEAR: 1979 CELL NO. 9

ATTRIBUTES:

FREQUENCY = 1.6 DISTANCE = 1953 MI. SEATS = 267

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	127	21.4	23.3
B727-100	100	16.8	5.1
B727-200	139	23.4	3.6
B737-200	1	0.1	0.1
B747	30	5.1	14.1
B747SP	1	0.2	8.2
DC8	31	5.2	38.7
DC8-60,70	41	7.0	18.8
DC10	60	10.1	13.9
L1011	37	6.3	10.6

WB-4	30	5.3
NB-4	200	33.6
WB-3	97	16.4
NB-3	239	40.2
WB-2	0	0.0
NB-2	1	0.1

Table A.1.10

YEAR: 1980 CELL NO. 1

ATTRIBUTES:

FREQUENCY = 32.6 DISTANCE = 861 SEATS = 4846

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	2	0.4	2.9
B707	3	0.6	0.8
B727-100	58	11.3	3.8
B727-200	189	36.4	4.7
B737-100	29	5.7	5.0
B747	36	7.0	17.1
DC8-60,70	4	0.8	2.1
DC9-10	16	3.1	3.0
DC9-30	15	3.0	0.8
DC9-50	10	1.9	1.9
DC10	40	7.8	9.5
L1011	26	5.0	7.6

WB-4	36	7.0
NB-4	7	1.4
WB-3	67	12.8
NB-3	248	47.7
WB-2	2	0.4
NB-2	71	13.7

Table A.1.11

YEAR: 1980   CELL NO. 2

ATTRIBUTES:

FREQUENCY = 1.0   DISTANCE = 164 MI.   SEATS = 63

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	7	0.3	1.8
B727-100	81	3.7	5.3
B727-200	115	5.3	2.8
B737-100	38	1.8	6.5
B737-200	228	10.4	22.5
B747	7	0.3	3.5
DC8	1	0.0	14.3
DC8-60,70	4	0.2	2.3
DC9-10	94	4.3	17.7
DC9-30	202	9.2	10.7
DC9-50	52	2.4	9.9
DC10	8	0.4	2.0
L1011	2	0.1	0.6
L1011-500	1	0.0	3.9
WB-4	7	0.3	
NB-4	12	0.5	
WB-3	11	0.5	
NB-3	197	9.0	
WB-2	0	0.0	
NB-2	615	28.1	

Table A.1.12

YEAR: 1980 CELL NO. 3

ATTRIBUTES:

FREQUENCY = 0.9 DISTANCE = 4354 MI. SEATS = 267

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	1	0.4	0.1
B747	84	60.6	39.9
B747SP	16	12.0	63.9
DC8-60,70	8	6.1	4.4
DC10	3	2.2	0.7
L1011	8	5.7	2.3
L1011-500	6	4.5	28.9

WB-4	100	72.6
NB-4	9	6.5
WB-3	17	12.4
NB-3	0	0.0
WB-2	0	0.0
NB-2	0	0.0

Table A.1.13

YEAR: 1980 CELL NO. 4

ATTRIBUTES:

FREQUENCY = 3.1 DISTANCE = 222 MI. SEATS = 252

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	1	0.0	1.4
B707	25	0.8	6.6
B727-100	200	6.2	13.0
B727-200	439	13.7	10.8
B737-100	134	4.2	22.6
B737-200	306	9.6	30.3
B747	2	0.1	0.9
DC8-60,70	1	0.0	0.5
DC9-10	165	5.2	31.0
DC9-30	481	15.0	25.5
DC9-50	122	3.8	22.9
L1011	4	0.1	1.2
WB-4	2	0.1	
NB-4	26	0.8	
WB-3	4	0.1	
NB-3	639	19.9	
WB-2	1	0.0	
NB-2	1209	37.8	

Table A.1.14

YEAR: 1980 CELL NO. 5

ATTRIBUTES:

FREQUENCY = 1.4 DISTANCE = 900 MI. SEATS = 185

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	2	0.2	3.3
B707	54	4.6	14.0
B727-100	294	24.6	19.2
B727-200	465	38.9	11.4
B737-100	36	3.1	6.1
B737-200	56	4.7	5.5
B747	13	1.1	6.3
B747SP	2	0.2	9.8
DC8-60,70	26	2.2	13.8
DC9-10	21	1.8	4.0
DC9-30	160	13.4	8.5
DC9-50	17	1.4	3.2
DC10	18	1.5	4.2
L1011	12	1.0	3.6
L1011-500	2	0.2	9.2
WB-4	15	1.3	
NB-4	81	6.8	
WB-3	32	2.7	
NB-3	760	63.5	
WB-2	2	0.2	
NB-2	292	24.4	

Table A.1.15

YEAR: 1980 CELL NO. 6

ATTRIBUTES:

FREQUENCY = 17.4 DISTANCE = 663 SEATS = 2603

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	24	1.4	35.3
B707	42	2.4	10.9
B727-100	131	7.4	8.5
B727-200	670	37.8	16.5
B737-100	64	3.6	10.8
B737-200	76	4.3	7.5
B747	24	1.4	11.4
B747SP	2	0.1	7.7
DC8	4	0.2	57.1
DC8-60,70	25	1.4	13.3
DC9-10	39	2.2	7.3
DC9-30	174	9.8	9.3
DC9-50	91	5.2	17.2
DC10	165	9.3	38.6
L1011	109	6.1	31.5
L1011-500	2	0.1	9.2

WB-4	26	1.5
NB-4	72	4.0
WB-3	277	15.5
NB-3	801	45.2
WB-2	24	1.4
NB-2	445	25.1

Table A.1.16

YEAR: 1980 CELL NO. 7

ATTRIBUTES:
FREQUENCY = 5.9 DISTANCE = 408 MI. SEATS = 613

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	18	0.5	25.9
B707	102	3.0	26.3
B727-100	334	9.7	21.7
B727-200	876	25.4	21.5
B737-100	211	6.1	35.5
B737-200	207	6.0	20.5
B747	13	0.4	6.4
B747SP	0	0.0	1.1
DC8-60,70	24	0.7	12.9
DC9-10	90	2.6	17.0
DC9-30	436	12.7	23.1
DC9-50	159	4.6	29.9
DC10	36	1.1	8.5
L1011	36	1.0	10.4
L1011-500	7	0.2	34.2
WB-4	13	0.4	
NB-4	127	3.7	
WB-3	79	2.3	
NB-3	1210	35.1	
WB-2	18	0.5	
NB-2	1104	32.0	

Table A.1.17

YEAR: 1980 CELL NO. 8

ATTRIBUTES:

FREQUENCY = 1.7 DISTANCE = 1955 MI. SEATS = 300

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	5	1.0	8.4
B707	81	13.5	21.0
B727-100	89	14.7	5.8
B727-200	185	30.7	4.6
B747	25	4.2	12.0
B747SP	4	0.7	16.4
DC8-60,70	38	6.4	20.1
DC10	87	14.4	20.3
L1011	59	9.8	17.1
L1011-500	3	0.5	14.5

WB-4	29	4.9
NB-4	120	19.9
WB-3	149	24.7
NB-3	274	45.4
WB-2	5	1.0
NB-2	0	0.0

Table A.1.18

YEAR: 1980 CELL NO. 9

ATTRIBUTES:

FREQUENCY = 10.6 DISTANCE = 515 MI. SEATS = 1279

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	15	0.5	22.8
B707	71	2.3	18.4
B727-100	348	11.2	22.7
B727-200	1125	36.2	27.7
B737-100	80	2.6	13.5
B737-200	137	4.4	13.6
B747	5	0.2	2.5
B747SP	0	0.0	1.1
DC8	2	0.1	28.6
DC8-60,70	59	1.9	30.6
DC9-10	106	3.4	20.0
DC9-30	415	13.4	22.0
DC9-50	80	2.6	15.0
DC10	70	2.3	16.3
L1011	89	2.9	25.9
WB-4	5	0.2	
NB-4	132	4.3	
WB-3	160	5.2	
NB-3	1474	47.4	
WB-2	15	0.5	
NB-2	404	26.4	

Table A.1.19

YEAR: 1981   CELL NO. 1

ATTRIBUTES:

FREQUENCY = 32.1   DISTANCE = 533 MI.   SEATS = 4470

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	4	0.4	5.2
B707	7	0.8	3.8
B727-100	73	7.6	5.1
B727-200	314	32.6	7.3
B737-100	58	6.1	11.5
B737-200	95	9.8	6.6
B747	37	3.9	18.0
DC8-60,70	6	0.6	3.1
DC9-10	16	1.7	2.9
DC9-30	70	7.3	3.7
DC9-50	90	9.3	18.0
DC9-80	11	1.1	16.3
DC10	30	3.1	6.6
L1011	32	3.3	8.8
WB-4	37	3.9	
NB-4	13	1.4	
WB-3	62	6.4	
NB-3	388	40.2	
WB-2	4	0.4	
NB-2	342	35.3	

Table A.1.20

YEAR: 1981 CELL NO. 2

ATTRIBUTES:

FREQUENCY = 1.3 DISTANCE = 128 MI. SEATS = 67

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	2	0.1	1.0
B727-100	71	2.4	5.0
B727-200	144	4.9	3.3
B737-100	24	0.8	4.9
B737-200	221	7.5	15.4
B747	2	0.1	1.3
DC8-60,70	1	0.1	1.0
DC9-10	133	4.6	23.0
DC9-30	222	7.6	11.6
DC9-50	57	2.0	11.4
DC9-80	1	0.0	2.1
DC10	2	0.1	0.6
WB-4	2	0.1	
NB-4	4	0.2	
WB-3	2	0.1	
NB-3	216	7.3	
WB-2	0	0.0	
NB-2	660	22.5	

Table A.1.21

YEAR: 1981 CELL NO. 3

ATTRIBUTES:

FREQUENCY = 1.4 DISTANCE = 511 MI. SEATS = 173

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	2	0.2	2.6
B707	20	1.7	9.9
B727-100	120	9.9	8.3
B727-200	263	21.7	6.1
B737-100	48	4.0	9.5
B737-200	270	22.3	18.8
B747	11	1.0	5.7
DC8-60,70	12	1.0	6.6
DC9-10	72	5.9	12.4
DC9-30	249	20.6	13.0
DC9-50	26	2.2	5.2
DC9-80	5	0.5	8.7
DC10	6	0.5	1.4
L1011	15	1.2	4.1
L1011-500	2	0.2	7.1

WB-4	11	1.0
NB-4	33	2.7
WB-3	23	1.9
NB-3	383	31.6
WB-2	2	0.2
NB-2	672	55.5

Table A.1.22

YEAR: 1981 CELL NO. 4

ATTRIBUTES:

FREQUENCY = 4.9 DISTANCE = 297 MI. SEATS = 440

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	12	0.3	15.9
B707	40	1.0	19.7
B727-100	316	7.5	21.9
B727-200	793	18.9	18.3
B737-100	134	3.2	26.3
B737-200	426	10.2	29.7
B747	9	0.2	4.3
DC8-60,70	12	0.3	6.6
DC9-10	216	5.2	37.3
DC9-30	596	14.2	31.1
DC9-50	132	3.2	26.4
DC9-80	20	0.5	30.1
DC10	16	0.4	3.5
L1011	21	0.5	5.7
WB-4	9	0.2	
NB-4	53	1.3	
WB-3	37	0.9	
NB-3	1109	26.4	
WB-2	12	0.3	
NB-2	1526	36.5	

Table A.1.23

YEAR: 1981 CELL NO. 5

ATTRIBUTES:

FREQUENCY = 0.9 DISTANCE = 4342 MI. SEATS = 275

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B747	88	57.0	42.5
B747SP	11	7.2	48.4
DC8-60,70	6	4.4	3.6
DC10	15	10.0	3.4
L1011	8	5.2	2.2
L1011-500	12	8.3	40.0
WB-4	99	64.2	
NB-4	6	4.4	
WB-3	35	23.5	
NB-3	0	0.0	
WB-2	0	0.0	
NB-2	0	0.0	

Table A.1.24

YEAR: 1981 CELL NO. 6

ATTRIBUTES:

FREQUENCY = 16.6 DISTANCE = 661 MI. SEATS = 2297

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	22	0.9	28.8
B707	32	1.4	16.0
B727-100	225	9.5	15.6
B727-200	888	37.6	20.5
B737-100	24	1.0	4.8
B737-200	113	4.8	7.9
B747	18	0.8	9.0
B747SP	2	0.1	8.7
DC8-60,70	77	3.3	40.3
DC9-10	51	2.2	8.9
DC9-30	247	10.5	12.9
DC9-50	50	2.1	10.0
DC9-80	11	0.5	17.2
DC10	165	7.0	36.4
L1011	128	5.4	35.1
L1011-500	2	0.1	6.2
WB-4	20	0.9	
NB-4	109	4.7	
WB-3	296	12.5	
NB-3	1113	47.1	
WB-2	22	0.9	
NB-2	499	21.1	

Table A.1.25

YEAR: 1981 CELL NO. 7

ATTRIBUTES:

FREQUENCY = 1.6 DISTANCE = 1155 MI. SEATS = 231

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	5	0.5	6.8
B707	34	3.4	16.8
B727-100	240	24.1	16.7
B727-200	465	46.5	10.8
B737-100	14	1.4	2.8
B737-200	39	3.9	2.7
B747	13	1.4	6.5
B747SP	6	0.6	26.7
DC8-60,70	17	1.7	9.0
DC9-10	7	0.7	1.2
DC9-30	66	6.7	3.5
DC9-50	17	1.7	3.4
DC9-80	2	0.2	3.0
DC10	30	3.1	6.8
L1011	24	2.4	6.7
L1011-500	3	0.4	11.1
WB-4	19	2.0	
NB-4	51	5.1	
WB-3	58	5.9	
NB-3	705	70.6	
WB-2	5	0.5	
NB-2	146	14.6	

Table A.1.26

YEAR: 1981 CELL NO. 8

ATTRIBUTES:
FREQUENCY = 9.0 DISTANCE = 573 MI. SEATS = 1126

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	29	0.8	38.2
B707	50	1.4	24.5
B727-100	356	9.6	24.7
B727-200	1353	36.4	31.3
B737-100	206	5.5	40.3
B737-200	271	7.3	18.9
B747	10	0.3	4.8
DC8-60,70	38	1.0	20.2
DC9-10	83	2.2	14.3
DC9-30	464	12.5	24.2
DC9-50	128	3.5	25.6
DC9-80	15	0.4	22.5
DC10	115	3.1	25.4
L1011	105	2.8	28.8
L1011-500	8	0.2	24.9
WB-4	10	0.3	
NB-4	89	2.4	
WB-3	228	6.1	
NB-3	1709	46.0	
WB-2	29	0.8	
NB-2	1168	31.4	

Table A.1.27

YEAR: 1981 CELL NO. 9

ATTRIBUTES:

