ANALYSIS OF AIRLINE STATION COST DATA

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Summary

Airline station costs are important to the airlines as well as to airport planners but have received little attention in the literature. The nature of the data reported to the Civil Aeronautics Board on Form 41 has been determined by historical regulatory needs rather than by its use in planning or research and it has frequently been necessary to supplement it with surveys or additional data for any meaningful analysis. With deregulation, some reporting requirements will undoubtedly be suspended. More serious will be the drift away from the standard accounting system imposed by the Uniform System of Accounts and Reports which will make it increasingly difficult to produce comparable data. Even if no financial data are reported at the station level, the continued availability of resource data in sufficient detail would go a long way toward meeting the data needs for planning and research.

Introduction

Airline operating costs have traditionally been divided by the United States Civil Aeronautics Board (CAB) and by industry practice into the costs associated with maintaining and flying the aircraft, termed direct operating costs (DOC), and other costs, termed indirect operating costs (IOC). A major element of IOC is the cost of providing staff and facilities at the airports served by the carrier for the purpose of handling the passengers and air cargo and performing those tasks associated with readying the aircraft for departure. These costs are termed station costs.

Airline station costs have important implications not only for the airlines but also for airport planners, although they have received little attention in the literature. Although small in comparison to DOC, they still represent a sizable expenditure that is likely to be influenced by changes in service pattern and scale of operation, as well as by such factors as the physical design of the airport facilities. Changes in market structure resulting from deregulation may render many airport facilities inappropriate for the number and size of the carriers using the airport. At the same time, from the standpoint of the airlines, competitive pressures may require tighter control of station costs or a closer consideration of the interaction between the network structure and service pattern and the consequent costs of handling traffic at the airport.

Examples of the type of questions that need to be addressed are, firstly, to what extent does the airport terminal configuration influence station costs and, secondly, are there any apparent patterns of returns to scale in airport operations and how are these influenced by the traffic characteristics at the station. The answer to the first question is of interest to airport planners in selecting appropriate designs for terminal area expansion or reconstruction while the latter issue may influence decisions on airline network structure and route development.

While station costs are of interest to the airline in dollar terms, there is another aspect of interest to the airport planner, namely that the costs arise from the use of resources, principally labor and facilities. The airline requirements in terms of number of employees and facility requirements have implications beyond their cost to the airline. Forecasts of future airport employment or facility requirements could be seriously in error if major changes in the assumed patterns of staff and space requirements were to occur. Such changes could arise either from changes in number and size of the carriers using the airport in the presence of strongly nonlinear scale effects, or from major changes in operating technology arising from changes in factor prices. Both aspects can be addressed using production theory as discussed in detail elsewhere [Gosling: 1979]. However, the state of the art is not very well developed or widely known, and much further research is required. The answers to the foregoing questions will assist in better understanding of the processes involved.

Analysis of airline station costs

The remainder of this paper addresses the analysis of airline station costs from the standpoints of airline operations and airport planning.

Airline operations

The principal concern from an airline operations standpoint is the pattern of returns to scale and the way in which these are influenced by such factors as the traffic composition and seasonal variation.

Airport planning

Three issues deserve attention.

- the influence of airport terminal configuration on station costs
- the variation in space requirements with traffic level and type
- the size and composition of the labor force required to handle a given volume and type of traffic.

The first issue has arisen in the past in connection with such developments as the mobile lounge or the gate arrival terminal concept. The latter two issues are frequently resolved in practice by simply using present day staffing levels and perceived space requirements, with obvious limitations for long-range planning.

Data requirements

Airline station costs are reported to the CAB on Form 41, although the actual data have major deficiencies for analysis as discussed below. The data are reported in financial terms, which cannot always be interpreted in terms of the staff and other resources deployed. This paper discusses the information that can be obtained from the existing data, and what future data collection effort would be required to support analysis of the type discussed above.

While there are no other readily available public data on station costs, the airlines themselves of course have internal accounting and reporting systems of varying capability to produce detailed station costs. The use of such data for studying station costs is explored below, and internal airline data for a major station compared to the CAB Form 41 data.

CAB Form 41 Station Cost Data

The U.S. certificated airlines are required to report certain financial and traffic data, including station costs, to the CAB on Form 41. These reports are based upon the CAB Uniform System of Accounts and Reports (USAR) [CAB: 1976], which establishes a system of functional and objective accounts. In general, accounts are identified by a four-digit number, the first two digits of which refer to the function or activity (e.g., reservations and sales) while the last two digits refer to the object or nature of the expense (e.g., rentals). Thus, account 6547 is rental expense incurred in reservations and sales. Air carriers are divided by the USAR into three groups based on size, with increasing reporting requirements in the higher groups. The major domestic trunk carriers are all in Group III.

Functional classifications

The USAR does not use the term IOC as such, but defines a broad class of expense termed Ground Servicing costs. These expenses are divided into five functions for Group III carriers as follows:

6100	Aircraft servicing
6200	Traffic servicing
6300	Servicing administration
6500	Reservations and sales
6600	Advertising and publicity

In addition, Form 41 also requires the reporting of expenses for

---- Direct maintenance and depreciation of general ground property

other than maintenance ground property. These latter expenses do not have a functional account of their own but are included in the Direct Maintenance and Maintenance Burden accounts.

