OPERATIONAL INITIATIVES IN AIR TRANSPORT

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ABSTRACT:

This paper is the result of a search for alternative operating arrangements whereby the congestion costs caused by international aircraft and passenger movements at Sydney's Kingsford-Smith Airport could be reduced. An initial examination of alternatives made it clear that congestion cost minimisation alone would not necessarily produce a satisfactory result for airline companies or air passengers. Hence the objective function was broadened to include the effects on airline operating costs and air passenger time of each alternative. It will be shown that any change to present day operations necessarily involves a trade-off between these different objectives and that no alternative is useful if practical difficulties prevent its implementation.

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INTRODUCTION

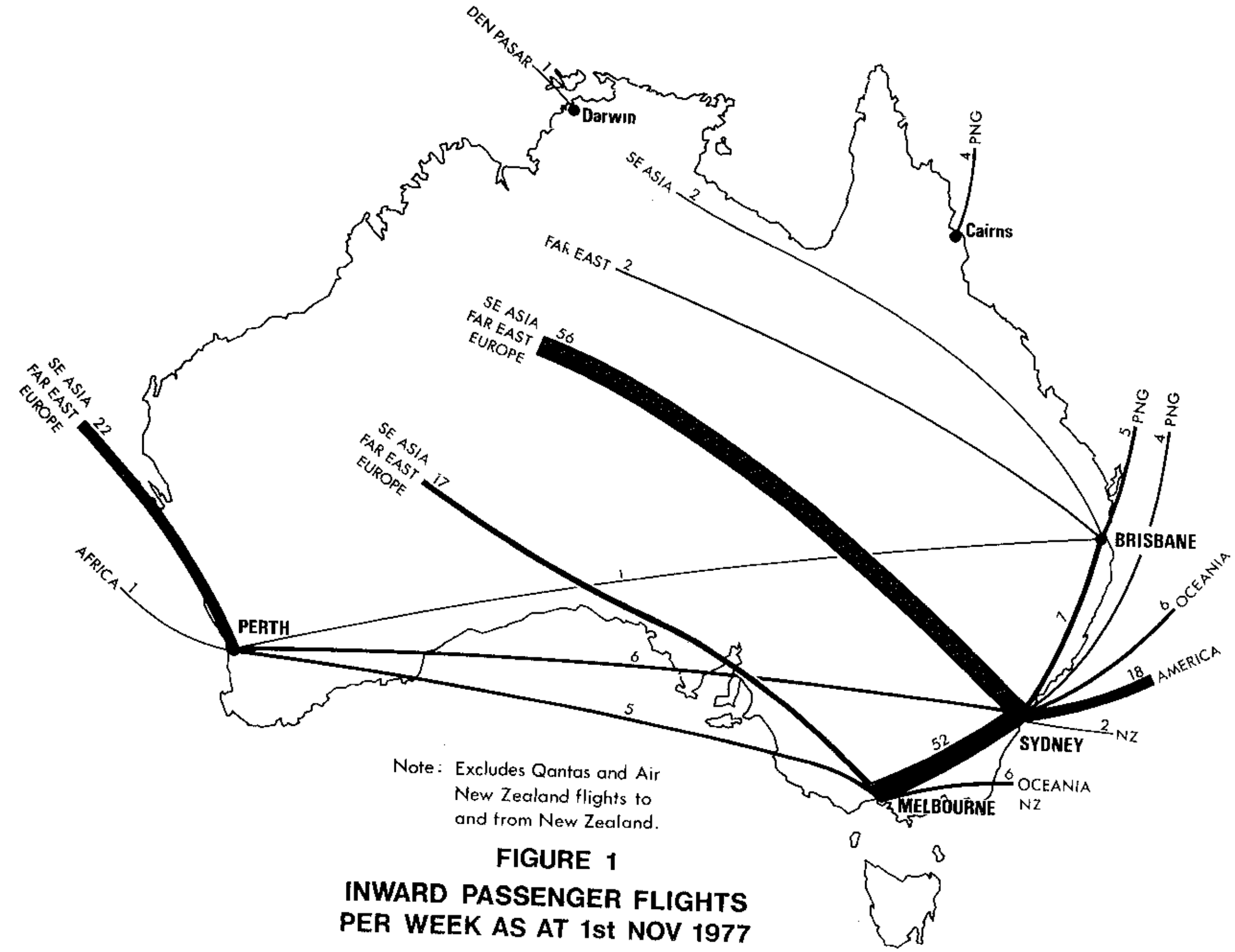
The current debate about the desirability or need for a second Sydney airport has come at a time when the usefulness of high cost infrastructural investment in the transport sector is being seriously questioned. Traffic generated by such investment has, in many cases, quickly absorbed the initial excess capacity which was provided.

In recognition of this, price and regulatory tools of traffic management are being much more widely used as ways to control the level of demand or to optimise the use of the existing transport system capacity. It is this latter optimisation problem which is the subject of this paper.

