Allocate the Right Aircraft Capacity

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ALLOCATE THE RIGHT AIRCRAFT CAPACITY

Abstract:

Aircraft evaluation and selection is usually governed by the economical approach of aircraft manufacturer companies such as Boeing and Airbus using cost per trip vs. cost per seat matrix. In a point to point airline operating model, airlines are characterized by three factors: demand of passengers, current market fare and distance between cities. In this paper a new approach is examined by using the concept of U curve technique and integer program. The cost element is used as a step function in the program, defining the optimum operating curve of the airline, which is representing by two main parameters: being the cost in terms of USD/ASK, and the number of seats to be defined at optimum solution.

Therefore airlines can position their existing fleet by mapping the actual cost of their aircrafts and their applicable seat configuration on optimum operating curve to assign the right aircraft to the right market segment. In case of airline startup, a fair evaluation and comparison can be derived by mapping the typical cost of the aircraft and the typical seat configuration that is approved from the manufactures on the operating curve of the planed network.

Keywords: U Curve, Operating Curve, Integer Program

1. Background:

Competition between Airbus and Boeing is a result of the two companies' domination of the large jet airliner market since the 1990s, which is itself a consequence of numerous corporate failures and mergers within the global aerospace industry over the years. Airbus began its life as a consortium, whereas Boeing took over its former arch-rival, McDonnell Douglas, in 1997. Other manufacturers, such as Lockheed, Convair in the US and Dornier and Fokker in Europe, have pulled out of the civil aviation market after disappointing sales figures and economical problems, while the collapse of the

Eastern Block and their trade organization Comecon around 1990 has put the former Soviet aircraft industry in a disadvantaged position, even though Antonov, Ilyushin, Sukhoi, Tupolev and Yakovlev still manufacture planes. All this has left Boeing and Airbus in a near-duopoly in the global market for large commercial jets comprising narrow-body aircraft, wide-body aircraft and jumbo jets, even though Embraer has gained market shares with their narrow-body aircraft with the Embraer E-jets series.

In the decade between 1999 and 2008 Airbus received 6,378 orders, while Boeing received 6,140, always fighting for the best commercial figures every year. The competition between the two companies is intense.

1.1 Head to Head – Airbus vs Boeing

Actually on the surface, the battle between the two aircraft manufacturers appears to be the A380 versus the 787 – or size versus efficiency. Airbus, however paints the battle as the A380 plus the A330 plus the A321 versus the 787 and the rest of Boeing product line, adding the dimension of operating economics. As airlines continue to recover and evaluate their future fleet needs they will face a choice between the two competing visions or strategies.

The philosophy of Airbus is based on consolidation Fig(1) i.e Hub to Hub operation while Boeing philosophy based on fragments Fig(2) i.e Point to Point operation, both strategies leads to support their new products.

Thus, Boeing Company and Airbus Industries, the competition between them is still very high, each one has its own philosophy and approaches in addressing the aviation markets, hence most of airlines are relay to their judgment, and solutions, of course some consultancy companies may offer some traditional solutions which are not far from of those solution, while airlines of third world countries don’t have any solution except to accept the traditional approaches of the major manufacturers.

1.2 The Traditional Approach:

The traditional approach for selection and evaluation aircrafts is developed by the Relative Cost Matrix (Cost per Trip and Cost per Seat Matrix), where a four regions indicate the four possibilities that positioning the fleet concerning the study for the Aircraft of the origin (Study). That analysis is always governed by the two major aircraft manufacturers in the world as Airbus Industries and Boeing Group Companies which actually is a matter of products marketing, they use all the marketing tools and efficient people to convince their customers. They develop their own cost matrix, based on their successful stories, indeed the competitive is very fierce, which arise between A230 Family and B737 NG.

Airbus Industries announced, that their aircrafts used the technology of Fly By Wire since they manufactured A320, which their competitors lack to have this technology as shown in Fig (3) Airbus Cost Matrix, indicate the Gap of Technology with same range Boeing B737 NG, declaring that their Aircrafts are the Best.

While Boeing Group plays on the reliability factors of the B737 classic types, which have a stable and reliable Learning Curve for more than 40 years, based on that a B737NG is developed declaring that their aircrafts are the best as shown in Fig (4). From above Statements and Relative Cost Matrixes, the situation is contrary, airlines are not in position to argue the manufacturers expertise of both Airbus and Boeing Companies. Also they are not willing to accept such situation.