Aircraft servicing includes such activities as flight planning and documentation, crew scheduling, communication with other stations, ramp control, cabin cleaning and commissary, aircraft fueling and line maintenance. These activities generally take place on, or in the proximity of, the airport ramp or at centralized control facilities.

Traffic servicing activities include passenger check-in, seat assignment, skycap service, baggage make-up, break-down and transfer, passenger baggage services (unclaimed bag storage, tracing lost baggage and handling claims for lost or damaged baggage), and cargo handling. Although the USAR definitions are not explicit on whether loading and unloading baggage and cargo on and off the aircraft is included in aircraft or traffic servicing, it appears that in practice it is included in the latter. Likewise, although the selling of tickets should be included in reservations and sales, the practice of performing both ticketing and check-in at the airline counter suggests that the allocation of counter agent time to reservations and sales may be somewhat arbitrary.

Servicing administration includes general supervisory or administrative activities relating solely to aircraft and traffic servicing, but not allocatable directly to one or the other. A separate account is provided for administrative expenses of a more general character, which are not considered part of ground servicing.

Reservations and sales expenses include the costs of reservations centers and city ticket offices, as well as activities at the airport that can be directly attributed to reserving space and issuing tickets and the associated record keeping and documentation. This account also includes commissions paid, such as to travel agents, for the sale of passenger tickets or cargo shipments.

Advertising and publicity and direct maintenance and depreciation are self-evident. The former includes the printing of tariffs and schedules.

Typical proportions for the various functional expenses for a major carrier are shown in Figure 1. In 1976 the total ground servicing expenses for American Airlines was $595 m, while the carrier enplaned 21.1 m passengers and 426,000 tons of cargo on 353,000 flights. It is common practice to consider one ton of cargo equivalent to ten passengers, based on an average weight for a passenger and baggage of 200 pounds. While this does not necessarily reflect the relevant workload involved in the ground handling of both types of traffic, analysis of detailed airline station data [Gosling: 1979] suggests that this may not in fact be a bad approximation, at least at major stations. Combining the passenger and cargo traffic gives an overall cost of $23 per equivalent passenger (EQP).

Object classifications

The titles of most of the object classifications in the USAR are self-explanatory. In general, personnel costs include vacation and sick leave pay as well as regular compensation, and each class includes direct supervisory personnel.

Aircraft control personnel are ground personnel with activities "identifiable with the protection and control of aircraft in flight and in scheduling or preparing flight crews for flight assignment" (USAR Section 12 Item 26.2). Passenger handling and cargo handling personnel are simply defined as ground personnel having activities identified with the handling of passengers, and of passenger baggage, mail, express or freight, respectively. General aircraft and traffic handling personnel are all others involved in "handling or controlling aircraft and generally servicing or handling traffic of all types and classes" (USAR Section 12 Item 26.1). Although this specifically includes "personnel engaged in . . . parking and servicing aircraft incidental to line operations" (USAR Section 12 Item 26(a)), by inference it also includes all traffic handling personnel whose duties cannot be defined as either passenger or cargo related.

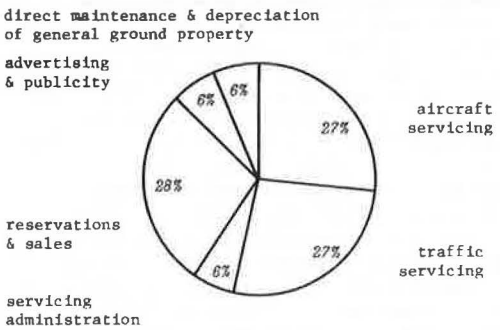
General management personnel include the company general officers and supervisors and immediate assistants responsible for an activity not provided for specifically in the accounts, or for an activity involving two or more accounts. In practice this turns out to be a very small number of people.

Communications personnel specifically include radio operators, telephone operators, switchboard operators, teletype operators, and messengers.

Record keeping and statistical personnel specifically include accountants, economists, statisticians, maintenance record clerks, stores record clerks, stores receiving and issuing clerks and file clerks. However, "the account shall not include personnel engaged in documentation or other activities constituting an integral part of activities encompassed by other objective accounts" (USAR Section 12 Item 31).

Various object classes can be considered as personnel overhead. These are personnel expenses, which include "travel, lodgings, meals, entertainment of individuals or groups of individuals, and membership fees and dues in professional or social

Figure 1. Composition of ground servicing expenses, American Airlines, 1976.



clubs and associations" (USAR Section 12 Item 36(b)), employee benefits and pensions, and payroll taxes.

Utilities include communications purchased, the "rental of communication services and for communication services of all types and classes not provided by personnel of the air carrier, such as telegraph, telephone, teletype, private line services, and charges for communication services from organizations operated jointly with associated companies or others" (USAR Section 12 Item 37). Utilities also include expenses for light, heat, power and water. Related taxes are included in utility expenses.