THE PROBLEM

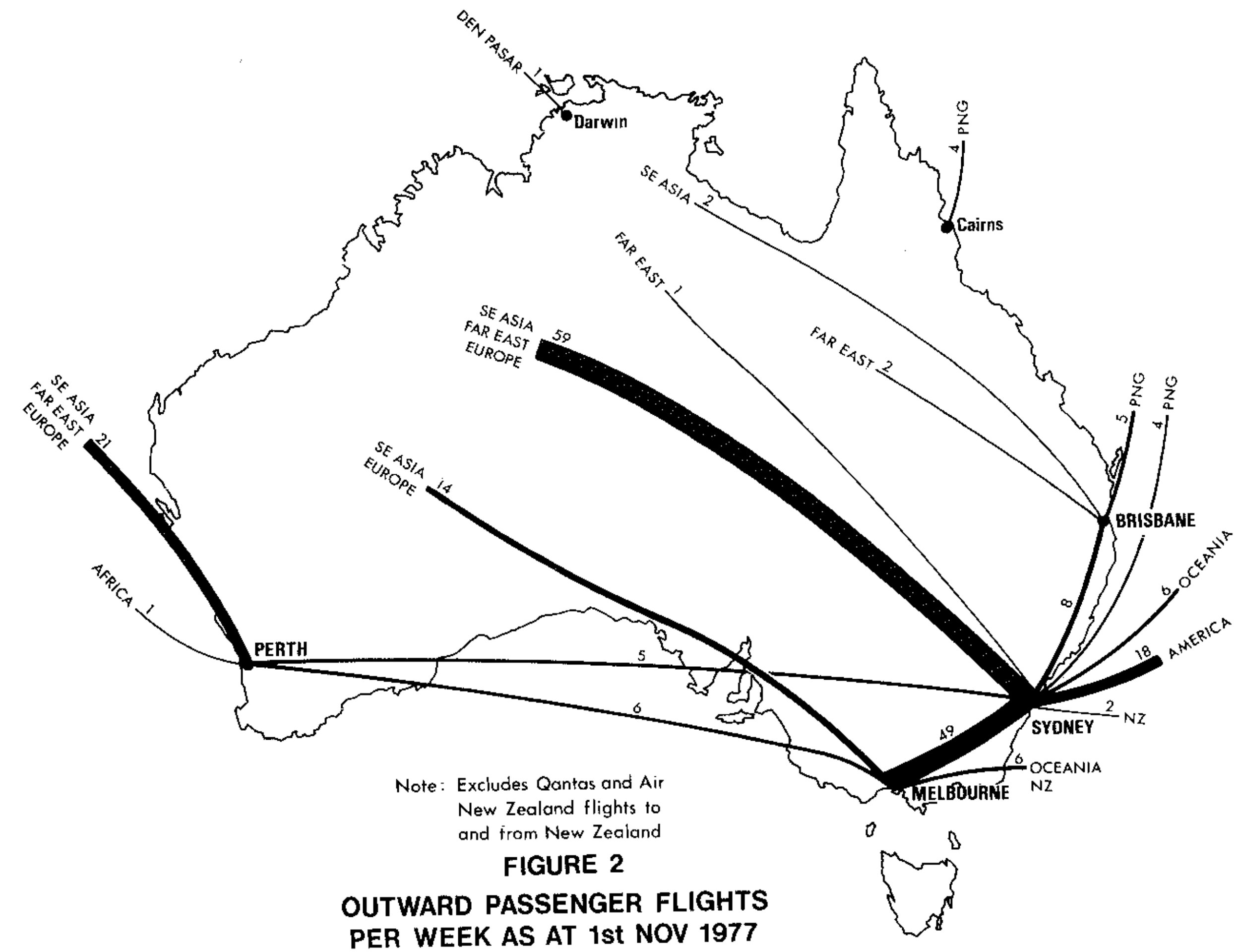
This paper developed from a recent involvement by the authors in the Major Airport Needs for Sydney (MANS) Study. This involvement led not only to an awareness of the developing congestion problem at Sydney's Kingsford-Smith Airport (KSA) but also of the existence of considerable excess capacity in the international air system within Australia. This excess capacity exists firstly at the international terminal during the off-peak demand period. As the only major congestion problem at this terminal occurs between the hours 0600 and 0900, the off-peak period can really be defined as the hours 0900 to 2300, at which time the curfew period commences. The second incidence of excess capacity occurs on board international aircraft travelling between Sydney and Melbourne. On this route, the busiest domestic route in Australia, international aircraft are presently travelling with load factors as low as 25%. The authors of this paper discovered that both these instances of excess capacity could be traced to the present operational procedure of international aircraft servicing Sydney and Melbourne.

An analysis of recent (November 1977) international timetables has revealed the weekly international aircraft movements into and out of Australia as shown in Figures 1 and 2. These figures clearly show the significance of Sydney-Melbourne movements in the Australian international air network. A further examination of individual aircraft flight paths indicated that a significant factor in this high level of Sydney-Melbourne movements was the current airline practice of serving Melbourne indirectly through Sydney. This flight path will be referred to as FPS (Flight Path via Sydney) in the remainder of this paper.



Note: Excludes Qantas and Air New Zealand flights to and from New Zealand.

FIGURE 1
INWARD PASSENGER FLIGHTS PER WEEK AS AT 1st NOV 1977



Note: Excludes Qantas and Air New Zealand flights to and from New Zealand

FIGURE 2

OUTWARD PASSENGER FLIGHTS PER WEEK AS AT 1st NOV 1977

Table 1 presents the weekly scheduled international aircraft movements at Sydney and Melbourne as at November 1977, by time of day. The number of FPS flights shown in brackets indicates their high relative contribution to total movements in the most congested time slots.