FREQUENCY = 1.3 DISTANCE = 2126 MI. SEATS = 258

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	2	0.6	2.6
B707	17	5.4	8.3
B727-100	38	12.2	2.7
B727-200	100	31.8	2.3
B747	16	5.1	7.8
B747SP	3	1.2	16.1
DC8-60,70	18	5.8	9.6
DC10	73	23.1	16.0
L1011	31	10.0	8.6
L1011-500	3	1.1	10.7

WB-4	19	6.3
NB-4	35	11.2
WB-3	108	34.2
NB-3	139	44.0
WB-2	2	0.6
NB-2	0	0.0

Table A.1.28

YEAR: 1982 CELL NO. 1

ATTRIBUTES:

FREQUENCY = 36.1 DISTANCE = 675 MI. SEATS = 6550

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	3	0.7	2.8
B707	1	0.2	0.9
B727-100	15	3.9	1.4
B727-200	71	17.5	1.8
B737-200	74	18.2	4.9
B747	26	6.3	12.4
DC9-10	2	0.5	0.3
DC9-30	4	1.0	0.2
DC9-50	32	7.8	6.7
DC9-80	38	9.3	13.5
DC10	20	4.9	4.3
L1011	12	3.0	3.4
WB-4	26	6.3	
NB-4	1	0.2	
WB-3	32	7.9	
NB-3	87	21.4	
WB-2	3	0.7	
NB-2	118	36.8	

Table A.1.29

YEAR: 1982 CELL NO. 2

ATTRIBUTES:

FREQUENCY = 1.3 DISTANCE = 173 MI. SEATS = 79

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	6	0.2	5.9
B727-100	85	2.9	7.5
B727-200	223	7.5	5.8
B737-100	26	0.9	4.8
B737-200	355	11.9	23.5
B747	9	0.3	4.5
B747SP	0	0.0	1.2
DC9-10	140	4.7	24.6
DC9-30	332	11.1	14.7
DC9-50	58	1.9	12.1
DC9-80	16	0.5	5.8
DC10	11	0.4	2.6
L1011	3	0.1	0.8
WB-4	9	0.3	
NB-4	6	0.2	
WB-3	14	0.5	
NB-3	309	10.4	
WB-2	0	0.0	
NB-2	929	31.0	

Table A.1.30

YEAR: 1982 CELL NO. 3

ATTRIBUTES:

FREQUENCY = 4.1 DISTANCE = 284 MI. SEATS = 364

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	7	0.2	6.5
B707	24	0.7	21.9
B727-100	223	6.0	19.5
B727-200	575	15.5	14.8
B737-100	85	2.3	15.8
B737-200	420	11.4	27.8
B747	1	0.0	0.5
DC8-60,70	9	0.2	5.8
DC9-10	174	4.7	30.5
DC9-30	670	18.1	29.6
DC9-50	118	3.2	24.7
DC9-80	42	1.1	14.9
DC10	5	0.1	1.1
L1011	5	0.1	1.4
WB-4	1	0.0	
NB-4	33	0.9	
WB-3	10	0.2	
NB-3	698	21.5	
WB-2	7	0.2	
NB-2	1512	40.8	

Table A.1.31

YEAR: 1982 CELL NO. 4

ATTRIBUTES:

FREQUENCY = 7.4 DISTANCE = 501 MI. SEATS = 853

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	24	0.7	22.8
B707	25	0.7	22.0
B727-100	268	7.4	23.5
B727-200	1134	31.2	29.2
B737-100	228	6.3	42.1
B737-200	271	7.5	18.0
B747	4	0.1	2.2
DC8-60,70	31	0.9	20.1
DC9-10	130	3.6	22.8
DC9-30	567	15.6	25.0
DC9-50	78	2.2	16.4
DC9-80	104	2.9	36.7
DC10	55	1.5	12.1
L1011	50	1.4	13.9
L1011-500	5	0.1	17.1

WB-4	4	0.1
NB-4	56	1.6
WB-3	111	3.0
NB-3	1403	38.6
WB-2	24	0.7
NB-2	1380	38.1

Table A.1.32

YEAR: 1982 CELL NO. 5

ATTRIBUTES:

FREQUENCY = 12.7 DISTANCE = 516 MI. SEATS = 1654

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	16	0.7	14.9
B707	17	0.7	15.1
B727-100	170	7.2	15.0
B727-200	725	30.6	18.7
B737-100	91	3.9	16.9
B737-200	166	7.0	11.0
B747	20	0.9	9.6
DC8-60,70	55	2.3	35.3
DC9-10	54	2.3	9.6
DC9-30	319	13.5	14.1
DC9-50	98	4.2	20.6
DC9-80	56	2.4	20.0
DC10	110	4.7	23.9
L1011	98	4.2	27.3
L1011-500	1	0.1	6.0
WB-4	20	0.9	
NB-4	74	3.0	
WB-3	210	9.0	
NB-3	895	37.8	
WB-2	16	0.7	
NB-2	788	33.3	

Table A.1.33

YEAR: 1982 CELL NO. 6

ATTRIBUTES:

FREQUENCY = 1.0 DISTANCE = 4329 MI. SEATS = 305

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B747	84	52.3	40.2
B747SP	12	7.9	54.3
DC8-60,70	5	3.4	3.5
DC10	11	7.2	2.5
L1011	11	7.1	3.2
L1011-500	20	12.7	66.7
WB-4	96	60.2	
NB-4	5	3.4	
WB-3	42	27.0	
NB-3	0	0.0	
WB-2	0	0.0	
NB-2	0	0.0	

Table A.1.34

YEAR: 1982   CELL NO. 7

ATTRIBUTES:

FREQUENCY = 1.4   DISTANCE = 915 MI.   SEATS = 199

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	4	0.3	3.7
B707	23	1.8	20.2
B727-100	204	15.8	17.9
B727-200	508	39.2	13.1
B737-100	34	2.6	6.3
B737-200	114	8.8	7.5
B747	14	1.1	6.9
B747SP	4	0.4	20.7
DC8-60,70	6	0.5	3.8
DC9-10	42	3.3	7.4
DC9-30	217	16.8	9.6
DC9-50	27	2.1	5.8
DC9-80	4	0.3	1.4
DC10	16	1.3	3.7
L1011	33	2.6	9.2
L1011-500	2	0.2	6.5
WB-4	14	1.5	
NB-4	29	2.3	
WB-3	52	4.1	
NB-3	712	55.0	
WB-2	4	0.3	
NB-2	439	33.9	

Table A.1.35

YEAR: 1982 CELL NO. 8

ATTRIBUTES:
FREQUENCY = 1.3 DISTANCE = 1906 MI. SEATS = 264

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	10	2.1	9.3
B707	10	2.1	8.8
B727-100	69	14.8	6.1
B727-200	163	34.8	4.2
B747	24	5.3	11.7
B747SP	1	0.3	6.1
DC8-60,70	23	4.9	14.7
DC10	92	19.7	20.1
L1011	58	12.5	16.3
L1011-500	0	0.2	2.8
WB-4	26	5.6	
NB-4	33	7.0	
WB-3	152	32.4	
NB-3	233	49.0	
WB-2	10	2.1	
NB-2	0	0.0	

Table A.1.36

YEAR: 1982 CELL NO. 9

ATTRIBUTES:

FREQUENCY = 19.1 DISTANCE = 690 MI. SEATS = 3006

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	42	2.9	39.9
B707	6	0.4	5.3
B727-100	103	7.1	9.0
B727-200	484	33.2	12.5
B737-100	76	5.2	14.0
B737-200	110	7.5	7.3
B747	25	1.7	11.9
B747SP	4	0.3	17.7
DC8-60,70	26	1.8	16.8
DC9-10	27	1.9	4.9
DC9-30	152	10.5	6.8
DC9-50	65	4.5	13.7
DC9-80	22	1.5	7.8
DC10	136	9.4	29.7
L1011	88	6.0	24.4
L1011-500	0	0.0	0.9

WB-4	29	2.0
NB-4	32	2.2
WB-3	225	14.4
NB-3	588	40.3
WB-2	42	2.9
NB-2	454	31.1

Table A.1.37

YEAR: 1983 CELL NO. 1

ATTRIBUTES:
FREQUENCY = 32.3 DISTANCE = 376 MI. SEATS = 4302

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	36	3.3	27.4
B707	1	0.1	2.6
B727-100	62	5.7	6.6
B727-200	236	21.5	5.9
B737-100	121	11.1	16.4
B737-200	180	16.5	9.9
B747	18	1.7	9.0
B757	1	0.1	2.0
B767	28	2.6	17.4
DC8-60,70	2	0.2	1.2
DC9-10	26	2.4	4.6
DC9-30	80	7.3	3.5
DC9-50	65	6.0	14.6
DC9-80	45	4.1	11.2
DC10	32	2.9	7.3
L1011	19	1.8	5.1
WB-4	18	1.7	
NB-4	3	0.3	
WB-3	51	4.7	
NB-3	298	27.2	
WB-2	64	5.9	
NB-2	522	47.5	

Table A.1.38

YEAR: 1983 CELL NO. 2

ATTRIBUTES:

FREQUENCY = 1.3 DISTANCE = 173 MI. SEATS = 75

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	1	0.0	1.0
B727-100	67	2.3	7.1
B727-200	249	8.5	6.2
B737-100	13	0.5	1.8
B737-200	360	12.4	19.8
B747	9	0.3	4.6
B747SP	1	0.0	5.0
DC9-10	140	4.8	23.9
DC9-30	242	8.3	10.7
DC9-50	36	1.2	8.0
DC9-80	18	0.6	4.6
DC10	2	0.1	0.6
L1011	3	0.1	0.9

WB-4	10	0.3
NB-4	0	0.0
WB-3	5	0.2
NB-3	316	10.8
WB-2	1	0.0
NB-2	811	27.8

Table A.1.39

YEAR: 1983 CELL NO. 3

ATTRIBUTES:

FREQUENCY = 1.6 DISTANCE = 908 MI. SEATS = 223

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	7	0.6	6.0
B707	5	0.4	14.7
B727-100	142	10.7	15.0
B727-200	542	41.0	13.4
B737-100	37	2.8	5.0
B737-200	133	10.1	7.3
B747	16	1.3	8.2
B747SP	1	0.1	7.5
B757	5	0.4	9.8
B767	5	0.4	3.3
DC8-60,70	4	0.3	2.4
DC9-10	42	3.2	7.3
DC9-30	245	18.5	10.8
DC9-50	29	2.2	6.6
DC9-80	20	1.6	5.2
DC10	17	1.3	4.1
L1011	29	2.3	7.9
L1011-500	1	0.1	6.0
WB-4	17	1.4	
NB-4	9	0.7	
WB-3	47	3.7	
NB-3	684	51.7	
WB-2	12	1.0	
NB-2	514	38.8	

Table A.1.40

YEAR: 1983 CELL NO. 4

ATTRIBUTES:

FREQUENCY = 7.0 DISTANCE = 499 MI. SEATS = 835

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	14	0.4	11.0
B707	9	0.2	23.8
B727-100	277	7.6	29.4
B727-200	1089	29.6	26.9
B737-100	257	7.0	34.6
B737-200	354	9.7	19.4
B747	5	0.1	2.5
B757	8	0.2	15.7
B767	40	1.1	24.8
DC8-60,70	37	1.0	22.5
DC9-10	115	3.1	19.7
DC9-30	587	16.0	25.8
DC9-50	104	2.8	23.2
DC9-80	114	3.1	28.4
DC10	33	0.9	7.7
L1011	70	1.9	18.7
L1011-500	4	0.1	13.9
WB-4	5	0.1	
NB-4	46	1.2	
WB-3	108	2.9	
NB-3	1366	37.2	
WB-2	54	1.5	
NB-2	1541	41.9	

Table A.1.41

YEAR: 1983 CELL NO. 5

ATTRIBUTES:

FREQUENCY = 4.1 DISTANCE = 246 MI. SEATS = 327

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	1	0.0	1.3
B707	9	0.3	25.7
B727-100	123	3.4	13.0
B727-200	430	11.7	10.6
B737-100	96	2.6	13.0
B737-200	424	11.6	23.3
B747	3	0.1	1.5
DC8-60,70	1	0.0	0.6
DC9-10	203	5.5	34.7
DC9-30	604	16.5	26.6
DC9-50	72	2.0	16.1
DC9-80	66	1.8	16.5
DC10	8	0.2	2.0
L1011	2	0.1	0.6
L1011-500	0	0.0	1.5
WB-4	3	0.1	
NB-4	10	0.3	
WB-3	11	0.3	
NB-3	553	15.1	
WB-2	1	0.0	
NB-2	1467	40.0	

Table A.1.42

YEAR: 1983 CELL NO. 6

ATTRIBUTES:

FREQUENCY = 11.9 DISTANCE = 517 MI. SEATS = 1448

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	24	0.9	18.5
B707	1	0.1	4.5
B727-100	127	4.8	13.5
B727-200	780	29.4	19.3
B737-100	147	5.6	19.9
B737-200	254	9.6	13.9
B747	9	0.3	4.5
B757	18	0.7	35.3
B767	32	1.2	20.2
DC8-60,70	43	1.6	26.1
DC9-10	38	1.4	6.5
DC9-30	341	12.9	15.0
DC9-50	94	3.6	21.0
DC9-80	91	3.4	22.6
DC10	81	3.1	18.6
L1011	62	2.4	16.7
L1011-500	4	0.2	13.9

WB-4	9	0.3
NB-4	44	1.7
WB-3	147	5.7
NB-3	907	34.2
WB-2	57	2.1
NB-2	985	37.2

Table A.1.43

YEAR: 1983 CELL NO. 7

ATTRIBUTES:
FREQUENCY = 1.0 DISTANCE = 4321 MI. SEATS = 316

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
B707	1	0.3	1.5
B747	96	58.0	47.3
B747SP	16	9.6	70.0
DC8-60,70	5	3.4	3.5
DC10	15	9.3	3.5
L1011	13	8.2	3.6
L1011-500	6	3.8	21.9
WB-4	112	67.6	
NB-4	6	3.7	
WB-3	34	21.3	
NB-3	0	0.0	
WB-2	0	0.0	
NB-2	0	0.0	

Table A.1.44

YEAR: 1983 CELL NO. 8

ATTRIBUTES:
FREQUENCY = 16.3 DISTANCE = 736 MI. SEATS = 2627

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	34	2.1	25.8
B707	9	0.6	25.7
B727-100	77	4.8	8.2
B727-200	496	31.0	12.3
B737-100	69	4.3	9.3
B737-200	115	7.2	6.3
B747	30	1.9	14.9
B747SP	2	0.1	8.7
B757	17	1.1	33.3
B767	36	2.3	22.6
DC8-60,70	47	3.0	28.9
DC9-10	19	1.2	3.3
DC9-30	165	10.3	7.3
DC9-50	47	3.0	10.5
DC9-80	33	2.1	8.2
DC10	157	9.8	35.9
L1011	117	7.3	31.1
L1011-500	8	0.5	27.9