Services include professional and technical fees and expenses, general services purchased from associated companies, and general services purchased from outside. Ground expense elements of the two latter accounts are subdivided into general interchange service charges and other services. The distinction between "associated companies" and "outside" companies is of course relevant to the CAB's regulatory role, but not to a causal analysis of costs, unless there is reason to believe that the figures for the associated companies are being distorted by hidden cross subsidy. In the absence of any such reason, it seems appropriate to ignore the distinction. General interchange service charges relate to the ground element of services provided to the air carrier under aircraft interchange agreements, including maintenance and rapair of ground properties, traffic solicitation and sales, supervision and administration. Other services are those not accounted for elsewhere, and include specifically "the operation of traffic offices or other facilities used jointly with the air carrier (except that reimbursement of expenses incurred expressly for the benefit of the air carrier shall be entered in appropriate personnel compensation or other object expense accounts), and "the repair of general ground properties . . . maintenance buildings and equipment" (SUAR Section 12 Items 42.9 and 43.9).

Detailed object classification of expenses by function at a system level are reported on Schedules P.6 through P.8 of Form 41. The proportional composition of aircraft and traffic servicing, servicing administration, and reservations and sales for American Airlines in a typical year is indicated on Figures 2(a-d).

Location of expenses

The foregoing reports describe what expenses were incurred for what activity, but not where they were incurred. Ground servicing expenses are reported by function and location on Schedule P.9. However, object level data are not reported by location. Thus while the total expense for aircraft servicing at a station is known, the relative proportion of staff cost to landing fees, for example, is not.

Data are reported separately for each on-line station and for regional and system expenses, those that cannot be allocated to a particular location. Where a carrier has city ticket offices (CTOs), these expenses are either reported separately or included in the city's airport. In general the CTO expenses are reported separately for the larger cities and combined for the smaller stations. This probably reflects the local station organization, with the CTOs reporting to the station manager at smaller stations and to a regional or division structure in the larger cities.

The distribution of the 1976 ground servicing expense for American Airlines between the various types of location is shown in Figure 3, with the distribution of four of the functional categories shown in Figure 4(a-d). Over 97 percent of advertising and publicity expense is allocated to the regional and system expenses, with the balance fairly evenly divided between the on-line stations and the CTOs. The functional distribution of expense at each type of location is shown in Figures 5 to 7.

With effect from the fourth quarter of 1979 these locational data are no longer reported due to the suspension of Schedule P.9 by the draft Economic Regulation 393.

Headcount data

Total counts of employees by object class is reported on Schedule P.10. This schedule was formerly filed quarterly but with effect from the first quarter of 1977 it has only been required annually. Total employees at each location are also reported on Schedule P.9, although no breakout is provided by object class. Since 1977 there has been a minor difference in the way the numbers are computed on the two schedules.

Comparison of CAB And Airline Accounting Data

Airline internal reporting and accounting systems can provide a much more detailed level of information than the CAB Form 41. However these systems have usually been established with somewhat different objectives than suitability for producing analytical data. The primary requirements of providing accounting and budgetary control often conflict with the data acquisition needs of planning or research. Thus the systems are usually structured to provide detailed reports at different levels that correspond to the organization of managerial responsibility, rather than on any functional basis (except insofar as this is reflected in the organization of responsibility). Reports are generated in progressively less detail at higher levels and tend to compare actual expense to budget or target, rather than in terms of output, although some of the more sophisticated systems do incorporate productivity or output measures.

Since these reports frequently correspond to the airline organizational structure, it is useful to understand the station organization of a particular carrier before attempting to use such data. Organization charts for typical major stations of two different carriers are shown in Figures 8 and 9.

Figure 2a. Composition of aircraft servicing expenses, American Airlines 1976.

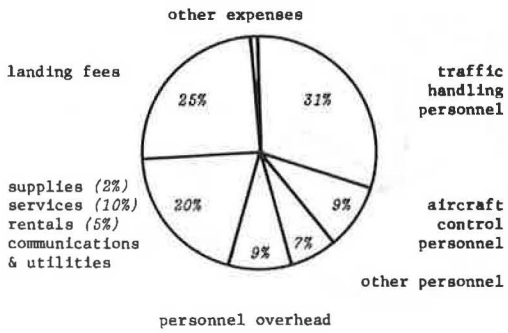


Figure 2b. Composition of traffic servicing expenses, American Airlines 1976.

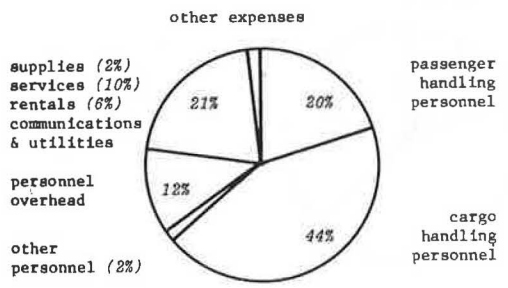


Figure 2c. Composition of servicing administration expenses, American Airlines 1976.

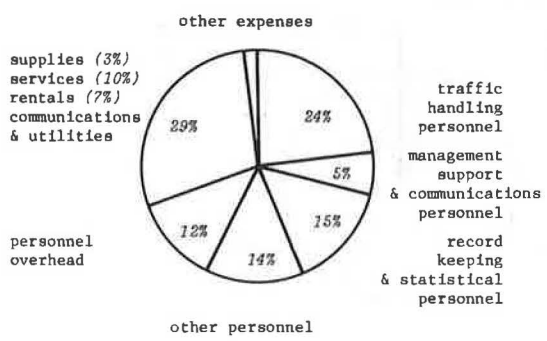


Figure 2d. Composition of reservations and sales expenses, American Airlines 1976.