The fact that such a large number of airlines follow FPS seems contrary to the number of direct international flights which would be expected to and from each port on the basis of relative population catchment areas. A population catchment area can be defined as the international port to which passengers could travel at the least cost. On this basis Melbourne could expect to attract passengers from Tasmania, South Australia, Victoria and Southern New South Wales. Sydney could expect to attract passengers from Central and Northern New South Wales and the Australian Capital Territory. Perth, Brisbane and Darwin international airports could expect to cater for most of the traffic from their respective states, although this would obviously depend on the direction of overseas travel. Population estimates indicate a slightly larger catchment area for Melbourne than Sydney, which is surprising as Sydney is by far the largest international terminal in Australia.

The reason for Sydney's predominance is partly due to the historical development of international air services in Australia. It was the first airport to provide these facilities and therefore has traditionally been the main port for international aircraft arrivals and departures. While there has been some shift of services to Melbourne since the opening of Tullamarine Airport in 1970, these services have mainly been seen as extensions of the Sydney service, as indicated by the significant number of FPS flights currently operating.

The phenomenon of Sydney receiving a disproportionate share of direct services with respect to its relative catchment area is made more complex by the practice of common-rating by the international airlines. This involves equivalent fares usually being quoted for travel from Sydney and Melbourne for economy and first-class travel. However, when domestic airlines act as booking agents for an international airline (a common practice in Australia) they are paid the full domestic fare by that international airline. It may therefore be in the interests of the domestic airlines to fly, say, an Adelaide passenger to Sydney to connect with an international flight rather than to Melbourne, even though Melbourne is the closest international port. The cost to the passenger is unaffected whereas the revenue

TABLE 1 - WEEKLY SCHEDULED INTERNATIONAL AIRCRAFT MOVEMENTS[a]

Time	International Airport			
	Sydney		Melbourne	
	Arrivals T[b] (FPS)[c]	Departures T (FPS)	Arrivals T (FPS)	Departures T (FPS)
0000-0059				
0100-0159	CURFEW			
0200-0259	PERIOD			
0300-0359				
0400-0459			1	
0500-0559			3	1
0600-0659	15 (6)		4	1
0700-0759	25 (15)	9 (4)	2	5
0800-0859	21 (6)	7 (5)	9 (2)	3
0900-0959	7	22 (18)	9 (7)	4
1000-1059	15 (4)	7	17 (17)	7 (2)
1100-1159	10 (3)	11 (4)	1 (1)	
1200-1259	4	15 (3)	6 (4)	8 (8)
1300-1359	11 (8)	16	4	4 (3)
1400-1459	4	15 (8)	3 (1)	12 (12)
1500-1559	12 (12)	6	6	10 (5)
1600-1659	8 (6)	15 (12)	7	4
1700-1759	2 (2)	11 (6)	-	8
1800-1859	2	3 (2)	-	6 (2)
1900-1959	11 (2)	-	3	-
2000-2059	-	-	-	3
2100-2159	5	7 (2)		-
2200-2259	2	6	1	-
2300-2359	CURFEW			1
Total Movements[d]	154 (64)	150 (64)	78 (32)	79 (32)

(a) As at November, 1977. The table excludes flights by Qantas and Air New Zealand to New Zealand. (b) Total hourly movements. (c) The number of movements conforming to this flight path. FPS is illustrated in Fig. 3. (d) The discrepancy between arrivals and departures is probably due to some unscheduled repositioning aircraft movements.

to the domestic airline is maximised. This practice could therefore falsely inflate the demand for international air services to and from Sydney compared with the demand at Melbourne, and further reinforce the belief by some airlines operating services to Australia that Sydney should remain as the first and last port of call.

For a variety of reasons, then, FPS has evolved as the primary method by which airlines cater for passengers travelling to and from Sydney and Melbourne. The major objection to FPS is that it increases congestion on an already congested route, possibly as a result of inefficient aircraft utilisation. As only Melbourne passengers are carried on this flight stage, the average load factor is only around one half of that on flight stages between Sydney and overseas ports. The net result is that there is considerable excess capacity on international aircraft travelling between Melbourne and Sydney.

This problem of congestion and excess capacity occurring simultaneously is not unique to this particular situation. It can be found in all areas of transport and nowhere more obviously than on the roads. Each morning and evening, commuters in most of the world's major cities suffer congestion delays in traffic where one-occupant cars dominate. A recognition of this problem has caused experimentation with many pricing and/or regulation formulas to encourage public transport use and car pooling (which increases the vehicle occupancy rate and hence eases congestion). These measures, by reducing the total commuter vehicle distance travelled, have the added benefit of reducing the daily transport resource cost. Nevertheless, it must be remembered that these benefits must be compared with the overall reduction in passenger convenience, which a switch to car pooling or public transport use usually involves, before any policy recommendation can be made.

In a search for a solution to this overcapacity problem on the Sydney-Melbourne air route, the three factors of congestion, transport resource cost and passenger inconvenience mentioned above were again found to be important. However, a simple minimization of these three parameters does not necessarily lead to a solution which can be readily implemented. Each theoretical solution must be constrained by the practical problems of implementation, which in this case proved to be significant, before a final recommendation can be made.