WB-4	32	2.0
NB-4	57	3.6
WB-3	274	17.6
NB-3	573	35.8
WB-2	70	4.4
NB-2	466	29.2

Table A.1.45

YEAR: 1983 CELL NO. 9

ATTRIBUTES:

FREQUENCY = 1.6 DISTANCE = 1888 MI. SEATS = 291

AIRCRAFT TYPE	DAILY FREQUENCY	% OF TOTAL CELL FREQ.	% OF TOTAL TYPE FREQ.
A300-B	12	2.2	9.1
B707	0	0.1	1.5
B727-100	67	12.4	7.2
B727-200	217	39.7	5.4
B737-200	2	0.4	0.1
B747	15	2.8	7.6
B747SP	2	0.4	8.7
B757	2	0.4	3.9
B767	19	3.5	11.7
DC8-60,70	24	4.5	14.9
DC9-30	6	1.1	0.3
DC9-80	13	2.4	3.3
DC10	88	16.2	20.2
L1011	58	10.6	15.4
L1011-500	4	0.8	14.9

WB-4	17	3.2
NB-4	25	4.6
WB-3	150	27.6
NB-3	284	52.1
WB-2	31	5.7
NB-2	23	4.3

APPENDIX A.2: OAG AIRCRAFT CODES

CODE	JET AIRCRAFT
AB3	AIRBUS INDUSTRIE (ALL SERIES)
B11	BRITISH AEROSPACE (BAC) ONE-ELEVEN (ALL SERIES)
DC8	MCDONNELL DOUGLAS DC8 ALL SERIES 10-50 PASSENGER
DC9	MCDONNELL DOUGLAS DC9 (ALL 10 & 20 SERIES)
D10	MCDONNELL DOUGLAS DC10 (ALL SERIES)
D8S	MCDONNELL DOUGLAS DC8 ALL 60/70 SERIES
D9S	MCDONNELL DOUGLAS DC9-30 & 40 SERIES
D95	MCDONNELL DOUGLAS DC9-50
D98	MCDONNELL DOUGLAS DC9 SUPER 80
F28	FOKKER-VFW F28 FELLOWSHIP (ALL SERIES)
IL6	ILYUSHIN IL62
L10	LOCKHEED L1011 (ALL SERIES)
L15	LOCKHEED L1011-500
TU5	TUPOLEV TU154
YK4	YAKOVLEV YAK 40
707	BOEING 707 PASSENGER (ALL SERIES)
72M	BOEING 727-100 MIXED PASSENGER/FREIGHTER
72S	BOEING 727-200
727	BOEING 727 PASSENGER JET (ALL SERIES)
73M	BOEING 737-200 MIXED PASSENGER/FREIGHTER
73S	BOEING 737-200/200C PASSENGER
737	BOEING 737 PASSENGER JET (ALL SERIES)
74L	BOEING 747 SP
74M	BOEING 747 MIXED PASSENGER/FREIGHTER
747	BOEING 747 PASSENGER JET (ALL SERIES)

CODE	PROPELLER AIRCRAFT
	TURBOPROP — MULTI-ENGINE
AN4	ANTONOV AN24
AN6	ANTONOV AN26
BEC	BEECHCRAFT (ALL SERIES)
CD2	GOVERNMENT AIRCRAFT FACTORIES N22/N24 NOMAD
CS2	CASA (CONSTRUCCIONES AERONAUTICAS S.A.) C212 AVIOCAR
CVR	CONVAIR (ALL SERIES)
DHT	DE HAVILLAND OF CANADA DHC6 TWIN OTTER
DH7	DE HAVILLAND OF CANADA DHC7 DASH-7
EMB	EMBRAER EMB 110 BANDEIRANTE
FK7	FAIRCHILD-HILLER FH227
F27	FOKKER-VFW-FAIRCHILD F27 FRIENDSHIP (ALL SERIES)
GRS	GULFSTREAM AMERICAN (GRUMMAN) GULFSTREAM
HPJ	HANDLEY PAGE JETSTREAM
HS7	BRITISH AEROSPACE (HAWKER SIDDELEY) 748 (ALL SERIES)
IL8	ILYUSHIN IL18
LOE	LOCKHEED ELECTRA L188
LPA	LIGHT PROPELLER AIRCRAFT — TYPE MAY VARY
ND2	NORD AVIATION 262
RV1	ISRAEL AIRCRAFT INDUSTRIES ARAVA 101-8/102
SH3	SHORTS 330
SWM	FAIRCHILD SWEARINGEN METRO
YS1	NIHON (NAMCO) YS11
298	NORD-AVIATION-FRAKES MOHAWK 298
	TURBOPROP — SINGLE-ENGINE
BH2	BELL HELICOPTER (ALL SERIES)
DHB	DE HAVILLAND OF CANADA TURBO BEAVER
LPA	LIGHT PROPELLER AIRCRAFT — TYPE MAY VARY
	PISTON — MULTI-ENGINE
ACD	ROCKWELL AERO COMMANDER (ALL SERIES)
BEC	BEECHCRAFT (ALL SERIES)
BNI	BRITTEN NORMAN ISLANDER
BNT	BRITTEN NORMAN TRISLANDER
CNA	CESSNA (ALL SERIES)
CVR	CONVAIR (ALL SERIES)
DC3	MCDONNELL DOUGLAS DC3/DAKOTA C47
DHH	DE HAVILLAND HERON
DHR	DE HAVILLAND RILEY
GRA	GULFSTREAM AMERICAN (GRUMMAN) ALBATROSS G 111
GRG	GULFSTREAM AMERICAN (GRUMMAN) GOOSE
GRM	GULFSTREAM AMERICAN (GRUMMAN) MALLARD
IL4	ILYUSHIN IL14
LPA	LIGHT PROPELLER AIRCRAFT — TYPE MAY VARY
MR4	MARTIN 404
PAG	PIPER (ALL SERIES)
SA2	SAUNDERS ST 27-ST2
	PISTON — SINGLE-ENGINE
CNA	CESSNA (ALL SERIES)
DHO	DE HAVILLAND OF CANADA OTTER
DHP	DE HAVILLAND OF CANADA BEAVER
LPA	LIGHT PROPELLER AIRCRAFT — TYPE MAY VARY
NDH	AEROSPATIALE DAUPHIN 360 HELICOPTER
PAG	PIPER (ALL SERIES)

Source: Official Airline Guide

APPENDIX A.3: HISTORICAL WEEKLY FREQUENCY FOR ALL AIRCRAFT TYPES PER CELL (NINE CELLS)[1]

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1 In the following tables all aircraft types considered in the OAG database have been considered.

A/C = aircraft type code

FRQ/WK. = number of flights per week per aircraft type in the given cell on the given year

% OF TYPE = Percentage of the total number of frequencies flown by the given aircraft type on the given year in that cell

Table A.3.1

YEAR: 1979

CELL NO. 1

A/C	FRQ/WK.	% OF TYPE
DC8	28	5.0
DC9	187	5.9
D9S	279	2.2
D95	381	11.2
L10	487	19.6
72S	2720	9.9
727	734	5.3
D8S	121	7.8
AB3	14	5.3
737	557	11.8
D10	974	32.1
707	231	6.0
747	324	21.5
B72	35	21.7
73S	430	6.6
D8F	162	35.9
72F	10	20.0
70F	31	17.8
D1F	6	33.3
74F	32	9.9
RFS	36	9.6
LOE	10	4.1
D9F	5	33.3

Table A.3.2 CELL NO. 2

A/C	FRQ/WK.	% OF TYPE
D10	628	20.7
D8F	141	31.3
707	519	13.5
72S	5663	20.7
727	2101	15.2
73S	422	6.5
74F	53	16.5
747	139	9.2
D9S	1669	13.4
D95	633	18.7
RFS	97	25.8
DC9	567	18.0
D8S	364	23.5
AB3	91	34.2
L10	775	31.2
DC8	154	27.5
LOE	15	6.1
70F	33	19.0
B11	127	5.8
737	142	3.0
CVR	239	5.2
DHT	529	13.7
DH7	56	19.0
72F	20	40.0
SH3	244	20.6
D9F	10	66.7
SWM	21	0.7
BE9	5	0.1
DC6	10	100.0

Table A.3.3 CELL NO. 3

A/C	FRQ/WK.	% OF TYPE
747	489	32.5
74L	82	83.7
D8S	56	3.6
74F	65	20.2
L10	40	1.6
707	158	4.1
D1F	6	33.3
D10	10	0.3
BE9	44	1.0

Table A.3.4

CELL NO. 4

A/C	FRQ/WK.	% OF TYPE
B11	335	15.4
D9S	1126	9.1
737	240	5.1
72S	847	3.1
747	34	2.3
LPA	829	100.0
CVR	1935	41.9
727	761	5.5
SWM	766	24.0
73S	1368	20.9
FJF	80	71.4
FKF	234	62.7
LOE	37	15.0
FK7	270	36.8
CNA	193	33.6
D8S	41	2.6
DHT	680	17.6
GRG	246	100.0
YS1	701	50.1
PAF	218	90.1
DC9	351	11.1
BE9	1074	23.5
74F	18	5.6
SH3	84	7.1
D10	35	1.2
BNI	51	15.4
707	151	3.9
ACD	82	100.0
BE1	90	100.0
RFS	49	13.0
HPJ	57	56.4
CN4	133	45.5
D95	251	7.4
PAN	139	30.3
CN2	50	100.0
PAC	35	43.8
PAS	24	100.0
ND2	114	10.7
DHO	11	20.0
298	26	4.8
DHP	13	6.3
MR4	6	100.0
D8F	8	1.8
70F	7	4.0
DC8	14	2.5

Table A.3.5

CELL NO. 5

A/C	FRQ/WK.	% OF TYPE
72S	3155	11.5
727	2490	18.0
707	475	12.4
747	128	8.5
LOE	22	8.9
73S	439	6.7
74L	8	8.2
74F	27	8.4
D9S	1082	8.7
YS1	4	0.3
D8S	136	8.8
DC9	133	4.2
737	141	3.0
D10	70	2.3
L10	98	3.9
B11	13	0.6
70F	14	8.0
D95	56	1.7
B72	7	4.3
AB3	35	13.2
D8F	6	1.3
DC8	14	2.5

Table A.3.6

CELL NO. 6

A/C	FRQ/WK.	% OF TYPE
72S	2246	8.2
D95	534	15.7
ND2	366	34.4
D9S	2589	20.8
DC9	681	21.6
727	1535	11.1
73S	1633	25.0
SWM	1454	45.6
CVR	1441	31.2
FJF	32	28.6
FKF	139	37.3
DHT	956	24.8
B11	859	39.5
SH3	262	22.1
FK7	252	34.4
BE9	2011	44.0
DHP	192	93.7
747	35	2.3
DH7	140	47.6
737	1032	21.8
YS1	489	35.0
L10	84	3.4
CN4	111	38.0
HPJ	23	22.8
CNA	249	43.4
D10	28	0.9
707	68	1.8
PAF	24	9.9
D8F	10	2.2
PAN	272	59.3
BNI	140	42.3
PAC	24	30.0
DHR	82	100.0
RFS	60	16.0
298	174	31.9
DC3	42	17.4
LOE	112	45.5
B72	49	30.4
AB3	7	2.6

Table A.3.7

CELL NO. 7

A/C	FRQ/WK.	% OF TYPE
ND2	227	21.3
BE9	1284	28.1
72S	5000	18.2
727	3035	22.0
73S	1517	23.2
707	566	14.7
B11	532	24.4
D9S	3692	29.7
737	1499	31.7
DC9	766	24.3
DHT	1181	30.6
YS1	204	14.6
L10	217	8.7
D95	1063	31.3
SWM	871	27.3
CVR	615	13.3
D10	105	3.5
RFS	50	13.3
SH3	360	30.4
HPJ	21	20.8
FK7	211	28.8
298	290	53.2
D8S	102	6.6
LOE	29	11.8
D8F	31	6.9
70F	17	9.8
74F	20	6.2
AB3	56	21.1
DC8	70	12.5
DH7	56	19.0
SSC	10	100.0
747	42	2.8
DC3	199	82.6
DHO	33	60.0
PAN	48	10.5
CN4	24	8.2
CNA	132	23.0
B72	28	17.4
BNI	140	42.3
PAC	21	26.2

Table A.3.8

CELL NO. 8

A/C	FRQ/WK.	% OF TYPE
72S	6791	24.8
727	2453	17.8
73S	723	11.1
DC9	472	15.0
D9S	1986	16.0
707	783	20.4
D8S	437	28.2
DHT	516	13.4
CVR	387	8.4
DH7	42	14.3
D95	475	14.0
L10	519	20.9
737	1118	23.6
AB3	63	23.7
DC8	63	11.2
LOE	15	6.1
D10	766	25.2
D8F	76	16.9
B11	310	14.2
70F	24	13.8
RFS	84	22.3
SH3	233	19.7
BE9	156	3.4
ND2	358	33.6
298	55	10.1
72F	10	20.0
74F	31	9.6
747	103	6.8
SWM	74	2.3
B72	14	8.7
DHO	11	20.0
CN4	24	8.2

Table A.3.9 CELL NO. 9

A/C	FRQ/WK.	% OF TYPE
707	895	23.3
L10	263	10.6
72S	978	3.6
D10	422	13.9
74F	76	23.6
D8F	17	3.8
727	701	5.1
D8S	291	18.8
747	212	14.1
DC8	217	38.7
70F	48	27.6
LOE	6	2.4
72F	10	20.0
73S	6	0.1
D1F	6	33.3
74L	8	8.2
B72	28	17.4

Table A.3.10

YEAR: 1980

CELL NO. 1

A/C	FRQ/WK.	% OF TYPE
DC9	112	3.0
D8F	57	11.1
D9S	109	0.8
72F	10	16.7
72S	1328	4.7
727	411	3.8
D10	285	9.5
74F	41	10.9
747	254	17.1
D8S	28	2.1
L10	184	7.6
DH7	36	3.1
EMB	145	11.7
PAG	148	14.2
RFS	113	10.2
SH3	60	2.7
70F	5	3.3
707	21	0.8
737	208	5.0
LOE	5	10.4
D95	70	1.9
AB3	14	2.9

Table A.3.11

CELL NO. 2

A/C	FRQ/WK.	% OF TYPE
B11	244	14.8
D9S	1415	10.7
SH3	311	14.1
DC9	663	17.7
747	52	3.5
BNI	114	100.0
DHT	789	24.7
727	572	5.3
72S	809	2.8
SWM	1529	34.5
CVR	2202	49.6
73S	1596	22.5
D95	368	9.9
LOE	5	10.4
DC3	56	60.2
CNA	435	61.5
PAG	463	44.3
LPA	382	100.0
GRG	270	100.0
RFS	141	12.7
BET	1099	28.9
EMB	383	31.0
74F	24	6.4
YS1	440	62.9
298	28	10.6
D10	59	2.0
707	49	1.8
737	269	6.5
FKF	53	85.5
DH7	62	5.3
D8S	31	2.3
D8F	5	1.0
CN2	50	90.9
DHP	54	26.6
FK7	119	36.7
DC8	7	14.3
DHR	50	29.8
ND2	55	4.7
ACD	18	100.0
L15	6	3.9
BEC	9	47.4
DHH	57	100.0
L10	14	0.6
70F	6	3.9