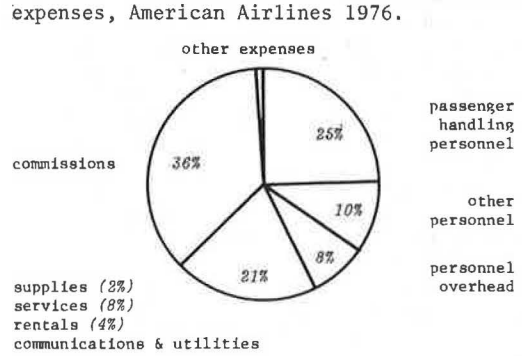


Figure 3. Location of ground servicing expenses, American Airlines 1976.

Structure of an airline reporting and accounting system

A typical reporting and accounting system will generate a series of reports at a number of levels in a hierarchical fashion. Thus the report at a given level corresponding to a particular managerial responsibility (such as station manager) will include all expenses of the various departments reporting to that level (such as passenger service, ramp service, etc.). There will probably be one combined report and then separate reports for each sublevel. These may be the full report for the next level down or an abbreviated version. By selecting the appropriate level of report, any desired level of detail can be obtained. However, at some levels of detail, combining detailed data across several functions can involve a great deal of manipulation.

Ideally, systems should report staffing levels by class of employee on some basis in addition to actual payment. Hours worked is preferable to number of personnel, as this can account for overtime, leave and part-time working. Some systems combine the two measures by weighting each staff member by the hours worked, giving a paid manpower equivalent or similar term.

The reports should also give relevant measures of output or performance at each level (such as passengers enplaned or tons of cargo handled). This forms one of the most useful parts for the analyst.

Finally for fiscal control, the reports will usually give some measure of the budgeted expense for the level, against which the actual expense to date can be compared.

The detail with which individual expenditure items are reported may vary considerably from system to system, although it is desirable that the nature of each item is clear and that functionally dissimilar expenditures are not combined, as tends to happen with items such as "services" or "supplies." It is also important that unspecified items ("other") are not large compared to the smaller specified items.

Case study using airline data

A major trunk airline (XA) made available the results of an internal study of the 1976 station operating expense at two airports at which XA does not have any system facilities such as hangers or flight kitchens or associated staff. These data are given in Table 1. Airport E is a small hub where XA enplaned about 115,000 passengers in 1976, while airport F is a large hub where XA enplaned about 200,000. Thus both stations are of comparable size, although the proportion of the total traffic at each airport enplaned by XA was very different.

The facilities item includes rents, utilities, facilities maintenance, and depreciation of tenant improvements and fixed ground equipment. Deprecia-

Figure 4a. Location of aircraft servicing expenses, American Airlines 1976.

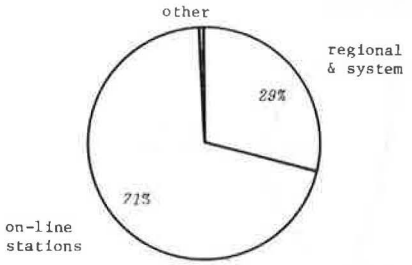


Figure 4b. Location of traffic servicing expenses, A ercian Airlines 1976.

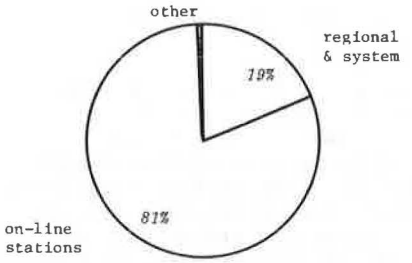


Figure 4c.
expenses, American Airlines 1976.

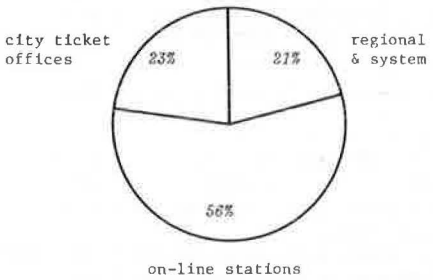
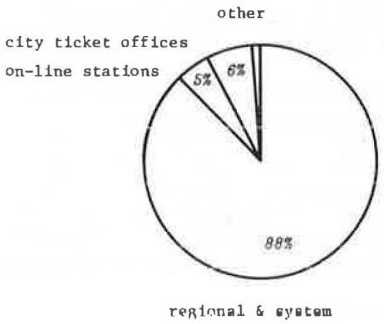


Figure 4d. Location of reservations and sales expenses, American Airlines 1976.



tion of mobile ground equipment is included in material and supplies.

Overall the larger airport appears to be approximately $1 per enplaned passenger more expensive. However this is entirely accounted for by the cost of facilities, which is nearly $2 per enplaned passenger more expensive. The landing fees however are lower. Allowing for the possibility that the two airport authorities might allocate their costs differently between the airfield and the terminal area, or have different policies regarding rental rates and landing fees, the combined figures for

Figure 5. Composition of regional and system expenses, American Airlines 1976.