THE ALTERNATIVES

A reduction of the excess capacity on the Melbourne-Sydney route can be brought about by a reduction in either the domestic or international airline flights. Domestic flights can perhaps most effectively be reduced by allowing all international aircraft to carry interstate traffic on the route (a practice which government regulation currently inhibits). This would have a substantial impact on the number of domestic flights as the passenger/aircraft ratio would be substantially increased with the use of larger aircraft. Nevertheless, this alternative was not evaluated in detail because of some important practical problems. These are outlined briefly below:

- frequent late arrivals from overseas would lead to an unpredictable domestic Sydney-Melbourne timetable,

- the separation of the international and domestic terminals at Sydney could cause logistic problems for passengers wishing to travel domestically beyond Sydney,

- the introduction of new domestic carriers would require a renegotiation of the two airline agreement,

- domestic airlines would object very strongly to any reduction in the demand for their services on one of their most profitable routes,

- the policy change would imply a transfer of income away from the Australian domestic carriers not only to Qantas but also to other overseas-based companies.

These practical considerations ruled out any further evaluation of this policy option.

The other alternative is to reduce the number of international flights on the Melbourne-Sydney route. The first way of doing this is to prohibit any on-carriage of passengers by international airlines and only allow domestic airlines to carry passengers between Australian ports. Once again this solution was found to be fraught with problems at the implementation stage. The most significant of these problems are:

- refusal to allow international airlines any on-carriage rights would be in direct conflict to many bilateral air agreements and would certainly be detrimental to the overseas operations of Qantas,

- elimination of all indirect flights would lead to a dramatic fall in service frequencies. For instance a daily indirect service ex-Melbourne to an overseas port via Sydney would in some cases be reduced to a direct service ex-Melbourne on perhaps three or at most four days per week. Sydney, Perth and Brisbane passengers would also suffer reductions in service frequencies to many overseas ports,

- aircraft movements may not be significantly reduced as passengers now carried by the international airlines transfer to smaller domestic aircraft.

Fortunately, there are still other ways to eliminate some international aircraft movements and reduce congestion on the Melbourne-Sydney route. The remaining alternatives come under the heading of flight path adjustments. There are three such adjustments:

1. FPT(S) A 'triangulated' flight path, shown in Fig. 4, which uses Sydney as first port of call and Melbourne as last port of call in Australia.

2. FPT(M) A flight path triangulated in the reverse direction to FPT(S), with Melbourne as the first port of call and Sydney as the last port of call. This is also shown in Fig. 4.

3. FPM A flight path which still involves two Sydney-Melbourne flights in a round trip, but one which uses Melbourne as the first and last port of call. FPM is illustrated in Fig. 5.

All three alternative flight paths involve one-half the number of aircraft movements at Sydney airport than FPS which flies via Sydney twice on a return journey. In addition, FPT(M) and FPM result in a reduction of the peak period demand at Sydney airport. A full evaluation of each of these alternative flight paths was undertaken. Each flight path is currently in operation to some extent and Figures 3, 4 and 5 indicate the number of weekly aircraft movements on each flight path in November 1977.

It must be emphasised that the three alternative flight paths discussed above are only interim measures (as is FPS) until the demand for the services for an airline increases to the extent that daily direct services into and out of Sydney and Melbourne are warranted. When this

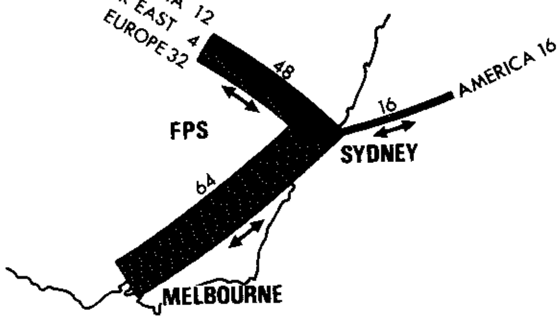


FIGURE 3 - WEEKLY FLIGHTS VIA SYDNEY
AS AT 1st NOV 1977

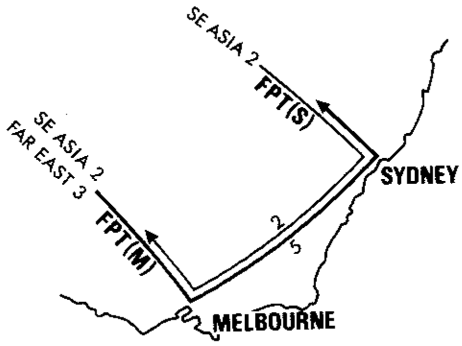


FIGURE 4 - WEEKLY TRIANGULATED FLIGHTS
AS AT 1st NOV 1977

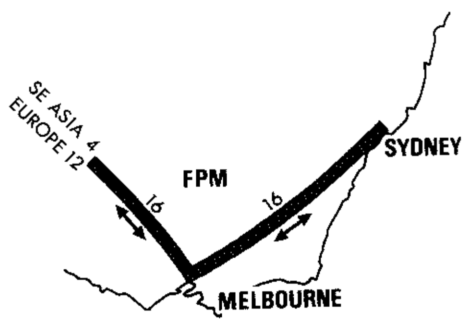


FIGURE 5 - WEEKLY FLIGHTS VIA MELBOURNE
AS AT 1st NOV 1977

occurs, the passenger convenience objective has usually been satisfied and there is no longer any need to maintain an indirect service which increases frequency. However, with 22 international airlines offering Australian services this frequency objective for direct services is unlikely to be obtained by most of the airlines over the next ten years. Furthermore, the replacement of Boeing 707's by higher capacity aircraft will accommodate future increases in demand on some routes and postpone the introduction of extensive direct services between Melbourne and some overseas ports.