Table A.3.12 CELL NO. 3

A/C	FRQ/WK.	% OF TYPE
74F	83	22.1
747	593	39.9
D8S	60	4.4
D10	22	0.7
L15	44	28.9
74L	117	63.9
L10	56	2.3
707	4	0.1

Table A.3.13 CELL NO. 4

A/C	FRQ/WK.	% OF TYPE
D95	855	22.9
72S	3075	10.8
D9S	3367	25.5
BET	1707	44.9
SH3	696	31.5
737	940	22.6
707	181	6.6
73S	2146	30.3
SWM	1927	43.5
CVR	1409	31.8
DHT	821	25.7
YS1	219	31.3
727	1401	13.0
B11	544	33.0
RFS	164	14.8
DH6	42	14.3
EMB	290	23.4
DC9	1159	31.0
PAG	220	21.1
DHP	149	73.4
FKF	2	3.2
DH7	350	30.0
CNA	239	33.8
CN2	5	9.1
D8F	16	3.1
DHR	83	49.4
ND2	295	25.0
L10	28	1.2
FK7	51	15.7
70F	9	5.9
298	36	13.6
747	14	0.9
BEC	8	42.1
D8S	7	0.5
AB3	7	1.4

Table A.3.14

CELL NO. 5

A/C	FRQ/WK.	% OF TYPE
72S	3258	11.4
D9S	1124	8.5
727	2062	19.2
73S	392	5.5
707	382	14.0
747	93	6.3
LOE	22	45.8
74L	18	9.8
74F	44	11.7
D8S	186	13.8
L10	87	3.6
D95	119	3.2
D10	126	4.2
B11	14	0.9
DC9	151	4.0
737	256	6.1
L15	14	9.2
70F	14	9.2
AB3	16	3.3

Table A.3.15

CELL NO. 6

A/C	FRQ/WK.	% OF TYPE
D10	1161	38.6
D8F	239	46.7
72S	4696	16.5
727	917	8.5
73S	533	7.5
74F	44	11.7
DC8	28	57.1
DC9	274	7.3
D9S	1222	9.3
D95	642	17.2
L10	764	31.5
D8S	180	13.3
L15	14	9.2
AB3	172	35.3
707	297	10.9
70F	50	32.9
747	169	11.4
CVR	107	2.4
DH6	168	57.1
RFS	160	14.4
737	450	10.8
72F	20	33.3
DC3	26	28.0
BEC	2	10.5
74L	14	7.7
LOE	10	20.8
SWM	25	0.6
DC6	20	100.0
B11	26	1.6

Table A.3.16

CELL NO. 7

A/C	FRQ/WK.	% OF TYPE
BET	729	19.2
B11	669	40.6
D9S	3054	23.1
727	2341	21.7
72S	6135	21.5
73S	1449	20.5
737	1479	35.5
DC9	634	17.0
707	718	26.3
DHT	999	31.3
298	200	75.8
YS1	40	5.7
L10	252	10.4
D95	1115	29.9
D8F	44	8.6
D8S	174	12.9
AB3	126	25.9
DH7	244	20.9
SWM	711	16.0
RFS	213	19.2
CVR	346	7.8
D10	255	8.5
ND2	595	50.5
CNA	9	1.3
FK7	54	16.7
70F	21	13.8
74F	24	6.4
SH3	582	26.3
EMB	414	33.5
74L	2	1.1
747	95	6.4
DHR	35	20.8
DH6	84	28.6
72F	10	16.7
MR4	12	100.0
PAG	214	20.5
DC3	11	11.8
L15	52	34.2

Table A.3.17

CELL NO. 8

A/C	FRQ/WK.	% OF TYPE
L10	414	17.1
72S	1299	4.6
747	178	12.0
D10	611	20.3
74F	72	19.1
727	623	5.8
D8S	271	20.1
AB3	41	8.4
D8F	50	9.8
707	573	21.0
70F	32	21.1
74L	30	16.4
L15	22	14.5
LOE	6	12.5
72F	10	16.7

Table A.3.18

CELL NO. 9

A/C	FRQ/WK.	% OF TYPE
72S	7879	27.7
727	2440	22.7
73S	962	13.6
DC9	747	20.0
D9S	2909	22.0
DHT	586	18.3
CVR	372	8.4
DH7	474	40.7
D95	561	15.0
L10	629	25.9
RFS	318	28.7
D8S	413	30.6
DC8	14	28.6
AB3	111	22.8
D8F	101	19.7
ND2	233	19.8
FKF	7	11.3
D10	492	16.3
707	502	18.4
B11	149	9.1
BET	266	7.0
EMB	5	0.4
SH3	561	25.4
737	562	13.5
70F	15	9.9
72F	10	16.7
SWM	240	5.4
74F	44	11.7
74L	2	1.1
747	37	2.5
FK7	100	30.9
CNA	24	3.4

Table A.3.19

YEAR: 1981

CELL NO. 1

A/C	FRQ/WK.	% OF TYPE
D9S	496	3.7
72S	2203	7.3
737	412	11.5
DC9	118	2.9
D8F	61	13.7
72F	10	25.0
727	515	5.1
D8S	42	3.1
AB3	28	5.2
D10	210	6.6
L10	225	8.8
707	54	3.8
74F	37	8.6
747	261	18.0
DH7	214	8.2
D95	632	18.0
73S	665	6.6
D98	77	16.3
EMB	352	15.7
RFS	110	7.3
SH3	38	1.6
D9F	5	33.3

Table A.3.20

CELL NO. 2

A/C	FRQ/WK.	% OF TYPE
ND2	93	13.1
SH3	639	27.0
B11	255	15.7
LOE	348	66.2
BNI	125	100.0
LPA	1107	93.0
SWM	2755	56.3
CVR	2185	67.9
73S	1548	15.4
D95	401	11.4
DC9	937	23.0
BEC	2168	66.1
CNA	459	72.1
72S	1012	3.3
DHT	909	33.6
GRG	302	100.0
YS1	387	76.6
D9S	1554	11.6
GRS	60	92.3
727	500	5.0
RFS	467	30.8
EMB	811	36.2
D10	19	0.6
74F	14	3.3
737	174	4.9
CS2	248	57.4
747	19	1.3
FKF	55	41.0
ACD	24	100.0
DH7	356	13.7
FJF	49	8.8
PAG	275	64.6
FK7	24	18.6
D8S	13	1.0
DC3	10	100.0
D8F	5	1.1
DHP	119	64.3
707	15	1.0
MR4	43	44.3
LOH	8	16.7
DHR	10	33.3
D98	10	2.1

Table A.3.21 CELL NO. 3

A/C	FRQ/WK.	% OF TYPE
72S	1843	6.1
73S	1891	18.8
747	83	5.7
707	143	9.9
LOE	62	11.8
YS1	20	4.0
727	842	8.3
CVR	82	2.5
D9S	1744	13.0
B11	296	18.2
DC9	504	12.4
73M	7	11.9
LOH	15	31.3
D8S	88	6.6
L10	105	4.1
D95	184	5.2
737	341	9.5
D10	44	1.4
FJF	45	8.1
L15	16	7.1
74F	17	4.0
D8F	4	0.9
LPA	4	0.3
DH7	14	0.5
RFS	30	2.0
AB3	14	2.6
D98	41	8.7

Table A.3.22 CELL NO. 4

A/C	FRQ/WK.	% OF TYPE
B11	766	47.0
72S	5552	18.3
ND2	424	59.6
SH3	865	36.5
D9S	4174	31.1
727	2212	21.9
737	942	26.3
SWM	1553	31.8
DHT	1471	54.4
707	284	19.7
CVR	611	19.0
DH7	1263	48.7
LOH	17	35.4
73S	2984	29.7
73M	42	71.2
DHP	66	35.7
D95	927	26.4
L10	147	5.7
DC9	1518	37.3
RFS	266	17.5
YS1	97	19.2
BEC	1036	31.6
AB3	86	15.9
D10	113	3.5
D8S	89	6.6
FJF	368	66.2
D98	142	30.1
LOE	45	8.6
PAG	151	35.4
EMB	589	26.3
CS2	132	30.6
DHR	20	66.7
FK7	46	35.7
D8F	10	2.2
74F	13	3.0
747	63	4.3
MR4	40	41.2
LPA	79	6.6
CNA	178	27.9
GRS	5	7.7

Table A.3.23 CELL NO. 5

A/C	FRQ/WK.	% OF TYPE
D10	108	3.4
74F	86	20.0
747	617	42.5
D8S	48	3.6
L15	90	40.0
L10	56	2.2
74L	78	48.4

Table A.3.24

CELL NO. 6

A/C	FRQ/WK.	% OF TYPE
D10	1161	36.4
D8F	272	61.1
72S	6218	20.5
727	1576	15.6
73S	792	7.9
737	171	4.8
74F	140	32.6
DC9	362	8.9
D9S	1735	12.9
D95	353	10.0
RFS	356	23.5
D8S	539	40.3
AB3	156	28.8
L10	898	35.1
LOE	10	1.9
L15	14	6.2
707	230	16.0
70F	1	100.0
B11	46	2.8
CVR	146	4.5
DHT	168	6.2
DH7	85	3.3
72F	20	50.0
747	131	9.0
FK7	35	27.1
SH3	271	11.4
SWM	238	4.9
74L	14	8.7
D98	81	17.2
EMB	252	11.2
D9F	10	66.7
FKF	27	20.1
D6F	10	100.0

Table A.3.25 CELL NO. 7

A/C	FRQ/WK.	% OF TYPE
727	1686	16.7
707	241	16.8
72S	3255	10.8
LOE	20	3.8
73S	276	2.7
D10	216	6.8
74L	43	26.7
74F	54	12.6
747	95	6.5
D8S	121	9.0
L10	171	6.7
AB3	37	6.8
D9S	468	3.5
D95	120	3.4
L15	25	11.1
DC9	49	1.2
737	100	2.8
72F	10	25.0
D98	14	3.0

Table A.3.26

CELL NO. 8

A/C	FRQ/WK.	% OF TYPE
72S	9472	31.3
73S	1899	18.9
DC9	583	14.3
727	2496	24.7
737	1442	40.3
707	352	24.5
D8S	271	20.2
D9S	3249	24.2
D10	810	25.4
LOH	8	16.7
RFS	288	19.0
73M	10	16.9
CVR	193	6.0
DH7	662	25.5
D95	899	25.6
L10	736	28.8
D8F	68	15.3
AB3	207	38.2
ND2	195	27.4
DHT	156	5.8
FKF	52	38.8
LOE	35	6.7
74F	15	3.5
B11	266	16.3
D98	106	22.5
BEC	74	2.3
SH3	554	23.4
FJF	94	16.9
EMB	236	10.5
YS1	1	0.2
747	70	4.8
SWM	344	7.0
CS2	52	12.0
72M	10	100.0
L15	56	24.9
MR4	14	14.4
FK7	24	18.6

Table A.3.27

CELL NO. 9

A/C	FRQ/WK.	% OF TYPE
707	119	8.3
72S	704	2.3
747	113	7.8
D10	511	16.0
74F	53	12.4
D8S	128	9.6
L10	221	8.6
727	271	2.7
L15	24	10.7
LOE	6	1.1
D8F	25	5.6
74L	26	16.1
AB3	14	2.6

Table A.3.28 YEAR: 1982

CELL NO. 1

A/C	FRQ/WK.	% OF TYPE
D10	140	4.3
74F	26	5.8
747	182	12.4
DH7	105	4.7
D95	224	6.7
73S	522	4.9
D98	268	13.5
EMB	415	22.1
RFS	142	5.0
SH3	52	1.9
72S	503	1.8
727	111	1.4
D8F	15	3.6
D9F	10	25.0
D9S	28	0.2
L10	87	3.4
707	7	0.9
AB3	21	2.8
DC9	14	0.3

Table A.3.29

CELL NO. 2

A/C	FRQ/WK.	% OF TYPE
B11	347	26.3
D9S	2329	14.7
D95	407	12.1
SH3	364	13.5
72S	1566	5.8
DHT	897	35.3
ACD	208	68.0
BNI	334	92.3
LPA	1532	94.2
737	183	4.8
SWM	2084	50.3
707	47	5.9
CVR	1109	59.6
DC9	984	24.6
RFS	577	20.1
CNA	723	84.9
BEC	1306	54.3
LOE	43	42.6
72M	29	30.9
73S	2486	23.5
73M	123	35.9
727	601	7.5
YS1	45	86.5
DH7	399	17.8
EMB	544	28.9
HS7	163	61.5
D10	83	2.6
74F	24	5.4
DC6	10	100.0
PAG	307	78.1
LOH	59	49.2
73F	3	33.3
DHP	118	100.0
747	67	4.5
D8F	41	9.8
F27	243	64.5
FK7	139	27.9
L10	21	0.8
D6F	10	25.0
D98	115	5.8
GRG	9	100.0
HPJ	40	50.6
F28	65	8.3
DHR	25	33.3
CS2	56	12.8
ND2	24	25.5
MR4	48	41.4
298	24	18.6
74L	2	1.2

Table A.3.30

CELL NO. 3

A/C	FRQ/WK.	% OF TYPE
DHT	622	24.5
SH3	1154	42.7
D9S	4696	29.6
737	599	15.8
72S	4026	14.8
SWM	1731	41.8
73S	2946	27.8
ACD	55	18.0
DC9	1220	30.5
B11	579	43.9
RFS	470	16.4
727	1562	19.5
BEC	960	39.9
CVR	444	23.9
LOH	28	23.3
73M	180	52.5
73F	6	66.7
72M	31	33.0
D95	829	24.7
L10	35	1.4
D8S	63	5.8
DH7	1136	50.8
AB3	49	6.5
D10	35	1.1
D8F	10	2.4
F27	40	10.6
EMB	483	25.7
FK7	212	42.5
F28	410	52.4
D6F	10	25.0
D98	296	14.9
PAG	76	19.3
HPJ	39	49.4
CS2	331	75.7
DHR	50	66.7
707	174	21.9
MR4	54	46.6
ND2	28	29.8
LPA	94	5.8
BNI	14	3.9
747	7	0.5
LOE	5	5.0
298	105	81.4
CNA	17	2.0
HS7	44	16.6

