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BASIC RELATIONSHIPS FOR LTA ECONOMIC ANALYSIS

Raymond A. Ausrotas*

ABSTRACT: Operating costs for conventional lighter than air craft are presented, based upon data of actual and proposed airships. An economic comparison of LTA with the B-747F is shown. A brief discussion of possible LTA economic trends concludes the paper.

INTRODUCTION

In the field of Lighter Than Air, there is a wealth of performance data and a dearth of economic data. Thus it is not surprising that most discussions about the potential of LTA end in agreement that an airship of a given size could carry out some specific mission, but in disagreement as to how much it would cost. Since commercial airship operations have not been undertaken for almost forty years, this paucity of data is not surprising, and any new proposal for LTA--as far as its economic viability--runs into immediate suspicion. It is not the intent of this paper to review the overall economics of LTA, but rather simply to present the supply (cost) side of the equation.

*Associate Director, Flight Transportation Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139

AIRSHIP ECONOMICS

The unit cost of an airship is the first in a series of unknowns in an economic analysis of LTA. This cost is determined by four basic variables: total development cost (non-recurring costs), the anticipated airship production run (required to allocate the development cost to each airship), the construction cost (recurring costs), and engine cost. Engine costs would be known before construction was undertaken--the other variables are largely unknown. (Also unknown are such operational factors as need for hangars, mooring masts, terminal buildings, as well as airspace utilization problems, etc.). Estimates of development costs vary from $50 million to $500 million; the number of airships needed ranges from 1 to 200; and construction cost estimates range from $0.50 per cubic foot to $4.00 per cubic foot. Clearly no definitive answer can be given to the question of "How much will an airship cost?"

Given some purchase price, the airship will be depreciated by the operator over its useful life. If the price of the ship is $20 million and assuming a life of 10 years, straight line depreciation results in annual ownership costs of $2 million. In U.S. scheduled airline operations depreciation typically amounts to 10% of total operating costs (direct and indirect). A possible annual operating cost of the airship could be $20 million. However, consider ocean tanker operations; here depreciation is typically 50% of direct operating costs, resulting in direct operating costs of $4 million. Adding 50% for indirect costs, total annual airship operating costs amount to $6 million. Until airships have been in commercial operation for some time, it is hard to judge whether airships will be more like shipping fleet or airline operations.

However, it is possible to take a look to the past when transport airships were in operation. This perspective should provide at least an outline of the likely cost structure should LTA become a commercial possibility.

Table 1 presents a detailed breakdown, in CAB Form 41 style (1931 dollars), of the pro forma costs for a metalclad airship of about the same size as the Navy's Akron/Macon[1]. Depreciation was projected to be 20% of total costs, about in line with airline costs; indirect operating cost was 50% of DOC; about the same as current freight airline experience.

The total projected costs of the MC-72 were probably unduly conservative. They were higher than those experienced by three commercial transports, the Bodensee, Graf Zeppelin and the Hindenburg, as is shown in Table 2[1,2,3,4,5]. The Hindenburg was practically a twin for the MC-72, and achieved about 16¢/available seat mile, compared to the projected 36¢/asm for the MC-72.

Figure 1 shows the improvement in productivity and decrease in costs achieved by the Zeppelins as their capacity increased. The Goodyear airship design of 1945 appeared to be a realistic follow-on to the Zeppelin line.

Table 1

Projected Operating Costs - Airship MC72 (1931 Dollars)
Based on: Block Speed 68 mph; Payload 20 tons; Utilization 3,000 hours; Available Seats 50; Volume 7.26M cu.ft.; Average Stage Length 3,300 miles; Airship Cost $5m.

Airship Operating Expenses (Per Block Hour)	
Flying Operations	
Crew	59.0
Fuel and Oil	11.0
Helium (at $0.40/cu.ft.)	100.0
Insurance	204.0
Other	58.0
Total Flying Operations	432.0
Maintenance-Flight Equipment	135.0
Depreciation	
Airframe	170.0
Engines	79.0
Total Depreciation	249.0
Total Airship Operating Expenses	815.0
Per Airship Mile ($)	12.0
Per Available Ton Mile (¢)	60.0
Per Available Seat Mile (¢)	24.0
Indirect Operating Costs (Per Hour)	408.0
Total Operating Costs (Per Hour)	1,224.0