2. The Research Problem:

The problem comes out by the manufacturers themselves, the general and classical aircraft evaluation method is Cost per Trip and Cost per Seat Matrix, for specified stage lengths (500 nm), each manufacturer developed its own matrix, which is unreasonable for the same input of the airlines, as it is indicated by Fig(3) and Fig(4), the contradiction is obviously between them for evaluation of the commercial aircraft for the same stage length (Distance Range) , for the same aircraft types and that is not accepted by airlines. Hence either Boeing is Right and own the best aircraft or Airbus is Right, **both are not Right**

3. The Methodology:

In the airline industry there are two network operating models named:

3.1 Point To Point Operating Model

3.2 Multi Stops Operating Model (Hub and Spoke, Hub to Hub)

We will address the first model **point to point operating model** – based on cost minimization objective, the research basically is build on three techniques and approaches as shown in the Fig (5).

3.1.1 U curve technique

3.1.2 Integer Program – Solver

3.1.3 Optimum Operating Curve

3.1.1 - **U Curve Technique**

The concept of this technique is based on two main costs: the first one is cost of offering services, the second will be cost of losing opportunity, the study will use the cost of offering seats, while the second cost will be of cost losing revenue due to unavailability of seats. The minimum out come points of these costs represents the best seat capacity to select. Similar situation can be solved by this technique, defining the best level preventive maintenance, deciding the right number of engine in stock, defining the right number of labor in a shift. The final outcome curve takes the shape of the letter U as shown in Fig (6).

3.1.2 - **Integer Program – Solver:**

Solver is the main tool used to solve U curve technique, based on the input of the airline, (Passengers, Market Fare, and Distance between routes), it is the soft version of Linear Program in Excel format. Solver can target three objectives:

1- Minimization Cost or the Errors

2- Maximization Profit or Revenue.

3- Designing the Required Budget.

This research is addressing the first objective (minimizing the cost) using the concept of U curve techniques.

While Profit analysis is addressing the second objective using the model of Multi Stops Operation.

3.1.3 - **Optimum Operating Curve:**

This curve is developed based on a number of solved trails of U curve technique using the cost as step function to get the right capacity at various values of cost.

Finally a curve is developed and different types of aircraft are positioned on the graph in terms of typical seat configuration and typical manufacture cost of ATK of the aircraft. It is a very useful tool to hold a benchmarking study as shown in Fig (7).

3.2 Theoretical Model

3.2.1 Linear Programming

Linear Programming had its beginnings in the input-output method of analysis developed by the economist W. W. leonteif. The present-day version is of more recent origin. Hitchcock first interpreted a "transportation type problem" in 1941, while koopmans studied the same topic in 1974. In 1945, Stigler studied the "diet problem" (concentrated with separate entities that can be selected and used in diversified quantities by choosing, combining, or mixing them with the purpose of obtaining an expected result). The current state of the art is attributed to Dr. Gorege D. Dantzig, a mathematician who introduced his "simplex method" as a systemic procedure for solving a linear programming problem.

During 1947, George Dantzig (with Marshall Wood and their associates) was involved in a project for the United States Air Force which resulted in the search for a technique capable of solving military planning problems. The essence of the research lay in viewing interrelations between activities of a large organization as a linear programming model and determining the optimizing program by minimizing a linear objective function. Dantzig indicated that this new approach could be widely applied to business problem, as is evident today.

Linear optimization models are characterized by linear mathematical expressions. In addition, they are usually deterministic in nature; that is, they do not take account of risk and uncertainty. The parameters of the model are assumed to be known with certainty.

So linear programming is a considerable field of optimization for several reasons. Many practical problems in operations research can be expressed as linear programming problems. Certain special cases of linear programming, such as *network flow* problems and *multicommodity flow* problems are considered important enough to have generated much research on specialized algorithms for their solution. A number of algorithms for other types of optimization problems work by solving LP problems as sub-problems. Historically, ideas from linear programming have inspired many of the central concepts of optimization theory, such as *duality*, *decomposition*, and the importance of *convexity* and its generalizations. Likewise, linear programming is heavily used in microeconomics and company management, such as planning, production, transportation, technology and other issues. Although the modern management issues are ever-changing, most companies would like to maximize profits or minimize costs with limited resources.

3.2.2 MATHEMATICAL MODEL

If the Thumb is characterize by 32 characters, and the Eye characterize by 520 characters, what are the characteristics of an airline, There is a relationship between, Capacity, Frequency, Passengers, Fares, Distance, and Cost, so any airline can be define by, Demand of Passengers, Market Fare, Distance between cities and applicable cost. The relation can be illustrated by the following equation:

$$\begin{pmatrix} \text{Right Capacity}, \\ \text{Optimum Frequency} \end{pmatrix} = f \begin{pmatrix} \text{Pax, Fare}, \\ \text{Distance, } \underline{\text{Cost}_{\text{Define}}} \end{pmatrix} \text{------} (1)$$

And that can be represented by Linear Program problem.