Table A.3.31

CELL NO. 4

A/C	FRQ/WK.	% OF TYPE
DC9	913	22.8
D9S	3969	25.0
72S	7942	29.2
73S	1903	18.0
737	1598	42.1
707	175	22.0
727	1880	23.5
DHT	1006	39.6
CVR	283	15.2
DH7	304	13.6
D8S	220	20.1
D95	548	16.4
RFS	531	18.5
D8F	58	13.8
L10	352	13.9
AB3	171	22.8
B11	270	20.5
D10	390	12.1
F28	228	29.2
SWM	80	1.9
ACD	35	11.4
D98	730	36.7
BEC	115	4.8
SH3	682	25.2
72F	20	25.6
EMB	336	17.9
CS2	45	10.3
747	33	2.2
L15	37	17.1
FK7	98	19.6
MR4	14	12.1
ND2	42	44.7
CNA	112	13.1
F27	10	2.7
74F	3	0.7
BH2	238	100.0
D9F	10	25.0
CWC	4	100.0
BNI	14	3.9
HS7	41	15.5

Table A.3.32

CELL NO. 5

A/C	FRQ/WK.	% OF TYPE
72S	5075	18.7
727	1196	15.0
73S	1168	11.0
LOH	21	17.5
RFS	840	29.3
73M	40	11.7
DC9	384	9.6
D9S	2236	14.1
D95	691	20.6
D8S	387	35.3
L10	690	27.3
D8F	123	29.4
D98	397	20.0
72F	28	35.9
AB3	112	14.9
747	141	9.6
74F	87	19.5
F28	6	0.8
D10	772	23.9
707	120	15.1
737	642	16.9
B11	90	6.8
BEC	25	1.0
DH7	265	11.8
EMB	99	5.3
SH3	453	16.7
DHT	18	0.7
D6F	15	37.5
72M	10	10.6
HS7	17	6.4
FK7	50	10.0
SWM	251	6.1
L15	13	6.0
ACD	8	2.6
PAG	10	2.5
70F	12	54.5
CVR	19	1.0
F27	70	18.6

Table A.3.33 CELL NO. 6

A/C	FRQ/WK.	% OF TYPE
74L	89	54.3
D10	82	2.5
74F	104	23.3
747	592	40.2
D8S	38	3.5
L15	144	66.7
L10	80	3.2
D8F	3	0.7

Table A.3.34 CELL NO. 7

A/C	FRQ/WK.	% OF TYPE
73S	799	7.5
72S	3557	13.1
L10	232	9.2
727	1431	17.9
747	102	6.9
LOE	45	44.6
D10	118	3.7
74F	56	12.6
LOH	12	10.0
YS1	7	13.5
F27	14	3.7
74L	34	20.7
D9S	1523	9.6
D95	193	5.8
D8S	42	3.8
AB3	28	3.7
707	161	20.2
F28	33	4.2
737	238	6.3
RFS	76	2.7
DC9	296	7.4
CVR	5	0.3
D8F	20	4.8
L15	14	6.5
72M	18	19.1
D98	28	1.4

Table A.3.35 CELL NO. 8

A/C	FRQ/WK.	% OF TYPE
72S	1145	4.2
74F	73	16.4
D10	648	20.1
L10	411	16.3
727	487	6.1
AB3	70	9.3
747	173	11.7
D8S	161	14.7
D8F	16	3.8
L15	6	2.8
LOE	8	7.9
707	70	8.8
74L	10	6.1
72M	6	6.4
RFS	2	0.1

Table A.3.36 CELL NO. 9

A/C	FRQ/WK.	% OF TYPE
D10	958	29.7
D8F	133	31.7
72S	3393	12.5
727	723	9.0
73S	771	7.3
74F	73	16.4
D8S	184	16.8
D9S	1070	6.8
L10	617	24.4
AB3	299	39.9
DC9	195	4.9
D95	459	13.7
72F	30	38.5
737	532	14.0
RFS	229	8.0
B11	32	2.4
F28	40	5.1
EMB	5	0.3
D98	155	7.8
D9F	20	50.0
747	176	11.9
D6F	5	12.5
CS2	5	1.1
DH7	28	1.3
74L	29	17.7
70F	10	45.5
707	42	5.3
L15	2	0.9

Table A.3.37 YEAR: 1983

CELL NO. 1

A/C	FRQ/WK.	% OF TYPE
AB3	252	27.4
L10	135	5.1
RFS	383	11.0
72S	1656	5.9
727	435	6.6
73S	1266	9.9
737	853	16.4
D9S	565	3.5
D10	224	7.3
747	129	9.0
DH7	153	6.8
D95	459	14.6
D8S	14	1.2
D98	316	11.2
DC9	188	4.6
EMB	400	16.7
D9F	10	50.0
74F	19	5.4
767	198	17.4
D8F	10	2.5
707	7	2.6
72F	10	8.7
757	7	2.0

Table A.3.38

CELL NO. 2

A/C	FRQ/WK.	% OF TYPE
SH3	434	20.5
DHT	1219	40.2
ACD	169	60.1
BNI	315	93.5
LPA	829	99.3
PAG	808	81.3
SWM	2359	50.0
73S	2524	19.8
CVR	843	40.4
D9S	1698	10.7
DC9	983	23.9
D95	253	8.0
RFS	898	25.9
LOM	5	15.2
CNA	615	71.4
DHB	49	100.0
EMB	572	23.8
72S	1744	6.2
LOH	58	46.8
73M	106	26.6
GRG	25	100.0
D6F	27	48.2
B11	266	17.5
DH7	443	19.8
HS7	90	39.0
BEC	173	90.1
YS1	42	75.0
AB3	9	1.0
747	65	4.6
D8F	30	7.6
FK7	177	28.2
727	472	7.1
737	95	1.8
BE9	1086	41.8
F27	246	51.1
F28	79	13.0
RV1	42	100.0
L10	24	0.9
D10	19	0.6
LOE	35	50.0
74F	16	4.5
DC3	10	17.2
D98	130	4.6
146	10	13.9
CS2	100	27.0
DHR	40	100.0
MR4	30	32.3
HPJ	59	50.4
74L	8	5.0
ND2	82	17.6

Table A.3.39 CELL NO. 3

A/C	FRQ/WK.	% OF TYPE
73S	934	7.3
757	35	9.8
DC9	300	7.3
D9S	1720	10.8
72S	3799	13.4
727	995	15.0
707	39	14.7
LOM	20	60.6
D10	125	4.1
747	117	8.2
LOH	7	5.6
CNA	8	0.9
YS1	14	25.0
F27	12	2.5
D6F	3	5.4
AB3	55	6.0
D95	207	6.6
L10	209	7.9
767	38	3.3
LOE	30	42.9
D98	146	5.2
737	261	5.0
D8S	28	2.4
RFS	52	1.5
74F	34	9.7
CVR	1	0.0
D8F	21	5.3
B11	7	0.5
74L	12	7.5
72M	18	69.2
73M	14	3.5
L15	12	6.0

Table A.3.40 CELL NO. 4

A/C	FRQ/WK.	% OF TYPE
72S	7624	26.9
727	1944	29.4
737	1799	34.6
SWM	169	3.6
73M	14	3.5
73S	2482	19.4
D8S	260	22.5
D9S	4113	25.8
DC9	809	19.7
SH3	416	19.6
SH6	53	19.1
CVR	238	11.4
DH7	430	19.2
D95	730	23.2
AB3	101	11.0
757	56	15.7
RFS	657	18.9
D8F	34	8.7
L10	495	18.7
FK7	194	30.9
D10	236	7.7
L15	28	13.9
F27	12	2.5
DHT	196	6.5
ACD	39	13.9
D98	799	28.4
B11	341	22.5
767	282	24.8
707	63	23.8
F28	245	40.3
BE9	130	5.0
EMB	385	16.0
CS2	63	17.0
D6F	5	8.9
HPJ	12	10.3
72F	35	30.4
747	35	2.5
ND2	107	23.0
MR4	14	15.1
74F	3	0.9
CNA	56	6.5
CWC	4	100.0
70F	10	50.0

Table A.3.41

CELL NO. 5

A/C	FRQ/WK.	% OF TYPE
B11	757	49.9
D9S	4230	26.6
D95	508	16.1
SH3	1000	47.1
737	678	13.0
72S	3011	10.6
D98	464	16.5
SWM	1995	42.3
ACD	65	23.1
DHT	1187	39.2
73S	2970	23.3
RFS	436	12.6
HS7	141	61.0
BE9	1362	52.4
CVR	793	38.0
LOH	44	35.5
73M	237	59.4
D6F	21	37.5
F27	103	21.4
EMB	883	36.8
DC9	1424	34.7
727	863	13.0
DH7	898	40.1
146	62	86.1
ND2	239	51.4
D8F	30	7.6
F28	284	46.7
AB3	12	1.3
D10	61	2.0
L10	16	0.6
FK7	151	24.1
D8S	7	0.6
SH6	113	40.8
D3F	14	100.0
PAG	95	9.6
CS2	154	41.5
HPJ	46	39.3
707	68	25.7
BEC	19	9.9
MR4	49	52.7
DC3	48	82.8
BNI	22	6.5
CNA	98	11.4
72M	2	7.7
747	21	1.5
LOE	5	7.1
L15	3	1.5
LPA	6	0.7

Table A.3.42

CELL NO. 6

A/C	FRQ/WK.	% OF TYPE
DC9	269	6.5
D9S	2390	15.0
RFS	850	24.5
72S	5463	19.3
73S	1779	13.9
737	1034	19.9
727	890	13.5
DHT	413	13.6
EMB	159	6.6
LOH	15	12.1
73M	28	7.0
D95	663	21.0
757	126	35.3
D8S	302	26.1
L10	440	16.7
767	230	20.2
AB3	170	18.5
FK7	105	16.7
PAG	91	9.2
D10	571	18.6
747	64	4.5
74F	49	13.9
B11	119	7.8
D98	638	22.6
DH7	202	9.0
SH3	271	12.8
D8F	68	17.3
72F	15	13.0
CS2	54	14.6
CVR	102	4.9
L15	28	13.9
BH2	423	100.0
SWM	194	4.1
ND2	6	1.3
73F	10	100.0
F27	108	22.5
BE9	19	0.7
ACD	8	2.8
707	12	4.5
CNA	84	9.8
SH6	111	40.1

Table A.3.43 CELL NO. 7

A/C	FRQ/WK.	% OF TYPE
D10	108	3.5
747	674	47.3
D8S	40	3.5
74F	82	23.3
L15	44	21.9
L10	95	3.6
74L	112	70.0
D8F	4	1.0
707	4	1.5

Table A.3.44 CELL NO. 8

A/C	FRQ/WK.	% OF TYPE
DC9	135	3.3
D9S	1160	7.3
72S	3476	12.3
727	540	8.2
73S	805	6.3
737	484	9.3
RFS	189	5.4
D10	1101	35.9
D8F	183	46.6
74F	89	25.3
D95	332	10.5
757	119	33.3
L10	822	31.1
767	257	22.6
D8S	334	28.9
AB3	238	25.8
72F	55	47.8
D98	231	8.2
B11	28	1.8
CVR	112	5.4
DHT	14	0.5
DH7	116	5.2
747	213	14.9
707	68	25.7
ND2	31	6.7
L15	56	27.9
74L	14	8.7
70F	10	50.0
D9F	10	50.0

Table A.3.45 CELL NO. 9

A/C	FRQ/WK.	% OF TYPE
L10	406	15.4
72S	1519	5.4
D10	620	20.2
74F	60	17.0
D8S	172	14.9
727	475	7.2
AB3	84	9.1
757	14	3.9
767	133	11.7
747	108	7.6
L15	30	14.9
LOM	8	24.2
D8F	13	3.3
RFS	8	0.2
D98	93	3.3
707	4	1.5
74L	14	8.7
73S	14	0.1
72M	6	23.1
D9S	42	0.3

APPENDIX B.1: <u>INPUT TABLES</u>

INPUT TABLES FOR THE NINE-CELL CASES

Cases A and B:

AIRCRAFT SELECTION TABLE

AN "X" IN FRONT OF AN AIRCRAFT NAME INDICATES THAT THAT AIRCRAFT IS
TO BE USED IN THIS RUN.

```
X A300-B
X A300-600
X A320
X B150
X B707
X B727-1
X B727-2
X B737-1
X B737-2
X B737-3
X B747
X B747-3
X B747SP
X B757
X B757-2
X B767-2
X B767-3
X B767-XX
X DC8
X DC8-73
X DC9-10
X DC9-30
X DC9-50
X DC9-80
X DC10-10
X DC10-30
X DC10-40
X L1011
X L1011-5
X F100
X TA11
```

TABLE 6

PARAMETERS

NUMBER OF PERIODS USED IN THIS RUN = 5
DISCOUNT RATE = 0.10

	YIELD ESCALATOR (% CHANGE)	COST ESCALATOR (% CHANGE)	FUEL PRICE ($/GALL)
PERIOD 1	0.0	0.0	0.82
PERIOD 2	2.7	2.7	0.78
PERIOD 3	1.4	1.4	0.69
PERIOD 4	5.2	5.2	0.71
PERIOD 5	6.7	6.7	0.76
PERIOD 6	6.9	6.9	0.83
PERIOD 7	6.0	6.0	0.91
PERIOD 8	6.4	6.4	1.01
PERIOD 9	6.1	6.1	1.12
PERIOD 10	6.3	6.3	1.23
PERIOD 11	6.4	6.4	1.36

TABLE 7

AIRCRAFT INPUT DATA

AIRCRAFT TYPE	SEAT CAPAC.	------ COST/NM ------ 0 TO 750NM	751 TO 2000NM	OVER 2000NM	COST/ DEP. ($)	PURCH. PRICE ($ MIL)	YEARS TO DEPREC	AVG AGE
A300-B	267.0	12.88	10.37	7.57	0.0	58.6	16	1.26
A300-600	267.0	12.52	9.85	7.88	0.0	73.5	16	0.0
A320	150.0	6.83	5.62	4.50	0.0	30.4	18	0.0
B150	150.0	6.83	5.62	4.50	0.0	32.7	18	0.0
B707	153.0	11.70	9.35	7.48	0.0	7.3	15	15.61
B727-1	106.1	7.65	6.38	5.10	0.0	8.0	15	15.91
B727-2	149.0	8.02	6.69	5.35	0.0	15.8	15	6.16
B737-1	100.0	5.64	4.72	0.0	0.0	6.0	15	13.18
B737-2	107.0	5.75	4.81	0.0	0.0	18.3	15	5.00
B737-3	125.0	6.34	5.27	0.0	0.0	25.2	15	0.0
B747	423.0	19.83	15.86	12.69	0.0	87.0	16	5.60
B747-3	472.0	0.0	0.0	15.49	0.0	92.0	18	0.0
B747SP	304.0	17.39	13.91	11.13	0.0	72.1	16	3.27
B757	160.0	7.90	6.66	5.33	0.0	40.5	18	0.0
B757-2	190.0	8.45	6.95	5.56	0.0	39.3	18	0.0
B767-2	208.0	10.21	8.26	6.61	0.0	47.7	18	0.0
B767-3	256.0	11.17	9.10	0.0	0.0	51.7	18	0.0
B767-XX	300.0	11.88	9.66	0.0	0.0	57.5	18	0.0
DC8	181.0	13.41	10.72	8.58	0.0	10.5	13	15.48
DC8-73	214.0	11.64	9.31	7.45	0.0	22.5	16	2.0
DC9-10	84.3	5.11	4.62	0.0	0.0	2.3	10	15.17
DC9-30	98.0	5.52	4.82	0.0	0.0	16.5	15	11.24
DC9-50	119.0	6.01	5.03	0.0	0.0	17.8	16	4.27
DC9-80	140.0	6.61	5.50	0.0	0.0	26.6	18	0.6
DC10-10	267.0	14.54	11.63	9.30	0.0	41.0	16	6.84
DC10-30	274.0	15.79	12.63	10.58	0.0	50.0	16	4.95
DC10-40	274.0	16.14	12.91	10.82	0.0	50.0	16	5.54
L1011	302.0	14.01	11.17	8.94	0.0	41.0	16	5.78
L1011-5	246.0	13.23	10.58	9.59	0.0	43.8	16	0.84
F100	98.0	5.30	0.0	0.0	0.0	16.0	18	0.0
TA11	267.0	0.0	0.0	9.50	0.0	77.8	18	0.0