Even when there are extensive direct services available at Melbourne, possible future international airports such as Adelaide and Hobart could require indirect linkages through Melbourne or Sydney to achieve an adequate service frequency at the new ports. In the meantime, the problem of adequately servicing Brisbane will exist for some time. Thus, while each alternative indirect flight path can be referred to as an interim measure, the need for an optimal indirect flight path will exist on several routes in Australia into the foreseeable future.

PASSENGER AND AIRCRAFT MOVEMENTS

This section outlines an approach developed in the Bureau of Transport Economics for deriving future passenger and aircraft movements at Sydney and Melbourne from forecasts of overseas arrivals in and departures from Australia. The sensitivity of the movements at Sydney and Melbourne to variations in Sydney-Melbourne flight configurations is then examined.

An econometric demand model used for forecasting purposes produces total Australian air demand forecasts by purpose of travel, direction of travel and by the overseas origin or destination region. This forecast demand is then allocated to a state or territory of Australia on the basis of recorded historical flows to those areas. Passengers are then allocated to the various international gateways in Australia according to their state or territory of origin or destination and their purpose of travel, combined with assumed developments in the future use of airports. Passengers who transit at Sydney but have origins and destinations outside Australia (e.g. N.Z. passengers travelling to Europe) are included in the Sydney forecasts. Given assumptions about aircraft type and seating capacity on each route for each operator on that route, the number of direct flights that would be needed to satisfy demand at each port are then calculated. These direct flights are divided amongst the carriers on the basis of present market shares.

The derivation of the number of direct flights warranted by each carrier from each port is still insufficient to forecast actual aircraft movements. This is because of the usual practice of providing more frequent indirect flights from ports which can only justify a low frequency direct flight service. The implicit assumption is that airlines strive to achieve a daily service frequency where possible at the expense of a less direct flight path. Table 2 shows the relationship between the forecast warranted direct service at Melbourne and the number of actual direct and indirect (via Sydney) services which would be likely to result. This relationship is used by the Bureau of Transport Economics for forecasting purposes on most international routes.

TABLE 2 - DIRECT/INDIRECT FLIGHT ASSUMPTIONS

Warranted Direct Services (per week)	Direct Services	Indirect Services
1	-	2
2	-	4
3	-	6
4	-	6
5	1	6
6	5	2
7+	7+	-

One final step is needed to predict aircraft movements at Melbourne and Sydney. This is to decide on the actual flight path of the indirect services offered. As discussed earlier, services to Australia which call at Sydney and Melbourne on each flight can fllow one of four possible flight paths: FPS as in Fig. 3, FPT(S) or FPT(M) as in Fig. 4 or FPM as in Fig. 5. The sensitivity of aircraft and passenger movement forecasts at Sydney and Melbourne to variations in the assumed mix of indirect flight paths can best be illustrated by use of a simple example.

Table 3 shows the number of aircraft and passenger movements at Melbourne and Sydney which would result from the application of each flight path to a hypothetical demand situation of 200 incoming and 200 outgoing passengers whose origins or destinations are equally divided between Sydney and Melbourne. Even though the number of passenger movements within Australia is unaffected in each case, the flight path does determine the allocation of these passenger movements between Sydney and Melbourne. For instance, a change from FPS to FPM would result in a reduction of Sydney passenger movements by two-thirds.

The flight path also determines the allocation of aircraft movements between the two ports. Unlike the passenger movement situation, Table 3 shows that total aircraft movements vary with the flight path. For instance, the triangulated flight paths FPT(S) and FPT(M) result in a reduction of one-third in aircraft movements over the non-triangulated FPS and FPM.

The significance of these differences indicate that a more detailed evaluation of the flight path alternatives is warranted. This evaluation, which is presented below, investigates each option beyond the effect on aircraft and passenger movements to examine the implications for peak period congestion, airline operating costs and passenger convenience.

EVALUATION OF ALTERNATIVES

In the previous section, four possible flight paths for international aircraft servicing Melbourne and Sydney have been outlined. Briefly they are a flight path to and from Melbourne via Sydney (FPS), two triangulated flight paths, FPT(S) and FPT(M), and a flight path to and from Sydney via Melbourne (FPM). For the purposes of evaluation, FPS will be considered to be the base case that is the situation which will continue in the absence of any operational initiatives. This base case will then be compared with three alternatives: FPT(S) FPT(M) and FPM. Benefits and costs will be converted into monetary terms where possible but a comprehensive cost-benefit analysis has not been carried out because of the difficulty of quantifying such things as passenger convenience.

The Base Case

A typical base case example is an international air service which arrives at Sydney at about 0730 each day and departs for Melbourne at 0910 where it terminates at 1030. The aircraft then stays in Melbourne until, say, mid-afternoon before leaving for its overseas destination via Sydney. It departs from Sydney about 2 hours 20 minutes after leaving Melbourne due to the 1 hour 20 minute flight and the 1 hour transit time in Sydney. The implications of this flight path (FPS) will now be analysed insofar as it affects air passengers, airline companies and the government (including the Sydney and Melbourne airport management).