Objective: *Minimize*

Sum of Total Cost = Sum of Offering Service Cost

+ Sum of Losing Opportunity Cost

$$\text{Cost of Offereing Seat (at k Capacity) for Sector ij}$$
$$= \text{Cost of ATK} \times \text{ATK}$$
$$\text{ATK}_{ij} \times \text{C} = 0.09 \times f_{ij} \times D_{ij} \times S_{ij} \times \text{C}$$

$$\text{Cost of Losing Opportunity} = \text{Market Revenue Opportunity at ij sector -}$$
$$= \left[P_{ij} - \left(f_{ij} \times S_{ij} \right) \right] \times F_{ij}$$

$$\text{Sum Of Total Cost} = \sum_{k=10}^{300} \sum_{ij=1}^{n} \left(\left[P_{ij} - \left(f_{ij} \times S_{ijk} \right) \right] \times F_{ij} \right) + \sum_{k=10}^{300} \sum_{ij=1}^{n} \left(0.09 \times f_{ij} \times D_{ij} \times S_{ijk} \times \text{C} \right)$$

Subjected to

$f_{ij} > 0$, integer

Where:

P_{ij} = Number of Passengers from (I) city to (j) city.

F_{ij} = Fares in USD from (i) city to (j) city.

D_{ij} = Distance in Km from (i) city to (j) city.

S_{ijk} = Number of Available Seat at for sector (ij) at k levels (10 - 300)

C = Cost in USD per Available tone kilometers (ATK).

f = Number of Frequencies

K = Seat levels at step of 10 from (10 -300)

N = Number of operating sectors (point to point)

0.09 = Conversion used for Passengers to Tonnes (Weight)

4. The Program:

Spread Sheet is developed, including input data in terms of passengers, market fare, and distance, the program is developed based on equation (1), and solver is setup, with constrained mentioned in the mathematical model, the program will evaluate the network based 100% load factor, i.e maximum capacity of the aircraft, this will lead to good comparison of the results to select the right capacity as shown in Flowchart (1).

While in real cases, we can assign a new constrains that reflects the actual load of the airline, and will force the program to increase the number of frequency and by trail and errors, it might be the cost applied coincided with the existing aircraft seat configuration. i.e once we know the right capacity, we have to run the program again with a new constrains to get the optimum frequency at that level of capacity. But the best procedure is to create a sequence of trail solutions by using the cost element as step function, to reflect the optimum operating curve of the airline as in it is shown in Fig (7).

5. Case Study:

Felix airways domestic network is considered and Spread Sheet is develop, including input data in terms of passengers, market fare, and distance, the program is developed based on equation (1).

5.1 Data Collection:

The input data can be taken on weekly, monthly, and quarterly or annually bases. Four month data – are used in Felix airways research to derive the optimum operating curve as in table (2). While the cost of ASK for low cost carriers fleets used in this study as benchmarking is shown in table (1).

5.2 **Program Implementation:** Using all the previous steps, the operating curve of Felix is developed as shown in Fig (8) The input data can be taken on weekly, monthly, quarterly or annually basis. So Felix airways can position its fleet according to the results of this curve but as they are in a lunching phase, the cost element of its fleets is not available. The other world wide low cost carries are fitted fairly on the operating curve as Air Asia, Air Arabia, Ryan Air and Jet Blue, it can also position any aircraft having seat configuration less than 300 seats to reflect the typical cost per ASK.

5.3 Results:

The optimum operating curve of domestic network of Felix Airways, represents the best picture of the typical seat configuration with respect to the required cost to achieved in Cost per ASK. It is reflecting all the characteristics of the domestic market in terms of Passengers, Fares, and Distance.

6. Conclusions:

By this method only three factors can define an airline, which is actually fair enough to hold the right decision to select the right capacity of aircraft without the interference and pressure of the aircraft manufacturers, so each airline in the world has its own optimum operating curve, that never coincided with another airline, and it is the only picture that is painted by the airline figures i.e passengers, fares and distance.

In fact, it positions and defines the leaders in aviation industry, in a fair mathematical way that derives the best economical results. Actually it is the hidden fingerprint to identify an airline.

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Tables:

Table 1.

Comparison of Cost/ASK

Source: Air Arabia Report

Company	Cost / ASK (AED - Fils)
Air Asia	11.2
Air Arabia	13.6
Ryan Air	16.8
Jet Blue	19.1
South West	20.8
Vigin Blue	31.3
WestJet	29.2
GOL	29.8
EasyJet	25.9
Vueling Airlines SA	27.9
UAL Corp (US)	27.6
North West Airlines (Corp)	27.3
LCC Median	**26.6**
Cathy	29.6
Emirates	25.2
SIA	30.8
Qantas	49.5
Air France - KLM	47.0
British Airways	38.0

Table 2.