TABLE 9

SYSTEM COSTS

COMMISSIONS AS A PERCENT OF PAX REVENUE = 0

COMMISSIONS AS A PERCENT OF CARGO REVENUE = 0

PASSENGER RESERVATIONS ($/PAX) = 0

FOOD AND BEVERAGE LIABILITY ($/1000 RPM) = 0

CARGO RESERVATIONS, LIABILITY ($/1000 RTM) = 0

OVERHEAD AS A PERCENT OF TOTAL EXPENSE = 50

OTHER REVENUE AS A PERCENT OF PAX REVENUE = 0

TABLE 10

CELL DATA

CELL NUMBER	AVG STAGE LENGTH MILES	NUMBER OF SEG-MENTS	AVG BLOCK TIME HOURS	MIN FREQ	MAX FREQ	PAX YIELD CENTS/ RPM	MAX UTIL HOURS/ DAY	PAX GROWTH %	SEG GROWTH RATE %
1	632	30.6	1.74	0	0	23.7	9.1	2	1
2	647	127.0	1.78	0	0	23.4	9.0	2	-1
3	4345	163.5	8.69	0	0	11.8	14.0	4	0
4	161	2428.4	.76	0	0	32.4	8.0	3	1
5	943	594.7	2.30	0	0	21.4	9.2	4	0
6	545	899.6	1.54	0	0	24.8	9.0	1	-1
7	313	753.8	1.05	0	0	28.1	8.7	-6	3
8	525	320.3	1.48	0	0	25.0	9.0	1	-2
9	1967	330.1	4.27	0	0	17.1	10.3	1	1

TABLE 11

DEMAND FREQUENCY DATA

NUMBER OF INTERVALS = 4

CELL NUMBER	SEATS	FREQ	SEATS	FREQ	SEATS	FREQ	SEATS	FREQ
1	29582	164	29999	206	30280	247	30280	2000
2	15869	88	16249	111	16505	133	16505	2000
3	1728	4	1914	6	1980	7	1980	2000
4	429	6	487	8	513	9	513	2000
5	2286	14	2450	18	2547	21	2547	2000
6	1371	12	1479	15	1540	17	1540	2000
7	2930	26	3138	33	3280	39	3280	2000
8	7838	53	8145	67	8353	80	8353	2000
9	1741	8	1848	10	1893	11	1893	2000

TABLE 12

AIRCRAFT LOAD FACTORS

NUMBER OF CELLS = 9
PAX LOAD FACTORS (%)

AIRCRAFT TYPE	CELL 1	CELL 2	CELL 3	CELL 4	CELL 5	CELL 6	CELL 7	CELL 8	CELL 9
A300-B	61	61	0	0	61	60	60	60	0
A300-600	61	61	0	0	61	60	60	60	0
A320	64	64	0	64	64	64	64	64	0
B150	64	64	0	64	64	64	64	64	0
B707	64	64	0	0	64	64	64	64	64
B727-1	64	64	0	0	64	64	64	64	0
B727-2	64	64	0	0	64	64	64	64	0
B737-1	64	64	0	64	64	64	64	64	0
B737-2	64	64	0	64	64	64	64	64	0
B737-3	64	64	0	64	64	64	64	64	0
B747	0	0	68	0	0	0	0	0	63
B747-3	0	0	68	0	0	0	0	0	63
B747SP	0	0	68	0	0	0	0	0	63
B757	64	64	0	64	64	64	64	64	0
B757-2	64	64	0	64	64	64	64	64	0
B767-2	61	61	0	0	61	60	60	60	0
B767-3	61	61	0	0	61	60	60	60	0
B767-XX	61	61	0	0	61	60	60	60	0
DC8	64	64	0	0	64	64	64	64	64
DC8-73	64	64	0	0	64	64	64	64	64
DC9-10	64	64	0	64	0	64	64	64	0
DC9-30	64	64	0	64	0	64	64	64	0
DC9-50	64	64	0	64	64	64	64	64	0
DC9-80	64	64	0	64	64	64	64	64	0
DC10-10	61	61	0	0	61	60	60	60	63
DC10-30	61	61	68	0	61	60	60	60	63
DC10-40	61	61	0	0	61	60	60	60	0
L1011	61	61	0	0	61	60	60	60	63
L1011-5	61	61	68	0	61	60	60	60	63
F100	64	64	0	64	64	64	64	64	0
TA11	61	61	0	0	61	60	60	60	0

TABLE 13
AIRCRAFT FUEL CONSUMPTION

BASE FUEL CONSUMPTION FOR EACH AIRCRAFT TYPE
ABSOLUTE FUEL CONSUMPTION

AIRCRAFT TYPE	FUEL FACTOR--	CELL 1 1.84	CELL 2 8.42	CELL 3 .78	CELL 4 1.06	CELL 5 2.28	CELL 6 1.13	CELL 7 1.55	CELL 8 1.63	CELL 9 4.16
A300-B	1774	2786	2852	17263	710	3747	2402	1380	2314	7815
A300-600	1774	2786	2852	17263	710	3747	2402	1380	2314	7815
A320	775	1282	1312	0	327	1691	1105	635	1065	3526
B150	775	1282	1312	0	327	1691	1105	635	1065	3526
B707	1530	2172	2223	14931	553	3240	1873	1076	1804	6759
B727-1	1162	1650	1689	0	420	2462	1423	817	1371	5136
B727-2	1253	2054	2103	0	523	2710	1771	1017	1706	5654
B737-1	850	1297	1328	0	330	1935	1118	642	1077	4037
B737-2	815	1272	1302	0	324	1701	1097	630	1057	3547
B737-3	775	1214	1243	0	309	1639	1047	601	1009	3418
B747	3397	0	0	26545	0	5761	0	0	0	12017
B747-3	3993	3993	4088	27454	1017	5958	3444	1978	3317	12428
B747SP	2964	0	0	24314	0	5277	0	0	0	11007
B757	923	1598	1636	0	407	2113	1378	791	1327	4407
B757-2	923	1598	1636	0	407	2113	1378	791	1327	4407
B767-2	1303	2167	2219	0	552	2816	1869	1073	1800	5874
B767-3	1350	2391	2447	0	609	3127	2062	1184	1986	6522
B767-XX	1400	2424	2481	0	617	3189	2090	1200	2013	6652
DC8	1774	2345	2401	16124	597	3499	2022	1162	1948	7300
DC8-73	1774	2104	2154	14465	536	3139	1814	1042	1748	6548
DC9-10	790	1214	1242	0	310	1608	1046	601	1008	3354
DC9-30	834	1282	1312	0	327	1698	1105	635	1065	3542
DC9-50	936	1454	1488	0	370	1913	1254	720	1208	3991
DC9-80	923	1485	1521	0	378	1973	1281	736	1234	4116
DC10-10	2154	3036	3109	0	774	4531	2618	1504	2522	9450
DC10-30	2650	3126	3200	20410	796	4664	2696	1548	2597	9730
DC10-40	2322	3300	3378	19755	841	4287	2845	1634	2741	8943
L1011	2270	3695	3783	22423	941	4866	3186	1830	3069	10151
L1011-5	2280	2699	2763	18492	687	4027	2327	1337	2242	8399
F100	700	1048	1073	0	267	1563	903	519	870	3261
TA11	1300	2180	2232	14991	555	3253	1880	1080	1811	6786

TABLE 14

MINIMUM AND MAXIMUM FLEET COUNT BY TYPE BY YEAR

AIRCRAFT TYPE	AVG AGE	1982 MIN	1983 MIN	1984 MIN	1985 MIN	1986 MIN	1987 MIN	1988 MIN	1989 MIN	1990 MIN	1991 MIN	1992 MIN
A300-B	2	30	30	32	33	33	33	33	31	3	3	1
A300-600	0	0	0	0	0	0	0	0	0	0	0	0
A320	0	0	0	0	0	0	0	0	0	0	0	30
B150	0	0	0	0	0	0	0	0	0	0	0	0
B707	15	74	0	0	0	0	0	0	0	0	0	0
B727-1	17	340	3	3	3	3	0	0	0	0	0	0
B727-2	7	790	813	813	804	789	768	743	712	679	642	642
B737-1	6	15	3	3	3	3	3	3	0	0	0	0
B737-2	7	264	315	356	375	375	374	369	360	349	337	324
B737-3	0	0	0	10	20	30	40	60	80	100	120	140
B747	11	102	103	105	105	105	105	105	105	105	105	105
B747-3	0	0	5	10	20	20	20	20	20	20	20	20
B747SP	5	15	11	11	11	11	11	3	0	0	0	0
B757	0	0	0	0	0	0	0	0	0	0	0	0
B757-2	0	10	10	20	30	40	60	80	100	120	130	140
B767-2	0	20	31	40	50	70	90	100	116	116	116	116
B767-3	0	0	0	0	0	0	0	0	0	0	0	0
B767-XX	0	0	0	0	0	0	0	0	0	0	0	0
DC8	14	44	0	0	0	0	0	0	0	0	0	0
DC8-73	1	20	20	20	20	20	10	0	0	0	0	0
DC9-10	8	3	3	0	0	0	0	0	0	0	0	0
DC9-30	10	317	321	317	311	303	293	281	268	253	238	221
DC9-50	5	55	55	55	55	55	13	13	0	0	0	0
DC9-80	1	43	48	65	75	88	95	110	130	150	175	195
DC10-10	7	117	111	111	111	111	111	111	111	111	111	111
DC10-30	5	23	23	12	12	12	12	12	0	0	0	0
DC10-40	9	22	22	22	22	22	22	22	22	22	22	22
L1011	7	105	104	104	104	104	104	104	104	104	104	104
L1011-5	2	15	15	15	15	15	15	15	15	0	0	0
F100	0	0	0	0	0	0	0	0	0	0	0	0
TA11	0	0	0	0	0	0	0	0	0	0	0	0

AIRCRAFT TYPE	AVG AGE	1982 MAX	1983 MAX	1984 MAX	1985 MAX	1986 MAX	1987 MAX	1988 MAX	1989 MAX	1990 MAX	1991 MAX	1992 MAX
A300-B	2	30	60	90	120	150	180	210	240	270	300	330
A300-600	0	0	0	30	60	90	120	150	180	210	240	270
A320	0	0	0	0	0	0	0	30	60	100	160	110
B150	0	0	0	0	0	0	0	30	60	90	120	150
B707	15	74	74	0	0	0	0	0	0	0	0	0
B727-1	17	340	113	3	3	3	3	3	3	3	3	0
B727-2	7	790	815	815	817	827	937	1157	1187	1407	1482	2592
B737-1	6	15	5	5	5	5	3	3	3	3	3	3
B737-2	7	264	315	450	600	750	900	1050	1200	1350	1500	1600
B737-3	0	0	10	240	380	520	760	900	1200	1400	1600	1700
B747	11	102	240	500	600	700	800	900	1000	1100	1200	1300
B747-3	0	0	5	100	200	300	400	500	600	700	800	850
B747SP	5	15	30	50	70	90	110	130	150	170	190	210
B757	0	0	140	380	520	760	900	1140	1380	1460	1580	1690
B757-2	0	10	140	380	520	760	900	1140	1380	1460	1580	1690
B767-2	0	20	320	600	880	1060	1240	1420	1600	1750	1900	2000
B767-3	0	0	0	0	0	100	200	300	400	500	600	700
B767-XX	0	0	0	0	0	0	0	0	0	0	100	200
DC8	14	44	0	0	0	0	0	0	0	0	0	0
DC8-73	1	20	40	60	80	100	120	140	140	140	140	140
DC9-10	8	3	3	3	0	0	0	0	0	0	0	0
DC9-30	10	317	359	459	539	619	799	879	959	1039	1119	1209
DC9-50	5	55	155	257	357	462	567	672	772	872	972	1072
DC9-80	1	43	200	350	500	750	900	1050	1200	1350	1500	1750
DC10-10	7	117	126	136	151	171	191	191	191	191	191	191
DC10-30	5	23	26	29	31	36	41	46	51	51	51	55
DC10-40	9	22	22	25	30	35	35	40	40	40	40	40
L1011	7	105	105	105	105	105	105	105	105	105	105	105
L1011-5	2	15	15	15	15	15	15	15	15	15	15	15
F100	0	0	0	0	0	0	100	200	300	400	500	600
TA11	0	0	0	0	0	0	0	0	0	0	100	200

UTILIZATION

(BLOCK HOURS PER DAY)

AIRCRAFT	YEAR OF OPERATION 1	2	3	4	5	6	7	8	9	10
A300-B	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
A300-600	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
A320	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B150	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B707	5.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
B727-1	5.0	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
B727-2	5.0	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
B737-1	5.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
B737-2	5.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
B737-3	5.0	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
B747	6.0	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
B747-3	5.0	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
B747SP	7.0	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
B757	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B757-2	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B767-2	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B767-3	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B767-XX	5.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
DC8	5.0	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
DC8-73	5.0	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
DC9-10	5.0	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
DC9-30	5.0	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
DC9-50	5.0	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
DC9-80	5.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
DC10-10	5.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
DC10-30	7.0	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
DC10-40	4.0	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
L1011	5.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
L1011-5	6.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
F100	4.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
TA11	6.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0

AIRCRAFT TYPE	YEAR OF OPERATION 11	12	13	14	15	16	17	18	19	20
A300-B	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
A300-600	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
A320	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B150	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B707	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
B727-1	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
B727-2	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
B737-1	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
B737-2	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
B737-3	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
B747	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
B747-3	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
B747SP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
B757	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B757-2	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B767-2	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B767-3	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
B767-XX	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
DC8	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
DC8-73	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
DC9-10	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
DC9-30	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
DC9-50	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
DC9-80	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
DC10-10	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
DC10-30	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
DC10-40	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
L1011	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
L1011-5	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
F100	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
TA11	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0

Case C:[2]

[2]Only the Maximum and Minimum Fleet Count by Type by Year Table is shown. Other tables are the same as in cases A and B.