TABLE 3 - FLIGHT PATH SENSITIVITY ANALYSIS

Flight Path	Arrival or Departure	Airport	Passenger and Aircraft Movements			
			Sydney		Melbourne	
			Passenger	Aircraft	Passenger	Aircraft
FPS	Arr	Syd	200	1		
	Dep	Syd	100	1		
	Arr	Mel			100	1
	Dep	Mel			100	1
	Arr	Syd	100	1		
	Dep	Syd	200	1		
TOTAL MOVEMENTS			600	4	200	2
FPT(S)	Arr	Syd	200	1		
	Dep	Syd	200	1		
	Arr	Mel			200	1
	Dep	Mel			200	1
TOTAL MOVEMENTS			400	2	400	2
FPT(M)	Arr	Mel			200	1
	Dep	Mel			200	1
	Arr	Syd	200	1		
	Dep	Syd	200	1		
TOTAL MOVEMENTS			400	2	400	2
FPM	Arr	Mel			200	1
	Dep	Mel			100	1
	Arr	Syd	100	1		
	Dep	Syd	100	1		
	Arr	Mel			100	1
	Dep	Mel			200	1
TOTAL MOVEMENTS			200	2	600	4

The first implication of FPS is that all inbound passengers travelling to Sydney arrive at their destination 3 hours earlier than their Melbourne counterparts, even from places such as South East Asia which are actually closer to Melbourne. This time difference is occasionally offset to some extent by the fact that Melbourne-bound passengers could pass through customs in Sydney and could therefore avoid this delay in Melbourne. However, this is not normally done under FPS. On the outbound flight, Melbourne passengers are again disadvantaged by about 2½ hours compared with Sydney passengers.

Another consequence of FPS affecting domestic and international passengers is the general congestion delays experienced at Sydney airport when aircraft arrive at Sydney and depart for Melbourne in the morning peak period. These congestion delays occur mainly at the international terminal during customs processing and baggage collection, but may occur before landing if the international aircraft has to compete with domestic aircraft for runway space during the morning domestic peak period.

From the international airline companies' point of view, FPS results in very low load factors on the Sydney-Melbourne and Melbourne-Sydney flight stages. This is mainly due to the fact that only Melbourne passengers are carried on each leg, but the problem is exacerbated by the practice of common rating mentioned earlier. The financial implications of the low load factors are reflected in the air navigation charges and other operating costs of the airlines.

Air navigation charges in Australia are calculated by multiplying a unit charge, which varies with aircraft weight, by a route factor, which is a rough measure of the relative cost of monitoring the aircraft in controlled Australian airspace. To give an example, the unit charge for a Boeing 747B entering or leaving Australia is currently about $276 which is, in turn, multiplied by route factors of 10, 4, 4 and 10 for an aircraft travelling between Singapore and Sydney, Sydney and Melbourne, Melbourne and Sydney and Sydney and Singapore respectively. This gives an approximate total Australian air navigation charge for this particular aircraft on FPS of $7,740 for a return journey or $2.83m per year for a daily service to and from Australia from Singapore.

Another consideration for airlines is the operating cost associated with FPS. In particular, the total operating cost of serving both Sydney and Melbourne is needed for comparisons with alternative flight paths. Using a 1976 estimate of $2,483 per block hour[1] as the direct operating costs for a 747B and a return block time of 2.67 hours between Sydney and Melbourne gives an annual (1976) estimate of $2.42m for the direct operating cost of a daily Sydney-Melbourne-Sydney service.

A further sector affected by FPS is the government, including the management of Sydney and Melbourne airports. In a recent report[2] the Bureau of Transport Economics suggested that the government was presently achieving almost full cost recovery from international airline operations. However air navigation charges do not vary by time of day and therefore it is quite likely that revenue is different from the costs of providing air navigation facilities in peak periods. A net loss to the government would result from peak period FPS movements if the marginal cost of providing air navigation facilities at this time was greater than the marginal air navigation charges received. Lack of information on the nature of air navigation cost functions has prevented any detailed discussion of this issue.

Triangulation

The base case situation of a daily service following FPS will now be compared to a daily triangulated service i.e. one following FPT(S) or FPT(M). The flight path FPT(S) will be examined first.

To give a parallel example to the base case, assume the triangulated flight arrives in Sydney at 0730 where some incoming passengers disembark while other outgoing passengers embark. The aircraft then departs for Melbourne at 0910 and arrives at 1030 where, once again, some passengers disembark while others embark. Allowing the minimum transit time of 1 hour, the aircraft could then depart for its overseas destination at 1130.

This change in the flight path has no effect on inbound Melbourne passengers. They still arrive 3 hours later than their Sydney counterparts. However, outbound Melbourne passengers now receive a direct service to their overseas port involving a time saving of up to 2½ hours over FPS. Against this benefit of FPT(S) must be set a new time disadvantage of 2½ hours to outbound Sydney travellers. If it is assumed that the Sydney/ Melbourne ratio of inter-

1 Department of Transport estimate which excludes air navigation charges and indirect operating costs.

2 Bureau of Transport Economics (1977). Cost Recovery in Australian Transport 1974-75 (AGPS: Canberra).

national travellers is 50-50 then FPS and FPT(S) can be said to be equal in terms of passenger travelling time for travel between Australia and overseas ports which are an equivalent distance from Sydney and Melbourne. If the overseas port is closer to Melbourne, then a net time saving accrues to FPT(S) over FPS. For instance, the Melbourne-Singapore route distance is approximately 250 kilometres less than the Sydney-Singapore journey, implying a passenger time saving of about 30 minutes[1] for a round trip.