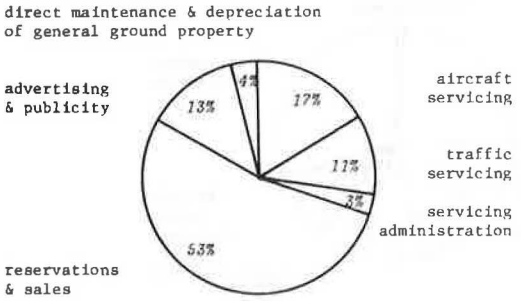


Figure 6. Composition of station costs, American Airlines 1976.

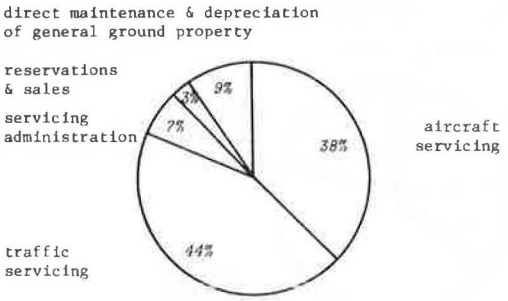
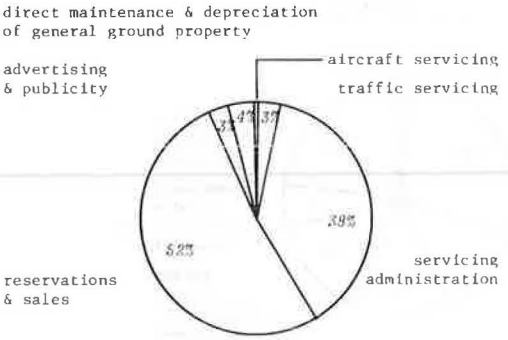


Figure 7. Composition of city ticket office expenses, American Airlines 1976.



facilities and landing fees still result in the larger airport being over $1 per enplaned passenger more expensive. It should be noted however that airport F is a much newer terminal.

The personnel costs per enplaned passenger show a wide disparity at first; however, the personnel at airport E have to perform aircraft servicing whereas at airport F this is done by contract. The combined personnel expense and aircraft servicing contract at airport F is $4.95 per enplaned passenger, surprisingly close to the $4.92 per enplaned passenger for the personnel at airport E. However the aircraft servicing contract presumably includes some provision for use of aircraft servicing equipment and supplies, so actual personnel costs would be somewhat lower. Material and supplies expense is .04 cents per enplaned passenger lower at airport F as would be expected since this does not include the depreciation on the mobile

Figure 8. Typical station organization, American Airlines Class 2 station.

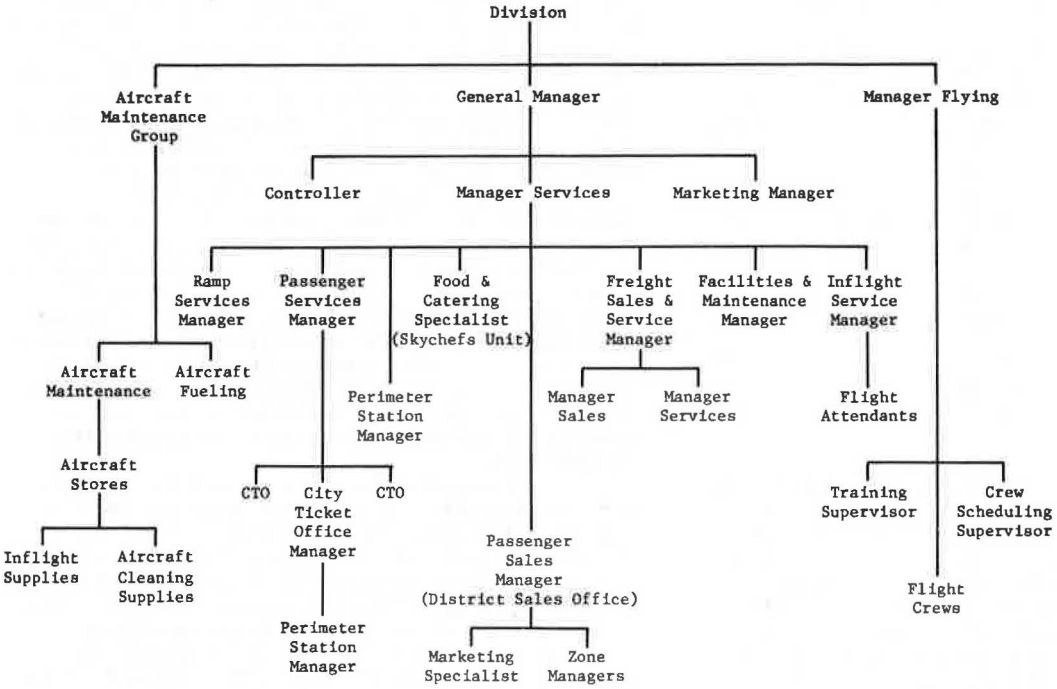
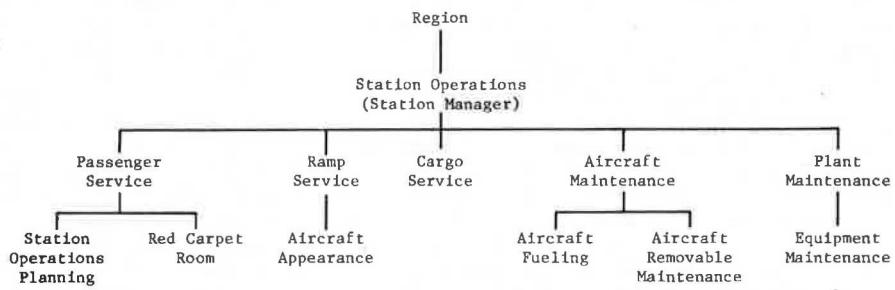