TABLE 14

MINIMUM AND MAXIMUM FLEET COUNT BY TYPE BY YEAR

AIRCRAFT TYPE	AVG AGE	1982 MIN	1983 MIN	1984 MIN	1985 MIN	1986 MIN	1987 MIN	1988 MIN	1989 MIN	1990 MIN	1991 MIN	1992 MIN
A300-B	2	30	30	32	33	33	33	33	31	3	3	1
A300-600	0	0	0	0	0	0	0	0	0	0	0	0
A320	0	0	0	0	0	0	0	0	0	0	0	30
B150	0	0	0	0	0	0	0	0	0	0	0	0
B707	15	74	0	0	0	0	0	0	0	0	0	0
B727-1	17	340	3	3	3	3	0	0	0	0	0	0
B727-2	7	790	813	813	750	700	650	600	550	500	450	350
B737-1	6	15	3	3	3	3	3	3	0	0	0	0
B737-2	7	264	315	356	375	375	374	369	360	349	337	324
B737-3	0	0	0	10	20	30	40	60	80	100	100	100
B747	11	102	103	105	105	105	105	105	105	105	105	105
B747-3	0	0	5	10	20	20	20	20	20	20	20	20
B747SP	5	15	11	11	11	11	11	3	0	0	0	0
B757	0	0	0	0	0	0	0	0	0	0	0	0
B757-2	0	10	10	20	30	40	60	80	100	100	100	100
B767-2	0	20	31	40	50	70	90	100	100	100	100	100
B767-3	0	0	0	0	0	0	0	0	0	0	0	0
B767-XX	0	0	0	0	0	0	0	0	0	0	0	0
DC8	14	44	0	0	0	0	0	0	0	0	0	0
DC8-73	1	20	20	20	20	20	10	0	0	0	0	0
DC9-10	8	3	3	0	0	0	0	0	0	0	0	0
DC9-30	10	317	321	317	300	270	240	210	180	150	120	90
DC9-50	5	55	55	55	55	55	13	13	0	0	0	0
DC9-80	1	43	50	65	75	88	95	100	100	100	100	100
DC10-10	7	117	111	111	111	111	111	111	111	111	111	111
DC10-30	5	23	23	12	12	12	12	12	0	0	0	0
DC10-40	9	22	22	22	22	22	22	22	22	22	22	22
L1011	7	105	104	104	100	95	90	85	80	75	70	65
L1011-5	2	15	15	15	15	15	15	15	15	0	0	0
F100	0	0	0	0	0	0	0	0	0	0	0	0
TA11	0	0	0	0	0	0	0	0	0	0	0	0

AIRCRAFT TYPE	AVG AGE	1982 MAX	1983 MAX	1984 MAX	1985 MAX	1986 MAX	1987 MAX	1988 MAX	1989 MAX	1990 MAX	1991 MAX	1992 MAX
A300-B	2	30	60	90	120	150	180	210	240	270	300	330
A300-600	0	0	0	30	60	90	120	150	180	210	240	270
A320	0	0	0	0	0	0	0	30	60	100	160	110
B150	0	0	0	0	0	0	0	30	60	90	120	150
B707	15	74	74	0	0	0	0	0	0	0	0	0
B727-1	17	340	200	100	50	10	3	3	3	3	3	0
B727-2	7	790	815	815	815	815	815	815	815	815	815	815
B737-1	6	15	5	5	5	5	3	3	3	3	3	3
B737-2	7	264	315	450	600	750	900	1050	1200	1350	1500	1600
B737-3	0	0	10	150	350	520	760	900	1200	1400	1600	1700
B747	11	102	250	350	450	550	650	750	850	950	1000	1100
B747-3	0	0	5	100	200	300	400	500	600	700	800	850
B747SP	5	15	30	50	70	90	110	130	150	170	190	210
B757	0	0	0	200	400	600	800	1000	1200	1400	1600	1800
B757-2	0	10	20	220	420	620	820	1020	1220	1420	1620	1820
B767-2	0	20	60	260	460	660	860	1060	1260	1460	1660	1860
B767-3	0	0	0	0	0	100	200	300	400	500	600	700
B767-XX	0	0	0	0	0	0	0	0	0	0	100	200
DC8	14	44	0	0	0	0	0	0	0	0	0	0
DC8-73	1	20	45	60	80	100	120	140	140	140	140	140
DC9-10	8	3	3	3	0	0	0	0	0	0	0	0
DC9-30	10	317	359	400	400	400	400	400	400	400	400	400
DC9-50	5	55	155	257	300	300	300	300	300	300	300	300
DC9-80	1	43	80	280	480	680	880	1080	1280	1480	1680	1880
DC10-10	7	117	126	136	151	171	191	191	191	191	191	191
DC10-30	5	23	26	29	31	36	41	46	51	51	51	55
DC10-40	9	22	22	25	30	35	35	40	40	40	40	40
L1011	7	105	105	105	105	105	105	105	105	105	105	105
L1011-5	2	15	15	15	15	15	15	15	15	15	15	15
F100	0	0	0	0	0	0	100	200	300	400	500	600
TA11	0	0	0	0	0	0	0	0	0	0	100	200

INPUT TABLES FOR THE THIRTY-CELL CASE

TABLE 10

CELL DATA

CELL NUMBER	AVG STAGE LENGTH MILES	NUMBER OF SEG-MENTS	AVG BLOCK TIME HOURS	MIN FREQ	MAX FREQ	PAX YIELD CENTS/ RPM	MAX UTIL HOURS DAY	PAX GROWTH %	SEG GROWTH RATE %
1	5539	22.6	11.08	0	0	12.0	14.5	5	0
2	3952	48.8	7.90	0	0	14.0	14.0	6	-1
3	2813	45.4	6.11	0	0	17.0	12.0	-2	6
4	2051	42.8	4.45	0	0	18.5	10.3	1	0
5	678	23.2	1.87	0	0	25.9	9.0	1	0
6	684	6.8	1.88	0	0	25.8	9.0	4	0
7	76	220.6	0.36	0	0	40.0	7.0	1	5
8	93	257.4	0.44	0	0	38.1	7.2	1	-3
9	231	189.8	1.09	0	0	33.5	8.0	-1	5
10	1641	98.4	3.56	0	0	20.2	10.2	-2	4
11	473	41.4	1.33	0	0	28.5	8.9	0	-3
12	113	166.0	0.53	0	0	37.6	7.4	1	0
13	387	64.6	1.30	0	0	29.6	8.8	1	3
14	354	22.6	1.19	0	0	30.5	8.8	1	0
15	90	21.2	0.42	0	0	38.0	7.2	0	0
16	100	51.4	0.47	0	0	37.8	7.2	1	0
17	225	207.2	1.06	0	0	33.6	8.0	3	3
18	172	233.6	0.81	0	0	35.5	7.9	-1	2
19	242	138.0	1.14	0	0	33.4	8.0	4	2
20	106	83.2	0.50	0	0	37.9	7.2	1	0
21	457	152.0	1.29	0	0	28.7	8.9	-4	2
22	731	132.4	2.01	0	0	25.0	9.1	0	0
23	1598	29.6	3.47	0	0	21.0	10.2	0	0
24	302	101.6	1.01	0	0	31.4	8.7	0	0
25	1672	14.8	3.63	0	0	20.0	10.2	0	0
26	332	91.0	1.11	0	0	31.0	8.7	8	0
27	1079	126.6	2.63	0	0	22.5	9.3	1	-1
28	668	105.8	1.84	0	0	26.0	9.0	-2	4
29	845	60.2	2.06	0	0	24.0	9.2	-3	2
30	1116	82.8	2.72	0	0	22.3	9.0	-4	5

TABLE 11

DEMAND FREQUENCY DATA

NUMBER OF INTERVALS = 4

CELL NUMBER	SEATS	FREQ	SEATS	FREQ	SEATS	FREQ	SEATS	FREQ
1	1583	4	1668	5	1668	6	1668	2000
2	1724	4	1918	6	1987	7	1987	2000
3	1524	4	1722	6	1795	7	1795	2000
4	2456	10	2610	13	2689	15	2689	2000
5	20650	105	21057	132	21332	158	21332	2000
6	34920	201	35304	252	35562	302	35562	2000
7	81	3	93	4	93	5	93	2000
8	222	7	248	9	260	10	260	2000
9	225	3	257	4	257	5	257	2000
10	1095	5	1225	7	1277	8	1277	2000
11	12257	73	12651	92	12920	110	12920	2000
12	477	13	531	17	566	20	566	2000
13	8558	55	8916	69	9164	82	9164	2000
14	13714	97	14117	122	14394	146	14394	2000
15	2518	66	2654	83	2752	99	2752	2000
16	1303	35	1397	44	1465	52	1465	2000
17	1550	12	1689	15	1770	17	1770	2000
18	706	5	821	7	871	8	871	2000
19	2661	20	2902	26	3063	31	3063	2000
20	814	22	886	28	936	33	936	2000
21	757	5	872	7	921	8	921	2000
22	641	4	757	6	804	7	804	2000
23	7934	35	8154	44	8295	52	8295	2000
24	3963	28	4250	36	4445	43	4445	2000
25	14083	52	14352	65	14528	77	14528	2000
26	5632	38	5950	48	6170	57	6170	2000
27	847	5	959	7	1005	8	1005	2000
28	2274	15	2438	19	2538	22	2538	2000
29	5326	31	5558	39	5711	46	5711	2000
30	2779	16	2932	20	3023	23	3023	2000

TABLE 12

AIRCRAFT LOAD FACTORS

NUMBER OF CELLS = 30
PAX LOAD FACTORS (%)

AIRCRAFT TYPE	CELL 1	CELL 2	CELL 3	CELL 4	CELL 5	CELL 6	CELL 7	CELL 8	CELL 9	CELL 10
A300-B	0	0	65	63	61	61	0	0	60	63
A300-600	0	0	65	63	61	61	0	0	60	63
A320	0	0	0	0	64	64	64	64	64	63
B150	0	0	0	0	64	64	64	64	64	63
B707	0	60	62	63	64	64	0	0	64	63
B727-1	0	0	0	0	64	64	0	0	64	63
B727-2	0	0	0	0	64	64	0	0	64	63
B737-1	0	0	0	0	64	64	64	64	64	63
B737-2	0	0	0	0	64	64	64	64	64	63
B737-3	0	0	0	0	64	64	64	64	64	63
B747	68	66	65	63	0	0	0	0	0	63
B747-3	68	66	65	63	0	0	0	0	0	63
B747SP	68	66	65	63	0	0	0	0	0	63
B757	0	0	0	0	64	64	64	64	64	63
B757-2	0	0	0	0	64	64	64	64	64	63
B767-2	0	0	0	0	61	61	0	0	60	63
B767-3	0	0	0	0	61	61	0	0	60	63
B767-XX	0	0	0	0	61	61	0	0	60	63
DC8	0	60	62	63	64	64	0	0	64	63
DC8-73	0	66	65	63	61	61	0	0	60	63
DC9-10	0	0	0	0	64	64	64	64	64	0
DC9-30	0	0	0	0	64	64	64	64	64	0
DC9-50	0	0	0	0	64	64	64	64	64	63
DC9-80	0	0	0	0	64	64	64	64	64	63
DC10-10	0	66	65	63	61	61	0	0	60	63
DC10-30	0	66	65	63	61	61	0	0	60	63
DC10-40	0	66	65	63	61	61	0	0	60	63
L1011	0	66	65	63	61	61	0	0	60	63
L1011-5	0	66	65	63	61	61	0	0	60	63
F100	0	0	0	0	64	64	64	64	64	63
TA11	0	66	65	63	61	61	0	0	60	63

AIRCRAFT TYPE	CELL 11	CELL 12	CELL 13	CELL 14	CELL 15	CELL 16	CELL 17	CELL 18	CELL 19	CELL 20
A300-B	60	0	60	60	0	0	60	0	60	0
A300-600	60	0	60	60	0	0	60	0	60	0
A320	64	64	64	64	64	64	64	64	64	64
B150	64	64	64	64	64	64	64	64	64	64
B707	64	0	64	64	0	0	64	0	64	0
B727-1	64	0	64	64	0	0	64	0	64	0
B727-2	64	0	64	64	0	0	64	0	64	0
B737-1	64	64	64	64	64	64	64	64	64	64
B737-2	64	64	64	64	64	64	64	64	64	64
B737-3	64	64	64	64	64	64	64	64	64	64
B747	0	0	0	0	0	0	0	0	0	0
B747-3	0	0	0	0	0	0	0	0	0	0
B747SP	0	0	0	0	0	0	0	0	0	0
B757	64	64	64	64	64	64	64	64	64	64
B757-2	64	64	64	64	64	64	64	64	64	64
B767-2	60	0	60	60	0	0	60	0	60	0
B767-3	60	0	60	60	0	0	60	0	60	0
B767-XX	60	0	60	60	0	0	60	0	60	0
DC8	64	0	64	64	0	0	64	0	64	0
DC8-73	60	0	60	60	0	0	60	0	60	0
DC9-10	64	64	64	64	64	64	64	64	64	64
DC9-30	64	64	64	64	64	64	64	64	64	64
DC9-50	64	64	64	64	64	64	64	64	64	64
DC9-80	64	64	64	64	64	64	64	64	64	64
DC10-10	60	0	60	60	0	0	60	0	60	0
DC10-30	60	0	60	60	0	0	60	0	60	0
DC10-40	60	0	60	60	0	0	60	0	60	0
L1011	60	0	60	60	0	0	60	0	60	0
L1011-5	60	0	60	60	0	0	60	0	60	0
F100	64	64	64	64	64	64	64	64	64	64
TA11	60	0	60	60	0	0	60	0	60	0