Congestion delays at Sydney airport in the morning peak period are identical for FPS and FPT(S). While FPT halves the number of aircraft movements at Sydney, the reduction is achieved in an off-peak period. Thus there is no effective saving in the congestion delay to incoming passengers. In fact there could be a net increase in total passenger congestion costs if the Sydney-Melbourne flight suffers runway delays in Sydney due to a clash with the domestic peak period. This is simply because any delay to aircraft departing Sydney for Melbourne on FPT(S) involves approximately twice as many passengers as under FPS due to the higher load factor.

Following on from this last point, FPT(S) suggests a more efficient aircraft utilisation on the Sydney-Melbourne route by the airline companies. This increase in efficiency is reflected firstly in the level of direct operating costs and the air navigation charges incurred by the airline under FPT(S). Annual direct operating costs for a daily service to Sydney and Melbourne operated by a 747B will be $1.21m (1976 costs) lower for FPT(S) than for FPS (due to the elimination of the Melbourne to Sydney flight) for travel to an overseas port which is a similar distance from Melbourne and Sydney. The cost saving will be greater than this for travel to those places which are closer to Melbourne, and below this for those places closer to Sydney. In the Melbourne-Singapore example above, the distance saving of 280 kilometres would result in additional operating cost savings of about $0.5m[2] for a daily 747 service switching to FPT(S). Annual air navigation charges will be about $0.4m per annum lower for FPT(S) for a daily service by a 747B, due to the elimination of the Melbourne-Sydney flight.

The reduction in time needed to serve both Australian ports may allow some airlines more flexibility in aircraft scheduling. Aircraft involved on routes using FPT(S) would now have more time available for other flights than aircraft remaining on FPS. The extent to which this extra aircraft time could be used would vary amongst airlines.

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1 Bureau of Transport Economics estimate.
2 Bureau of Transport Economics estimate.

It is now appropriate to discuss implications of reverse triangulation - that is FPT(M) which uses Melbourne as first port of call in Australia.

The triangulated flight in this case was assumed to arrive in Melbourne at 0730, depart for Sydney at 0910 and arrive at 1030. Once again a minimum transit time would imply an 1130 departure from Sydney.

Compared with the base case, this application of a triangulated flight path in a non-congested period would generally result in a transference of some benefits from Sydney-based passengers to Melbourne-bound passengers with no net time saving. However, this flight path results in a transference of aircraft movements out of the Sydney early morning peak period. Therefore delays to passengers in collecting their baggage and passing through customs in Sydney will be significantly reduced, although it was not possible to quantify and evaluate this benefit.

From the airline companies' point of view the direction of triangulation has no effect on the direct operating cost or air navigation cost savings. That is, a switch from FPS to FPT(M) yields a similar benefit to the airlines as a switch to FPT(S). Nevertheless, an application from an overseas-based airline for commercially desirable time slots in Australia is likely to be treated more favourably if the Sydney early morning peak is avoided. For this reason, reverse triangulation (i.e. FPT(M)) may be inherently more attractive to some airline companies.

The government and airport management authorities would seem to benefit from any change from FPS to FPT(M) which triangulates through Melbourne first, as this reduces Sydney airport congestion. An 0730 arrival and 0910 departure at Sydney have been replaced by a 1030 arrival and 1130 departure, both of which are in non-congested time slots for international and domestic aircraft movements.

Flying via Melbourne

One final method of servicing Melbourne and Sydney in a non-direct fashion is via FPM. This involves the use of Melbourne as first and last port of call in Australia. A change from the base case to FPM switches benefits from Sydney passengers to Melbourne passengers. But, as is the case with reverse triangulation, a net gain to passengers results as peak period movements at Sydney are usually avoided with this flight path.

Airline operating costs and navigation charges for FPS and FPM will vary slightly for different routes, but are lower for flights to ports which are closer to Melbourne than Sydney. For example a return trip to Singapore would save an airline 560 kilometres on a round trip which is approximately equal to a cost saving of $1m per annum for a daily 747 service. Alternatively a switch from FPS to FPM for flights to the Pacific region (approximately 700 kilometres closer to Sydney) would imply additional airline operating costs of around $3m per annum for a daily 747 service.

The reduction of airport congestion at Sydney will again benefit airport management and the government to a similar extent to FPT(M).

Practical Considerations

While the above discussion of the costs and benefits of each flight path has considered the airlines' interest in terms of operating costs and air navigation charges, no attempt has yet been made to assess the problems which individual airlines may face on some routes, and which could prevent the implementation of one or more of the suggested alternative flight paths. A general discussion of these possible problems is presented below.

Firstly, the application of FPM does not seem to present any practical difficulties to airlines. However it should be stressed that it can really only be considered for travel between Australia and overseas ports which are not significantly closer to Sydney than Melbourne. Hence FPM is not considered to be applicable to flights to Oceania and North America. However, on flights to Europe and South East Asia (e.g. London, Singapore) FPM offers operating cost savings to the airlines over FPS and would seem to be no less commercially desirable. The absence of a curfew at Melbourne would also allow a more flexible arrival time in Australia (Sydney airport has a curfew from 2300 to 0600).