Figure 9. Typical station organization, United Airlines.



aircraft servicing equipment that is included at airport E.

The federal security program expenses per passenger are also considerably lower at airport F, as would be expected given the obvious returns to scale in security screening. A level of 200,000 annual passengers corresponds to a peak daily flow of the order of 1,000 passengers, or perhaps 100 in the peak hour, well within the capacity of conventional search procedures with the minimum practical staff levels. Thus federal security program expenses are more likely to be controlled by the layout of the terminal and the extent to which costs can be shared with other airlines than by the level of traffic handled, at least at the traffic volumes at airports E and F. Purchased services and other expenses are comparable at both airports, with airport F about 13 percent more expensive on an enplaned passenger basis.

While one cannot draw any strong conclusions from such limited data, these results tend to suggest that there are no obvious returns to scale in personnel or materials and supplies. There appear to be fairly clear increasing returns to scale in the federal security program expense and less clear diminishing returns to scale in purchased services and other expense. Ignoring possible cross-subsidy between airside and landside, and any effects of the age of the facility, it appears there are increasing returns to scale in the airside facilities but decreasing returns to scale in the landside facilities. This is interesting because of its correspondence to the results expected from a theoretical consideration of the issues.

Table 1. XA comparative station operating expense, 1976 (dollars per enplaned passenger)

	Airport E	Airport F
Facilities	0.63	2.35
Landing fees	0.83	0.45
Personnel	4.92	2.88
Aircraft servicing contract	-	2.07
Federal security program	0.73	0.34
Material and supplies	0.23	0.19
Purchased services and other	0.95	1.07
Total	8.30	9.36

Detailed accounting data for a major XA station (enplaning in excess of 2 million passengers per year), here termed airport G, were also made

Table 2. Comparative operating expenses for a major station, 1976 (dollars per enplaned passenger).

	Including off-line maintenance	Excluding off-line maintenance	Cargo service
Facilities	1.03	0.86	0.06
Landing Fees	1.34	1.34	0.05
Personnel	10.17	8.36	2.17
Federal security program	0.24	0.24	-
Material and supplies	0.99	0.67	0.05
Purchased services and other	0.62	0.57	0.05
Total	14.49	12.04	2.38

available. The results of an extensive analysis of these data are described elsewhere [Gosling: 1979]. Table 2 gives the operating expense per enplaned passenger, classified on the same basis as Table 1. Since this station includes hangar facilities, the operating expenses are given both including and excluding off-line maintenance, insofar as this can be identified. Personnel costs have been adjusted assuming 30 percent of maintenance direct labor is allocated to aircraft servicing at the ramp. All aircraft maintenance material and supplies have been assumed to be for off-line maintenance, while line servicing supplies have been included in both cases. All facility costs directly associated with the hangar and aircraft maintenance equipment expenses have been excluded in the second case; however, aircraft servicing equipment expenses have been retained. No attempt has been made however to reduce the plant and equipment maintenance personnel expenses to account for maintenance work on the hangar or maintenance equipment. Likewise no attempt has been made to allocate aircraft maintenance overhead expense, such as office supplies and telephone, between aircraft servicing and maintenance. Thus the figures in Table 2 are probably overestimated for the expenses excluding off-line maintenance.

Another important difference between the three stations is the amount of cargo enplaned. Airport E enplaned approximately five pounds per enplaned passenger, airport F enplaned approximately twelve pounds per enplaned passenger, while airport G enplaned over 45 pounds per enplaned passenger. Table 2 also gives the portion of the total operating expense attributable to cargo service, including ramp personnel handling cargo. Landing fees are based only on the percentage of all-cargo departures. Facility depreciation was prorated among the various facilities on the basis of the rent paid for them, (giving an assumed cargo facility depreciation of $0.0198 per enplaned passenger).