AIRCRAFT TYPE	CELL 21	CELL 22	CELL 23	CELL 24	CELL 25	CELL 26	CELL 27	CELL 28	CELL 29	CELL 30
A300-B	60	61	62	60	63	60	61	61	61	61
A300-600	60	61	62	60	63	60	61	61	61	61
A320	64	64	63	64	63	64	64	64	64	64
B150	64	64	63	64	63	64	64	64	64	64
B707	64	64	63	64	63	64	64	64	64	64
B727-1	64	64	63	64	63	64	64	64	64	64
B727-2	64	64	63	64	63	64	64	64	64	64
B737-1	64	64	63	64	63	64	64	64	64	64
B737-2	64	64	63	64	63	64	64	64	64	64
B737-3	64	64	63	64	63	64	64	64	64	64
B747	0	0	62	0	63	0	0	0	0	0
B747-3	0	0	62	0	63	0	0	0	0	0
B747SP	0	0	62	0	63	0	0	0	0	0
B757	64	64	63	64	63	64	64	64	64	64
B757-2	64	64	63	64	63	64	64	64	64	64
B767-2	60	61	62	60	63	60	61	61	61	61
B767-3	60	61	62	60	63	60	61	61	61	61
B767-XX	60	61	62	60	63	60	61	61	61	61
DC8	64	64	63	64	63	64	64	64	64	64
DC8-73	60	61	62	60	63	60	61	61	61	61
DC9-10	64	64	0	64	0	64	64	64	64	64
DC9-30	64	64	0	64	0	64	64	64	64	64
DC9-50	64	64	63	64	63	64	64	64	64	64
DC9-80	64	64	63	64	63	64	64	64	64	64
DC10-10	60	61	62	60	63	60	61	61	61	61
DC10-30	60	61	62	60	63	60	61	61	61	61
DC10-40	60	61	62	60	63	60	61	61	61	61
L1011	60	61	62	60	63	60	61	61	61	61
L1011-5	60	61	62	60	63	60	61	61	61	61
F100	64	64	63	64	63	64	64	64	64	64
TA11	60	61	62	60	63	60	61	61	61	61

TABLE 13
AIRCRAFT FUEL CONSUMPTION

BASE FUEL CONSUMPTION FOR EACH AIRCRAFT TYPE
ABSOLUTE FUEL CONSUMPTION

AIR-CRAFT TYPE	FUEL FACTOR	CELL 1	CELL 2	CELL 3	CELL 4	CELL 5	CELL 6	CELL 7	CELL 8	CELL 9	CELL 10
A300-B	1774	0	8540	6079	8198	3007	3033	337	412	1024	6560
A300-6	1774	0	8540	6079	8198	3007	3033	337	412	1024	6560
A320	775	0	0	0	3699	1384	1396	155	190	471	2960
B150	775	0	0	0	3699	1384	1396	155	190	471	2960
B707	1530	19037	13582	9668	6272	2344	2364	262	321	798	5018
B727-1	1162	0	0	0	5388	2014	2031	225	276	686	4310
B727-2	1253	0	0	0	5931	2217	2236	248	304	755	4745
B737-1	850	0	0	0	3794	1400	1412	157	192	477	3036
B737-2	815	0	0	0	3721	1373	1385	154	188	468	2977
B737-3	775	0	0	0	3586	1311	1322	147	180	447	2869
B747	3397	34045	24291	17290	11219	4194	4230	0	0	1428	8976
B747-3	3993	34998	24970	17774	11533	4311	4348	0	0	1468	9227
B747SP	2964	31185	22250	15837	10276	3841	3874	0	0	1308	8221
B757	923	0	0	0	4623	1725	1740	193	237	588	3699
B757-2	923	0	0	0	4623	1725	1740	193	237	588	3699
B767-2	1303	0	0	0	6162	2339	2360	262	321	797	4930
B767-3	1350	0	0	0	6801	2565	2587	287	352	874	5441
B767-XX	1400	0	0	0	6936	2600	2623	291	357	886	5550
DC8	1774	20667	14753	10501	6771	2531	2552	283	347	861	5417
DC8-73	1774	18552	13237	9422	6075	2271	2290	254	311	773	4860
DC9-10	790	0	0	0	3519	1310	1322	147	180	446	2815
DC9-30	834	0	0	0	3716	1383	1396	155	190	471	2973
DC9-50	936	0	0	0	4187	1569	1583	176	215	535	3350
DC9-80	923	0	0	0	4318	1603	1617	180	220	546	3455
DC10-10	2154	0	0	0	9914	3713	3745	416	509	1265	7932
DC10-30	2650	26177	18677	13294	10207	3823	3856	428	524	1302	8167
DC10-40	2322	27634	19717	14034	10775	4036	4071	452	553	1374	8622
L1011	2270	28666	20452	14558	10649	3988	4023	447	547	1359	8520
L1011-5	2280	23718	16922	12045	8811	3300	3329	370	453	1124	7050
F100	700	0	0	0	3005	1124	1134	126	154	383	2405
TA11	1300	19110	13635	9705	6296	2353	2373	263	322	801	5037

AIR- CRAFT TYPE	FUEL FACTOR-	CELL 11	CELL 12	CELL 13	CELL 14	CELL 15	CELL 16	CELL 17	CELL 18	CELL 19	CELL 20
A300-B	1774	2097	501	1716	1570	399	443	998	763	1073	470
A300-6	1774	2097	501	1716	1570	399	443	998	763	1073	470
A320	775	965	231	790	722	184	204	459	351	494	216
B150	775	965	231	790	722	184	204	459	351	494	216
B707	1530	1635	390	1338	1223	311	346	778	594	836	367
B727-1	1162	1404	335	1149	1051	267	297	669	511	719	315
B727-2	1253	1546	369	1265	1157	294	327	736	562	791	347
B737-1	850	977	234	799	731	186	206	465	355	500	219
B737-2	815	958	229	784	717	182	202	456	348	490	215
B737-3	775	914	218	748	684	174	193	435	332	468	205
B747	3397	2924	0	2393	2189	0	0	1392	1063	1496	0
B747-3	3993	3006	0	2460	2250	0	0	1431	1093	1538	0
B747SP	2964	2678	0	2192	2005	0	0	1275	974	1370	0
B757	923	1203	287	984	900	229	254	572	437	616	270
B757-2	923	1203	287	984	900	229	254	572	437	616	270
B767-2	1303	1632	390	1335	1221	311	345	776	593	835	366
B767-3	1350	1789	427	1464	1339	340	378	851	651	915	401
B767-XX	1400	1814	433	1484	1357	345	383	863	660	928	406
DC8	1774	1765	421	1444	1320	336	374	840	641	903	396
DC8-73	1774	1584	378	1296	1184	301	336	754	575	810	355
DC9-10	790	914	219	748	684	174	193	435	332	468	205
DC9-30	834	965	231	790	722	184	204	459	351	494	216
DC9-50	936	1095	261	896	819	208	231	521	398	560	245
DC9-80	923	1118	267	915	837	213	236	532	407	572	251
DC10-10	2154	2590	619	2119	1938	492	547	1233	942	1326	581
DC10-30	2650	2667	637	2182	1995	507	563	1269	970	1365	598
DC10-40	2322	2815	672	2303	2106	535	594	1340	1024	1441	631
L1011	2270	2782	665	2276	2082	529	588	1324	1012	1424	624
L1011-5	2280	2302	550	1883	1723	438	487	1095	837	1178	516
F100	700	784	187	642	587	149	166	373	285	401	176
TA11	1300	1641	391	1343	1228	312	347	781	596	839	368

AIRCRAFT TYPE	FUEL FACTOR	CELL 21	CELL 22	CELL 23	CELL 24	CELL 25	CELL 26	CELL 27	CELL 28	CELL 29	CELL 30
A300-B	1774	2027	3242	6388	1339	6683	1472	4313	2962	3378	4461
A300-6	1774	2027	3242	6388	1339	6683	1472	4313	2962	3378	4461
A320	775	933	1492	2882	616	3016	677	1946	1363	1524	2013
B150	775	933	1492	2882	616	3016	677	1946	1363	1524	2013
B707	1530	1580	2527	4886	1044	5113	1147	3299	2309	2584	3412
B727-1	1162	1357	2171	4198	897	4392	986	2834	1984	2220	2931
B727-2	1253	1494	2390	4621	987	4835	1085	3120	2184	2444	3227
B737-1	850	943	1509	2956	624	3093	685	1996	1380	1563	2065
B737-2	815	925	1480	2899	612	3033	672	1958	1353	1533	2025
B737-3	775	883	1413	2794	584	2923	642	1887	1291	1477	1951
B747	3397	2826	4520	8741	1867	9146	2053	5902	4131	4623	6104
B747-3	3993	2905	4647	8986	1919	9402	2110	6067	4247	4752	6275
B747SP	2964	2588	4141	8007	1710	8377	1880	5406	3784	4234	5591
B757	923	1162	1859	3602	768	3769	844	2432	1699	1905	2515
B757-2	923	1162	1859	3602	768	3769	844	2432	1699	1905	2515
B767-2	1303	1577	2522	4801	1042	5023	1145	3242	2305	2539	3353
B767-3	1350	1729	2765	5299	1142	5544	1256	3578	2527	2802	3701
B767-XX	1400	1752	2803	5404	1158	5654	1273	3649	2562	2858	3774
DC8	1774	1706	2728	5275	1127	5520	1238	3561	2493	2790	3683
DC8-73	1774	1531	2448	4733	1011	4953	1111	3195	2237	2503	3304
DC9-10	790	883	1413	2741	583	2868	641	1851	1291	1450	1915
DC9-30	834	932	1492	2895	616	3029	677	1955	1363	1531	2022
DC9-50	936	1058	1692	3262	699	3413	768	2203	1546	1728	2278
DC9-80	923	1081	1729	3364	714	3520	785	2272	1580	1779	2349
DC10-10	2154	2502	3533	7724	1653	8082	1818	5216	3658	4085	5394
DC10-30	2650	2576	3638	7953	1702	8321	1872	5370	3766	4205	5554
DC10-40	2322	2719	3840	8396	1797	8784	1976	5669	3976	4439	5863
L1011	2270	2688	4300	8297	1776	8681	1953	5602	3929	4387	5794
L1011-5	2280	2224	3140	6865	1469	7183	1616	4635	3251	3630	4794
F100	700	758	1212	2341	501	2450	550	1581	1107	1238	1635
TA11	1300	1586	2537	4905	1048	5133	1147	3312	2318	2594	3425

APPENDIX B.2: **SAMPLE OF DETAILED CELL RESULTS**[1]

1 Tables shown are tables no. 5 in the Cell Model's output report

TABLE 5
CELL FLEET PLANNING MODEL

AIRCRAFT ACTIVITY FOR EACH YEAR FOR EACH CELL

1982

CELL NUMBER: 2
ATTRIBUTES (AVERAGE PER SEGMENT PER DAY): 13. FLIGHTS PER DAY 647. MILES 2267. SEATS PER DAY

NUMBER OF ROUTE SEGMENTS IN THIS CELL = 127.
TOTAL PASSENGER VOLUME FOR ALL SEGMENTS IN THIS CELL = 287877.

THE FOLLOWING FIGURES ARE GIVEN FOR ALL SEGMENTS IN THE CELL AND ARE FOR AN AVERAGE DAY

AIRCRAFT TYPE	FREQ (PER DAY)	AVAILABLE SEATS	ASM (MILLIONS)	LOAD FACTOR	BLOCK HOURS	FUEL BURN GALLONS	REVENUES ($ 000,000)	TOTAL COST ($ 000,000)	OPERATING RESULTS ($ 000,000)
A300-B	129.78	34650.	22.419	61.	231.	370119.	3.2	2.1	1.1
A300-600	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
A320	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B150	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B707	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B727-1	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B727-2	648.95	96693.	62.560	64.	1155.	1364735.	9.4	6.7	2.6
B737-1	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B737-2	414.52	44353.	28.697	64.	738.	539700.	4.3	3.0	1.3
B737-3	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B747	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B747-3	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B747SP	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B757	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B757-2	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B767-2	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B767-3	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B767-XX	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC8	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC8-73	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC9-10	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC9-30	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC9-50	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC9-80	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC10-10	201.97	53926.	34.890	61.	360.	627926.	5.0	3.6	1.4
DC10-30	89.36	24485.	15.842	61.	159.	285953.	2.3	1.7	0.5
DC10-40	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
L1011	111.82	33770.	21.849	61.	199.	423018.	3.1	2.0	1.1
L1011-5	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
F100	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
TA11	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
TOTALS	1596.39	287877.	186.256	62.	2842.	3611448.	27.2	19.2	8.1

TABLE 5

CELL FLEET PLANNING MODEL

AIRCRAFT ACTIVITY FOR EACH YEAR FOR EACH CELL

1984

CELL NUMBER: 5

ATTRIBUTES (AVERAGE PER SEGMENT PER DAY): 2. FLIGHTS PER DAY 943. MILES 368. SEATS PER DAY

NUMBER OF ROUTE SEGMENTS IN THIS CELL = 595.

TOTAL PASSENGER VOLUME FOR ALL SEGMENTS IN THIS CELL = 218788.

THE FOLLOWING FIGURES ARE GIVEN FOR ALL SEGMENTS IN THE CELL AND ARE FOR AN AVERAGE DAY

AIRCRAFT TYPE	FREQ (PER DAY)	AVAILABLE SEATS	ASM (MILLIONS)	LOAD FACTOR	BLOCK HOURS	FUEL BURN GALLONS	REVENUES ($ 000,000)	TOTAL COST ($ 000,000)	OPERATING RESULTS ($ 000,000)
A300-B	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
A300-600	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
A320	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B150	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B707	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B727-1	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B727-2	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B737-1	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B737-2	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B737-3	75.63	9454.	8.915	64.	174.	123956.	1.2	0.8	0.4
B747	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B747-3	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B747SP	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B757	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B757-2	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B767-2	133.91	27854.	26.266	61.	308.	377099.	3.5	2.4	1.1
B767-3	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
B767-XX	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC8	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC8-73	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC9-10	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC9-30	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC9-50	411.25	48939.	46.150	64.	946.	786726.	6.4	4.4	2.0
DC9-80	608.70	85217.	80.360	64.	1400.	1200955.	11.2	7.0	4.1
DC10-10	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC10-30	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
DC10-40	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
L1011	156.70	47324.	44.626	61.	360.	762506.	5.9	3.9	2.0
L1011-5	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
F100	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
TA11	0.00	0.	0.000	0.	0.	0.	0.0	0.0	0.0
TOTALS	1386.19	218788.	206.317	63.	3188.	3251241.	28.2	18.5	9.7

APPENDIX C: **COMPUTER STATISTICS**

I. Number of cells = 9

Number of years = 10

Number of aircraft = 31

	Avg. Elapsed Time	Avg. CPU Time	Avg. Cost[1] ($)
Preprocessor	41 s.	18 s.	1.41
SESAME	18 m. 55 s.	13 m. 37 s.	81.45
Postprocessor	36 s.	10 s.	1.42
Total	20 m. 12 s.	14 m. 05 s.	84.28

Number of Rows = 1201

Number of Columns = 4418

[1] All runs were made during M.I.T.'s Information Processing Services "shift 3". This is the late night shift in which costs are 40% of the regular daytime costs.

II. Number of cells = 30

Number of years = 5

Number of aircraft = 31

	Avg. Elapsed Time	Avg. CPU Time	Avg. Cost ($)
Preprocessor	32 s.	13 s.	1.75
SESAME	11 m. 00 s.	9 m. 51 s.	60.41
Postprocessor	46 s.	12 s.	1.80
Total	12 m. 18 s.	10 m. 16 s.	63.96

Number of Rows = 916

Number of Columns = 5958

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