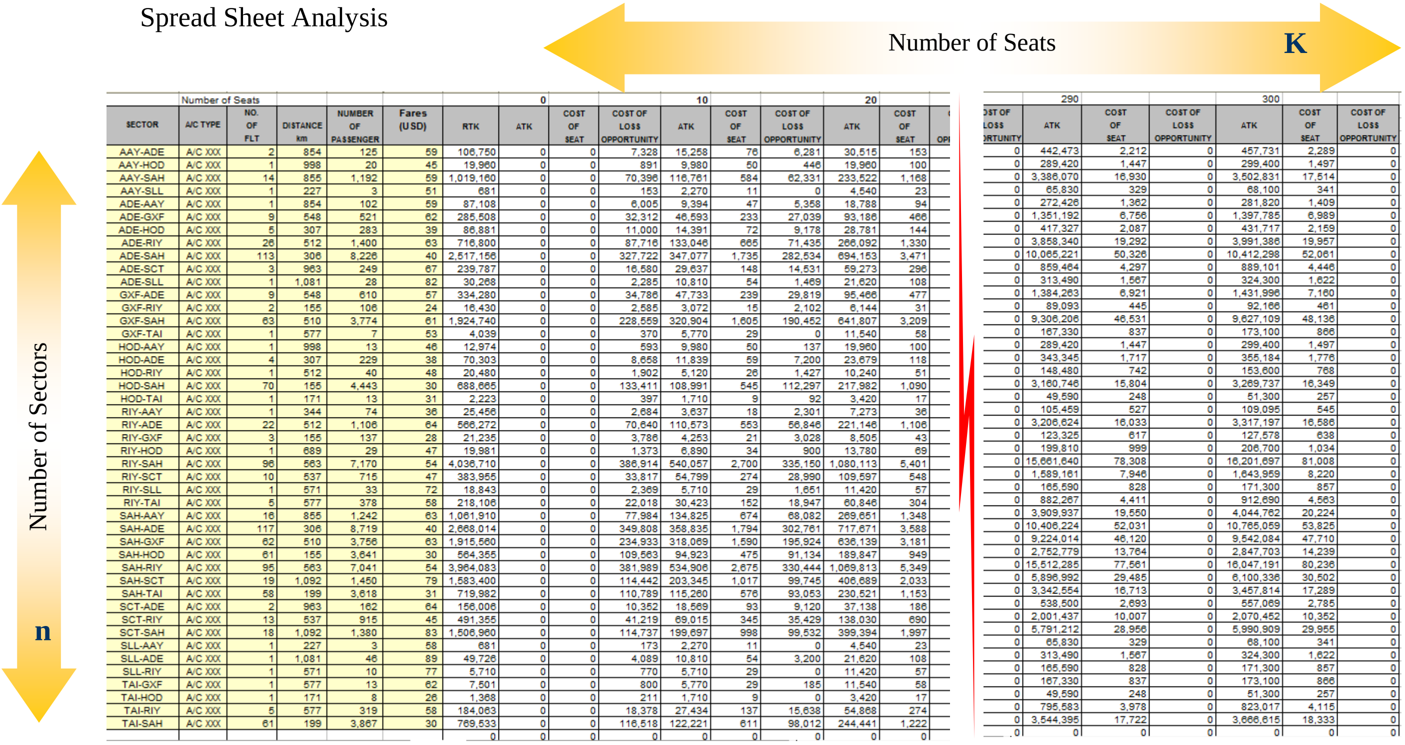
Input of Domestic Routes

Source: Felix Air ways Report

SECTOR	DISTANCE km	NUMBER OF PASSENGERS	Fares (USD)
AAY-ADE	854	125	59
AAY-HOD	998	20	45
AAY-SAH	855	1,192	59
AAY-SLL	227	3	51
ADE-AAY	854	102	59
ADE-GXF	548	521	62
ADE-HOD	307	283	39
ADE-RIY	512	1,400	63
ADE-SAH	306	8,226	40
ADE-SCT	963	249	67
ADE-SLL	1,081	28	82
GXF-ADE	548	610	57
GXF-RIY	155	106	24
GXF-SAH	510	3,774	61
GXF-TAI	577	7	53
HOD-AAY	998	13	46
HOD-ADE	307	229	38
HOD-RIY	512	40	48
HOD-SAH	155	4,443	30
HOD-TAI	171	13	31
RIY-AAY	344	74	36
RIY-ADE	512	1,106	64
RIY-GXF	155	137	28
RIY-HOD	689	29	47
RIY-SAH	563	7,170	54
RIY-SCT	537	715	47
RIY-SLL	571	33	72
RIY-TAI	577	378	58
SAH-AAY	855	1,242	63
SAH-ADE	306	8,719	40
SAH-GXF	510	3,756	63
SAH-HOD	155	3,641	30
SAH-RIY	563	7,041	54
SAH-SCT	1,092	1,450	79
SAH-TAI	199	3,618	31
SCT-ADE	963	162	64
SCT-RIY	537	915	45
SCT-SAH	1,092	1,380	83
SLL-AAY	227	3	58
SLL-ADE	1,081	46	89
SLL-RIY	571	10	77
TAI-GXF	577	13	62
TAI-HOD	171	8	26
TAI-RIY	577	319	58
TAI-SAH	199	3,867	30