The comparison between airport G and airports E and F is interesting. The overall operating expense appears to support the hypothesis of decreasing returns to scale, even after adjusting for the hangar activity and thehigher cargo traffic. Of course, the larger stations may perform functions that are not done as much (or at all) at the smaller stations. Whether this is considered part of the scale effect or a separate issue is a question of semantics. However the proportions of the elements of the total expense show different patterns. The facilities expense lies between that of airports E and F, while the landing fee expense is much greater than either. The combined total for facilities and landing fees is 21 percent less than for airport F but 51 percent more than for airport E. This suggests that the higher cost of facilities at airport F is not entirely due to the recent development of the passenger terminal. This finding is not changed by adjusting the figures for the different cargo traffic. Personnel costs at airport G are considerably higher than at either of the other stations, about 38 percent more than at airport E after adjusting for cargo personnel. Federal security program expenses continue to show increasing returns to scale, as expected. Material and supplies shows a much higher expense per enplaned passenger than at airport E or F; however the purchased services and other expenses are considerably lower. This might be explaned by an increased tendency to use own personnel at a larger station rather than use service contracts. This would lead to the higher personnel and material and supplies expense but lower purchased services expense that is observed.

The CAB Form 41 station costs from Schedule P.9 for airports E, F and G are given in Tables 3 and 4. For convenience these are expressed as dollars per enplaned passenger in Table 4. These data also suggest diminishing returns to scale. However in interpreting them certain factors should be noted. The reservations & sales and direct maintenance & depreciation expenses include the costs of city ticket offices (CTO). In 1976 XA has one CTO in the city served by airport E, none in the city served by airport F and over 15 in the metropolitan area around airport G. The increasing expense per enplaned passenger of aircraft servicing, and the low cost at airport E, may in part reflect the increasing amount of servicing performed at larger stations and in part the distribution of aircraft control personnel across stations of various sizes. The reduction in traffic servicing expense per enplaned passenger between airports E and F may reflect a tendency for increasing returns to scale at these traffic volumes. This account includes the federal security program, which has already been shown to exhibit this feature. Excluding this component, the traffic servicing expenses per enplaned passenger increase from $3.61 at airport E, through $3.74 at airport F to $4.35 at airport G. However the amount of cargo enplaned at these stations also increases in the same order. Prorating the relevant cargo service expenses (facilities, personnel, material and supplies and purchased services and other, excluding reservations and sales personnel - $0.10 per enplaned passenger, and depreciation and maintenance expense - $0.06 per enplaned passenger) from Table 2 on the basis of cargo enplanement ratios (pounds of cargo per passenger enplaned), gives adjusted values for passenger and baggage traffic servicing expenses of $3.37, $3.16 and $2.18, respectively, which supports the expected result of increasing returns to scale in passenger and baggage handling. The reduction in servicing administration expense at airport G may be due to two effects. Firstly, there are fixed cost aspects of servicing administration which are likely to be more pronounced at smaller stations and secondly the scale of operations at smaller stations is such that one person is likely to have responsibilities for both aircraft and traffic servicing, thereby putting his time in the servicing administration account, whereas at larger stations personnel are likely to be more specialized. The increase in the advertising and publicity expenditure with station size reflects the marketing approach of the airline and has no particular relevance to station costs. The

Table 3. Comparison of XA expense report and CAB Form 41 data ($000).

	CAB functional classification					
	Aircraft Servicing (6100)	Traffic Servicing (6200)	Servicing Administration (6300)	Reservations & Sales (6500)	Advertising & Publicity (6600)	Direct Maint. & Depreciation General Ground Property
Schedule P.9	3,284	4,591	531	5,461	894	1,127
Station expense report						
Personnel expense						
Station ops. planning			320			
Ramp service[a]	1,659	1,421	71			
Passenger service		901		797		
Cargo service		1,173		97		
Plant & equip. maint.						600
Non-personnel expense	1,429	1,075	102	11		561
Flight ops. administration	414					
	3,502	4,570	493	905		1,161
Difference	+218	-21	-38			+64

a. Including aircraft appearance and fueling.

Table 4. Ground servicing expenses from CAB Form 41, 1976 (dollars per enplaned passenger).

Aircraft servicing	1.15	3.07	3.28
Traffic servicing	4.34	4.08	4.59
Servicing administration	1.03	1.07	0.53
Direct maintenance and depreciation[a]	0.13	0.38	1.13
	6.66	8.61	9.54
Reservations and sales	2.68	2.01	5.46
Advertising and publicity	0.03	0.13	0.89
Total	9.37	10.75	15.89

a. Of general ground property, excluding maintenance facilities.

increase in direct maintenance and depreciation expense with station size may result from a tendency to own more of the facilities and equipment at larger stations outright. If so, then this should be offset by lower rental and other payments. If these in part account for the reduction in traffic servicing expenses per enplaned passenger, then the increasing returns to scale are not as strong as suggested above. Combining the direct maintenance and depreciation expenses (less $0.06 for cargo facilities and equipment in the case of airport G and prorated for the other airports) with the passenger and baggage traffic servicing expenses from before gives new costs per enplaned passenger of $3.49, $3.52 and $4.25, respectively. Since this ignores the maintenance and depreciation of facilities and equipment for aircraft servicing, these figures are overestimated and the reduction in returns to scale exaggerated. It therefore appears that the returns to scale do exist but are not very strong.

Reporting Requirements for Planning and Research

The nature of the data reported to the CAB on Form 41 has been determined by historical regulatory needs, rather than by its suitability for use in planning or research. In fact, as has been suggested above, when it comes to studying station costs, the form of the data makes it quite difficult to use. Nor is this restricted to applications of the type described. In a recent comparative study of airline productivity, McKinsey [1977] found the CAB Form 41 data insufficiently detailed for any meaningful analysis and instead developed their own survey which included 102 categories of employee, 47 types of income and expenditure and 39 measures of output. While such an approach is attractive from the point of view of collecting exactly the data required and avoiding an unnecessary reporting burden, it is restricted to those airlines willing to take the trouble to put the data in the form requested and cannot of course produce data that have not been collected in some form in the first place.