More significant practical problems are associated with the triangulated flight paths, FPT(S) and FPT(M). These problems centre around the fact that, to minimise passenger inconvenience, triangulation must be a continuous service with transit times at Sydney and Melbourne of less than two hours. In this time, the aircraft must be cleaned and restocked with food for the outward flight, a task which would be more difficult and might prove more costly for those aircraft on the longer haul routes.

A more substantial objection to the low transit times is that it reduces the time buffer zone presently available to airlines under FPS to guard against late arrivals. Roughly 25% of all overseas arrivals into Australia are more than one hour late, with a higher proportion applying to the long haul routes. If an airline was operating on the minimum transit times, a late arrival would not only inconvenience the on-board passengers (as is the case under FPS and FPM) but would also delay the departure of all passengers booked on the outward flight. The commercial undesirability of this situation may lead to elimination of the triangulation alternative on routes which have historically been associated with frequent delays.

The need for a continuous service implies that triangulation is more difficult for Qantas than for an airline based overseas. This is for two reasons. Firstly, the need to service Qantas aircraft in Australia implies a need for passengers to change planes in either Sydney or Melbourne on some triangulated flights. As Qantas routinely inspect their aircraft every 100 hours, this is a particularly significant problem on long haul routes where the aircraft must be inspected after only two return journeys. Any change of aircraft is seen as commercially undesirable to the airlines in the light of past passenger complaints. In addition, an aircraft change implies a need to occupy two parking spaces on the airport apron which could cause problems in the peak period. Airline companies based overseas would not face the same service difficulties in Australia.

The second reason why Qantas may find triangulation more difficult to implement than other airlines concerns international curfews and commercially desirable arrival and departure times. Unless the return journey time was exactly 24 hours a continuous triangulated service operated by Qantas would soon run into the problem of unacceptable arrival or departure times either in Sydney or at the overseas port. Overseas based airlines can overcome this problem by rescheduling the aircraft on another route until acceptable times become available on the Australian route, an option which is not open to Qantas as its route structure radiates from Australia. In addition, overseas airlines can use this method to achieve consistent arrival and departure times in Australia on each day of the service. To do this, Qantas would need to have long layovers in foreign ports which would be an under-utilization of their aircraft, although perhaps there is a trade-off here between this inefficiency and the costs involved in an additional Melbourne-Sydney flight under FPS and FPM.

In summary, the prospect for the triangulation of Qantas flights does not seem particularly bright, particularly on the long haul routes. Servicing difficulties would be less on the shorter-haul routes but other problems associated with the continuous service would remain. On the other hand, triangulation in Australia poses many less problems for overseas-based airlines. The only major difficulty concerns the need for a time buffer zone, particularly for the less reliable longer-haul routes.

SUMMARY AND CONCLUSIONS

The objective of the preceding descriptive evaluation has been to derive a more efficient way of catering for international air travel demand at Sydney and Melbourne. The present practice of flying to Melbourne via Sydney on both the inward and outward international trips (FPS) has been found to be undesirable from several aspects. In general, this flight path significantly contributes to congestion at the Sydney international air passenger terminal, results in an inefficient use of aircraft on flights between Melbourne and Sydney and provides Melbourne passengers with a much less convenient service than that provided to Sydney passengers. Various alternative arrangements have been discussed which overcome some of the problems with the present flight path.

Several changes in the present traffic rights of domestic and international airlines have been discussed and have been found to be difficult to implement in the present regulatory framework. A more promising solution appears to be in the adoption of alternative Sydney-Melbourne flight paths by some airlines on several routes. In particular, the relative merits of a flight path which served Sydney via Melbourne on each of the inward and outward journeys (FPM), and two 'triangulated' flight paths, FPT(S) and FPT(M), (passing through Sydney and Melbourne once on a return journey) over the present Sydney-Melbourne flight path have been examined. Each of these new flight paths results in varying levels of net benefit, depending on the characteristics of each flight change under consideration.

A change from FPS to FPM for early morning arrivals in Australia reduces congestion at the Sydney international airport by reducing the number of peak period aircraft and passenger movements. It also reduces airline operating costs for travel between Australia and South East Asia which is closer to Melbourne than Sydney. Melbourne passengers receive a more direct service at the expense of a less direct service for Sydney passengers.

Another alternative is to switch from FPS to a 'triangulated' flight path on which aircraft arrive in Australia at Sydney and depart from Melbourne (FPT(S)). The introduction of this flight path is not expected to reduce congestion at Sydney airport as it usually involves the same number of aircraft movements and a higher number of passenger departures in the morning peak period. Nevertheless, considerable airline operating cost savings result from the elimination of one Sydney-Melbourne journey on a round trip.

The final alternative is to change from FPS to a flight path on which aircraft arrive in Australia at Melbourne and depart from Sydney (FPT(M)). This alternative has the congestion cost savings of FPM and the airline operating cost savings of FPT(S) and is therefore recommended as the most desirable option.

In the final analysis, the special circumstances of a particular airline on a particular route will determine the extent to which the alternative flight paths discussed above can be implemented. A brief review of practicalities has revealed lower implementation difficulties for flights to Europe and South East Asia operated by non-Australian airlines. The significant operating cost savings which can be achieved on each of these routes may be sufficient inducement to the airlines to voluntarily undertake flight path adjustments without the need for any changes to the present regulatory environment.