Table. 3.

Spread Sheet Analysis



	Number of Seats						0			10			20	
SECTOR	A/C TYPE	NO. OF FLT	DISTANCE km	NUMBER OF PASSENGER	Fares (USD)	RTK	ATK	COST OF SEAT	COST OF LOSS OPPORTUNITY	ATK	COST OF SEAT	COST OF LOSS OPPORTUNITY	ATK	COST OF SEAT
AAY-ADE	A/C XXX	2	854	125	59	106,750	0	0	7,328	15,258	76	6,281	30,515	153
AAY-HOD	A/C XXX	1	998	20	45	19,960	0	0	891	9,980	50	446	19,960	100
AAY-SAH	A/C XXX	14	855	1,192	59	1,019,160	0	0	70,396	116,761	584	62,331	233,522	1,168
AAY-SLL	A/C XXX	1	227	3	51	681	0	0	153	2,270	11	0	4,540	23
ADE-AAY	A/C XXX	1	854	102	59	87,108	0	0	6,005	9,394	47	5,358	18,788	94
ADE-GXF	A/C XXX	9	548	521	62	285,508	0	0	32,312	46,593	233	27,039	93,186	466
ADE-HOD	A/C XXX	5	307	283	39	86,881	0	0	11,000	14,391	72	9,178	28,781	144
ADE-RIY	A/C XXX	26	512	1,400	63	716,800	0	0	87,716	133,046	665	71,435	266,092	1,330
ADE-SAH	A/C XXX	113	306	8,226	40	2,517,156	0	0	327,722	347,077	1,735	282,534	694,153	3,471
ADE-SCT	A/C XXX	3	963	249	67	239,787	0	0	16,580	29,637	148	14,531	59,273	296
ADE-SLL	A/C XXX	1	1,081	28	82	30,268	0	0	2,285	10,810	54	1,469	21,620	108
GXF-ADE	A/C XXX	9	548	610	57	334,280	0	0	34,786	47,733	239	29,819	95,466	477
GXF-RIY	A/C XXX	2	155	106	24	16,430	0	0	2,585	3,072	15	2,102	6,144	31
GXF-SAH	A/C XXX	63	510	3,774	61	1,924,740	0	0	228,559	320,904	1,605	190,452	641,807	3,209
GXF-TAI	A/C XXX	1	577	7	53	4,039	0	0	370	5,770	29	0	11,540	58
HOD-AAY	A/C XXX	1	998	13	46	12,974	0	0	593	9,980	50	137	19,960	100
HOD-ADE	A/C XXX	4	307	229	38	70,303	0	0	8,658	11,839	59	7,200	23,679	118
HOD-RIY	A/C XXX	1	512	40	48	20,480	0	0	1,902	5,120	26	1,427	10,240	51
HOD-SAH	A/C XXX	70	155	4,443	30	688,665	0	0	133,411	108,991	545	112,297	217,982	1,090
HOD-TAI	A/C XXX	1	171	13	31	2,223	0	0	397	1,710	9	92	3,420	17
RIY-AAY	A/C XXX	1	344	74	36	25,456	0	0	2,684	3,637	18	2,301	7,273	36
RIY-ADE	A/C XXX	22	512	1,106	64	566,272	0	0	70,640	110,573	553	56,846	221,146	1,106
RIY-GXF	A/C XXX	3	155	137	28	21,235	0	0	3,786	4,253	21	3,028	8,505	43
RIY-HOD	A/C XXX	1	689	29	47	19,981	0	0	1,373	6,890	34	900	13,780	69
RIY-SAH	A/C XXX	96	563	7,170	54	4,036,710	0	0	386,914	540,057	2,700	335,150	1,080,113	5,401
RIY-SCT	A/C XXX	10	537	715	47	383,955	0	0	33,817	54,799	274	28,990	109,597	548
RIY-SLL	A/C XXX	1	571	33	72	18,843	0	0	2,369	5,710	29	1,651	11,420	57
RIY-TAI	A/C XXX	5	577	378	58	218,106	0	0	22,018	30,423	152	18,947	60,846	304
SAH-AAY	A/C XXX	16	855	1,242	63	1,061,910	0	0	77,984	134,825	674	68,082	269,651	1,348
SAH-ADE	A/C XXX	117	306	8,719	40	2,668,014	0	0	349,808	358,835	1,794	302,761	717,671	3,588
SAH-GXF	A/C XXX	62	510	3,756	63	1,915,560	0	0	234,933	318,069	1,590	195,924	636,139	3,181
SAH-HOD	A/C XXX	61	155	3,641	30	564,355	0	0	109,563	94,923	475	91,134	189,847	949
SAH-RIY	A/C XXX	95	563	7,041	54	3,964,083	0	0	381,989	534,906	2,675	330,444	1,069,813	5,349
SAH-SCT	A/C XXX	19	1,092	1,450	79	1,583,400	0	0	114,442	203,345	1,017	99,745	406,689	2,033
SAH-TAI	A/C XXX	58	199	3,618	31	719,982	0	0	110,789	115,260	576	93,053	230,521	1,153
SCT-ADE	A/C XXX	2	963	162	64	156,006	0	0	10,352	18,569	93	9,120	37,138	186
SCT-RIY	A/C XXX	13	537	915	45	491,355	0	0	41,219	69,015	345	35,429	138,030	690
SCT-SAH	A/C XXX	18	1,092	1,380	83	1,506,960	0	0	114,737	199,697	998	99,532	399,394	1,997
SLL-AAY	A/C XXX	1	227	3	58	681	0	0	173	2,270	11	0	4,540	23
SLL-ADE	A/C XXX	1	1,081	46	89	49,726	0	0	4,089	10,810	54	3,200	21,620	108
SLL-RIY	A/C XXX	1	571	10	77	5,710	0	0	770	5,710	29	0	11,420	57
TAI-GXF	A/C XXX	1	577	13	62	7,501	0	0	800	5,770	29	185	11,540	58
TAI-HOD	A/C XXX	1	171	8	26	1,368	0	0	211	1,710	9	0	3,420	17
TAI-RIY	A/C XXX	5	577	319	58	184,063	0	0	18,378	27,434	137	15,638	54,868	274
TAI-SAH	A/C XXX	61	199	3,867	30	769,533	0	0	116,518	122,221	611	98,012	244,441	1,222
						0	0	0	0	0	0	0	0	0