With deregulation, two things are likely to happen to the data reporting process. The first and most obvious is that progressively some reporting requirements will be suspended. This has already happened to the station level data contained in Schedule P.9 of Form 41. The second, more subtle and ultimately perhaps more serious, problem is a probable drift away from the standard accounting system imposed by the Uniform System of Accounts and Reports. As each airline develops its accounting and reporting system independently, it may become harder and harder to produce comparable data. This problem is not unique to airlines of course. However few other industries are in the position of operating their production equipment within the framework of a physical plant planned and operated by a large number of government and quasigovernment agencies. If these agencies are to adequately monitor, plan and develop their part of the system in a coordinated fashion, sound planning and research data must be available. The questions are what and how much. The answer will depend on the use to which the data will be put. Within the general topic discussed in this paper, two separate measures can be identified: financial costs and physical resources. Of the two, resource data are perhaps the more important.

Whether or not financial data are reported at a station level, the reporting of employee PME by a suitable number of staff classifications by location

would go a long way toward meeting the requirement for planning data. Where significant activities covered by the reporting requirements are performed through a service contract, either the service expense or the staff PME of the contractor should be reported.

Data on facility requirements (square feet of space by class or use) could be collected directly from airport authorities.

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AN ENGINE MANUFACTURER'S VIEW OF CAB FORM 41 DATA

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Summary

The aerospace manufacturing industry makes extensive use of data from Civil Aeronautics Board reports in projecting world traffic growth and potential demand for new aircraft and engines, in analysis of airplane usage and evaluation of new and derivative engine designs and in studies to optimize overall engine maintenance costs. Use of this data and concerted effort by the manufacturers and the airlines have resulted in commercial aircraft with lower operating costs and have given the United States leadership in commercial aviation.

CAB Form 41 data would be much more useful to engine and aircraft manufacturers if additional data such as flight length, derate, average engine age and accounting practices could be factored into the final value. In order to achieve this type of standardization, the industry would have to agree on a common format and a mutually acceptable method to normalize engine maintenance cost data.

New and Existing Airplane Evaluation

CAB data provides the basis for many new and derivative airplane and engine evaluations which compare calculated direct operating costs of new systems with those in service. Elements of CAB data are used to develop empirical relationships between direct operating costs and design or operating factors that influence these costs. Design decisions based on these analyses contribute to progressive reductions in direct operating costs as new airplanes and engines are introduced.

The use of this data as references and concerted effort by the manufacturers and the airlines have resulted in commercial aircraft with lower operating costs and has given the U.S. leadership in commercial aviation.

Aircraft Market Forecast and Market Analysis

The manufacturer has developed a number of computer programs which use CAB data and related economic factors to forecast future travel demand. The U.S. and foreign segments can be combined to yield total world forecasts. Detailed CAB statistics such as load factor, seats, stage length, etc., can be analyzed to permit a better understanding of the total system as well as individual airline operation. In this way the individual airline and industry's future needs in new aircraft and engines can be more clearly defined. This permits an assessment of future market needs by aircraft size, range, and operating characteristics. Because of the long lead time in developing new aircraft systems - particularly the propulsion system - the manufacturers must anticipate airline requirements by three to five years in order to be able to offer, at the proper time, the type aircraft which meets airline requirements.

The total market for new aircraft is generated by the need to accommodate growth as well as replacement of aircraft being retired. Aircraft retirement plans are frequently influenced by the airline financial status. Studies of financial trends of the industry and debt structure permit projection of capital requirements and resources. This provides a guide of the industry's ability to purchase new equipment. These studies forecast the measure of the financing assistance which may be required by the airline industry.

In analyzing the travel demand and the type of equipment being utilized to meet this demand, the manufacturers are able to identify new product opportunities, and hence new market opportunities. New airplanes allow the airlines to serve their routes more efficiently.

Engine Maintenance Cost Elements

Engine maintenance costs consist primarily of three elements:

1. Material cost
2. Labor costs
3. Outside services.

The combination of these three elements establishes the total direct maintenance cost for the engine. From an engine manufacturer's viewpoint and also the airlines' viewpoint, this data provides the basis for judging the cost performance of competing equipment.

In the past several years, fuel costs (Figure 1) have risen at a much faster rate than material and labor costs (Figure 2). For this reason engine and aircraft manufacturers are conducting trade-off studies comparing engine maintenance costs versus fuel burn.

Preliminary results of studies conducted on future twin engine, wide-body aircraft indicate, for example, that the fuel burn savings by climbing at maximum available power (zero derate) will offset the increased engine maintenance cost by a factor of two and one half to one. As fuel prices continue to rise in comparison to engine maintenance costs, airline operators will probably modify their engine maintenance practices to optimize overall direct operating costs. For example, it may become economically feasible to remove an engine prematurely to restore specific fuel consumption performance.