Figure 1

Productivity and Operating Costs of Commercial Dirigibles

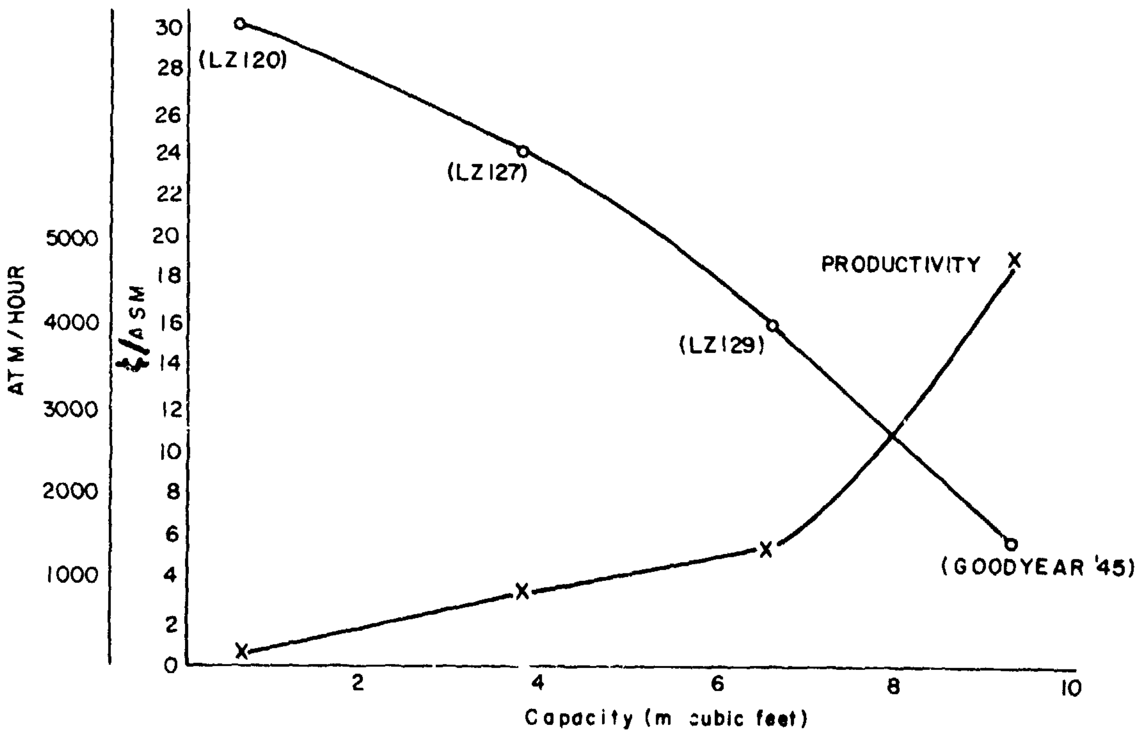

TABLE 2

Economic Comparison of Various Airships, Actual and Proposed (*)

Airship	LZ 120 Bodensee	LZ127 Graf Zeppelin	LZ 129 Hindenburg	MC-72* (Metalclad)	Goodyear* '45 Dirigible	SCACI* AMC 7.4
Gas Volume (M cu.ft.)	0.812	3.708	7.062	7.26	10	7.4
Max. Payload (tons)	3.2	14.8	20.4	20	70	60
Block Speed (mph)	61	61	68	68	68	100
Available Seats	30	20	50	50	112 - 288	250 (est.)
Av. Stage Length (miles)	400	3,000	3,500	3,500	4,000	2,000
Money Value (Dollars)	1935	1935	1935	1931	1946	1974
Total Operating Costs:						
1. ¢/available seat mile	30	24	16	36	9 - 4	3 (est.)
2. $/mile	9.0	4.8	8.0	18.0	10.0	7.1
3. $/hour	549	292	544	1,224	680	707
4. ¢/available ton mile	282	32	39	90	14	13
5. $/seat hour	18.3	14.6	10.9	24.5	6.1 - 2.4	2.8 (est.)

Moving forward some forty years to Table 3, a similar breakdown of costs is shown for two of the Southern California Aviation Council, Inc. proposed airships[4]. The AMC-7.4 is about the same size as the MC-72, and it is interesting to note that although the dollar's value has decreased by a factor of about 3 since the mid-thirties, the operating expenses for the airship are assumed to have gone down while the unit price of the airship has more than doubled. Depreciation of the newer airships is about 30% of total operating costs, somewhat closer to ship operations, while indirect costs are assumed to average only about 10% of DOC.

Table 4 provides the operating expenses for a B-747 freighter flying in the United States[6]. A comparison of the airship and aircraft operating cost indicates that the aircraft costs are below those anticipated for all the 7 million cu. feet airships shown in Table 2- only at the super-airship sizes do costs become competitive with the B-747. Then the insurance premiums of the large airships become the dominating operating expense.

Although Table 2 shows the costs at current dollars, the actual value of the dollar has deflated by 300-400% from the mid-thirties. However it is not totally unreasonable to assume that airship expenses would in fact decrease. The average U.S. scheduled airline cost per available seat mile in 1938 was 5.5¢,[7] while in 1970 it had decreased to 3.6¢/asm. However, the available seat miles during this period grew from 1,067,793,000 to 264,903,850,000, and the economics of scale, operating experience and increased safety which the airlines gained during this period of 30 years have all contributed to reducing costs. Clearly airships have not had the benefit of a similar learning period, and it is not quite correct to extrapolate directly from airline data. Only after some years of actual airship operations will it be possible to determine if similar trends will hold.

Table 3

Projected Operating Costs - SCACI Airships (1974 Dollars)
Based on: Airborne Speed 100 mph; Stage Length 2,000 miles, Utilization 4,000 hours.

Airship Operating Expenses (Per Airborne Hour)	AMC-7.4 (Cost $13M, Payload 60 tons)	AMC-42 (Cost $74M, Payload 804 tons)
Flying Operations		
Crew	143.0	154.0
Fuel and Oil	52.0	163.0
Helium	0.0	0.0
Insurance	189.0	1,125.0
Other	0.0	0.0
Total Flying Operations	384.0	1,442.0
Maintenance	58.0	95.0
Depreciation	167.0	903.0

Total Airship Operation Expenses	609.0	2,440.0
Per Airship Mile ($)	6.0	24.0
Per Available Ton Mile (¢)	10.0	3.0
Indirect Operation Costs (Per Hour)	98.0	206.0
Total Operating Costs (Per Hour)	707.0	2,646.0

Table 4

Estimated B-747F Operating Costs (1972 Dollars)
Based on: Block Speed 500 mph; Stage Length 2,000 miles; Utilization 3,000 hours; Payload 100 tons.

Aircraft Operating Expenses (Per Block Hour)

Flying Operations	
Crew	300.0
Fuel and Oil	400.0
Insurance	50.0
Total Flying Operations	750.0
Maintenance	500.0
Depreciation	500.0
Total Aircraft Operating Expenses	1,750.0
Per Airship Mile ($)	3.5
Per Available Ton Mile (¢)	3.5
Indirect Operating Costs (Per Hour)	900.0
Total Operating Costs (Per Hour)	2,650.0

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