		290			300		
SECTOR	…ST OF LOSS …RTUNITY	ATK	COST OF SEAT	COST OF LOSS OPPORTUNITY	ATK	COST OF SEAT	COST OF LOSS OPPORTUNITY
AAY-ADE	0	442,473	2,212	0	457,731	2,289	0
AAY-HOD	0	289,420	1,447	0	299,400	1,497	0
AAY-SAH	0	3,386,070	16,930	0	3,502,831	17,514	0
AAY-SLL	0	65,830	329	0	68,100	341	0
ADE-AAY	0	272,426	1,362	0	281,820	1,409	0
ADE-GXF	0	1,351,192	6,756	0	1,397,785	6,989	0
ADE-HOD	0	417,327	2,087	0	431,717	2,159	0
ADE-RIY	0	3,858,340	19,292	0	3,991,386	19,957	0
ADE-SAH	0	10,065,221	50,326	0	10,412,298	52,061	0
ADE-SCT	0	859,464	4,297	0	889,101	4,446	0
ADE-SLL	0	313,490	1,567	0	324,300	1,622	0
GXF-ADE	0	1,384,263	6,921	0	1,431,996	7,160	0
GXF-RIY	0	89,093	445	0	92,166	461	0
GXF-SAH	0	9,306,206	46,531	0	9,627,109	48,136	0
GXF-TAI	0	167,330	837	0	173,100	866	0
HOD-AAY	0	289,420	1,447	0	299,400	1,497	0
HOD-ADE	0	343,345	1,717	0	355,184	1,776	0
HOD-RIY	0	148,480	742	0	153,600	768	0
HOD-SAH	0	3,160,746	15,804	0	3,269,737	16,349	0
HOD-TAI	0	49,590	248	0	51,300	257	0
RIY-AAY	0	105,459	527	0	109,095	545	0
RIY-ADE	0	3,206,624	16,033	0	3,317,197	16,586	0
RIY-GXF	0	123,325	617	0	127,578	638	0
RIY-HOD	0	199,810	999	0	206,700	1,034	0
RIY-SAH	0	15,661,640	78,308	0	16,201,697	81,008	0
RIY-SCT	0	1,589,161	7,946	0	1,643,959	8,220	0
RIY-SLL	0	165,590	828	0	171,300	857	0
RIY-TAI	0	882,267	4,411	0	912,690	4,563	0
SAH-AAY	0	3,909,937	19,550	0	4,044,762	20,224	0
SAH-ADE	0	10,406,224	52,031	0	10,765,059	53,825	0
SAH-GXF	0	9,224,014	46,120	0	9,542,084	47,710	0
SAH-HOD	0	2,752,779	13,764	0	2,847,703	14,239	0
SAH-RIY	0	15,512,285	77,561	0	16,047,191	80,236	0
SAH-SCT	0	5,896,992	29,485	0	6,100,336	30,502	0
SAH-TAI	0	3,342,554	16,713	0	3,457,814	17,289	0
SCT-ADE	0	538,500	2,693	0	557,069	2,785	0
SCT-RIY	0	2,001,437	10,007	0	2,070,452	10,352	0
SCT-SAH	0	5,791,212	28,956	0	5,990,909	29,955	0
SLL-AAY	0	65,830	329	0	68,100	341	0
SLL-ADE	0	313,490	1,567	0	324,300	1,622	0
SLL-RIY	0	165,590	828	0	171,300	857	0
TAI-GXF	0	167,330	837	0	173,100	866	0
TAI-HOD	0	49,590	248	0	51,300	257	0
TAI-RIY	0	795,583	3,978	0	823,017	4,115	0
TAI-SAH	0	3,544,395	17,722	0	3,666,615	18,333	0
	0	0	0	0	0	0	0

Figures:

Fig. 1.

Consolidation "hub-to-hub

Source: Airbus & Boeing Reports"

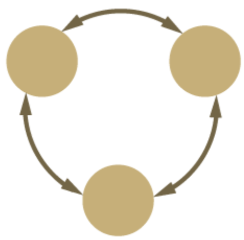


Fig. 2.

Fragmentation "point -to-point

Source: Airbus & Boeing Reports"

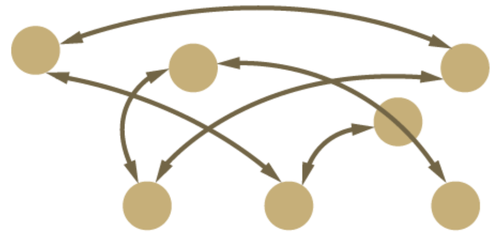


Fig. 3.

Relative Direct Operating Cost Matrix (Airbus).

Source: Airbus Report

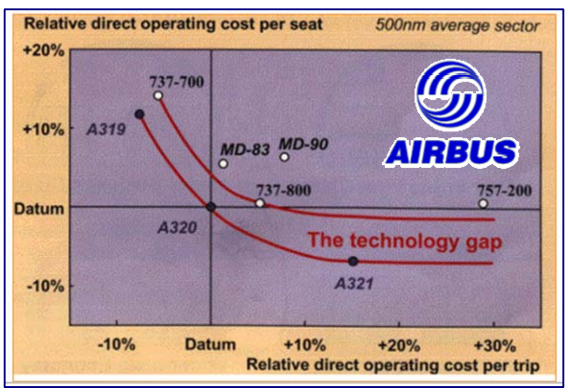


Fig. 4.

Relative Direct Operating Cost (Boeing).

Source: Boeing Report

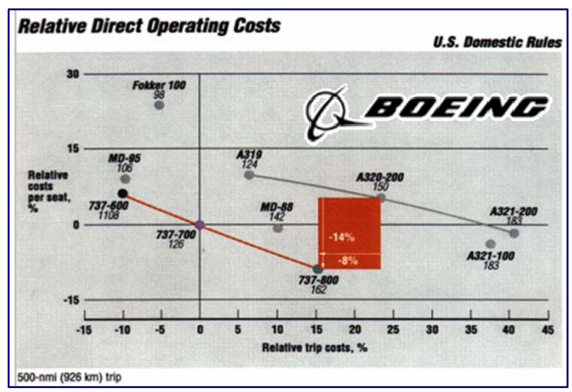


Fig. 5.

The Model

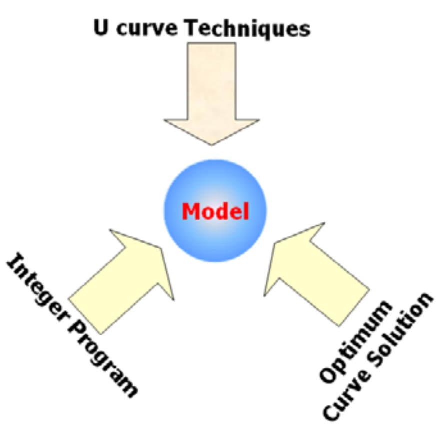


Fig. 6.

U Curve Technique

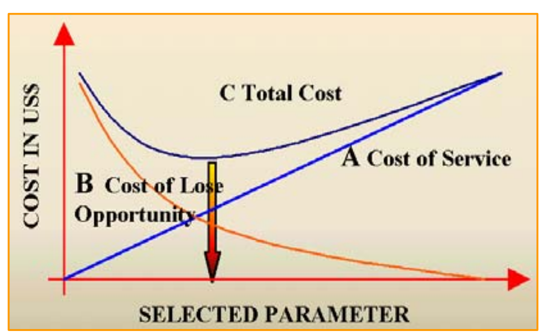


Fig. 7.

Optimum Operating Curve

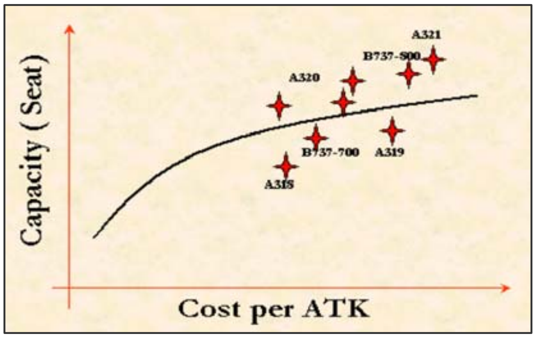
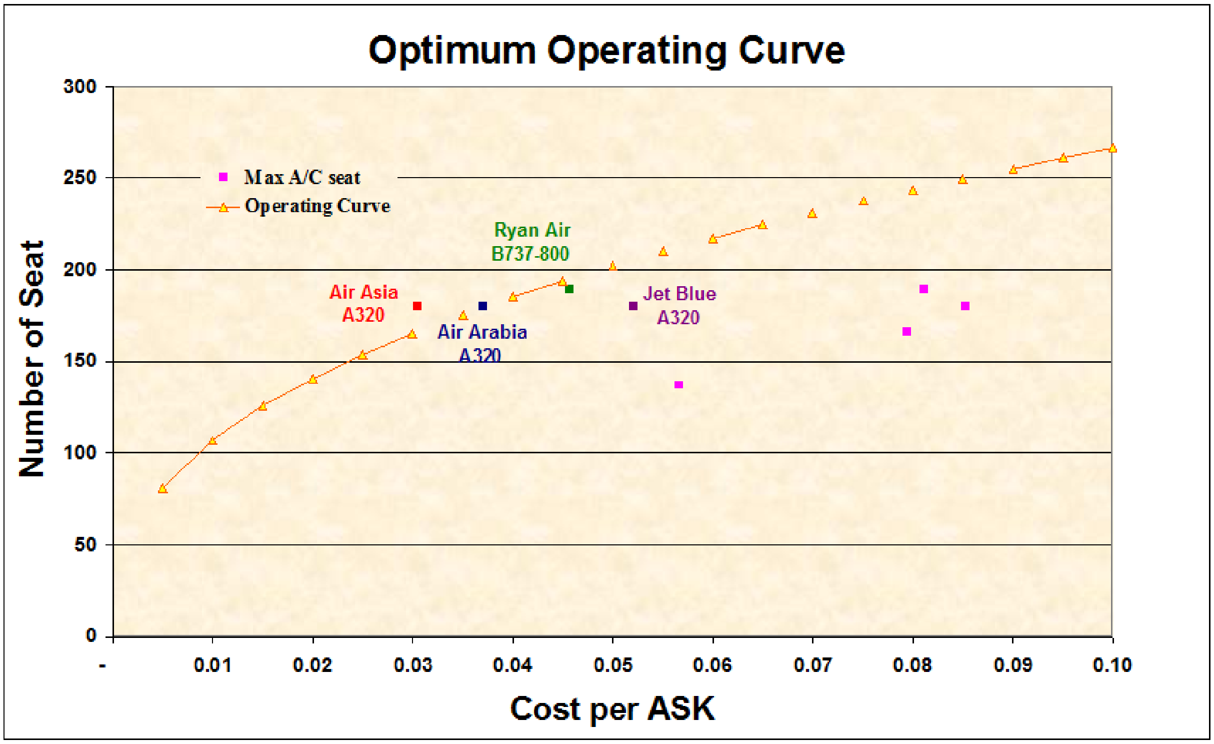


Fig. 8.

Optimum Operating Curve of Felix Airways and positions of world LCC Fleet.



Charts:

Chart. 1.

Flow chart of main components of the program.