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Expanding the revenue management frontier: Optimal air planning in the cruise industry

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ABSTRACT

Applications of revenue management usually focus on the sale of products to customers. This paper shows how revenue management can also be applied to a company's purchase of services. We focus on the cruise-line industry, where the purchase of airfare for cruise passengers can exceed 20 per cent of revenues. An outline for an optimal air planning programme is proposed, with emphasis on decision support for routing passengers on flights and negotiating contract fares with the airlines. Benefits of such a programme include improving both customer service and relationships with airlines and reducing airfare expenses by 5–8 per cent.

KEYWORDS: revenue management, air planning, minimum cost network flow model, cruise-line industry, negotiating contract fares

INTRODUCTION

Revenue management. Pricing. What picture does that bring to mind? A common initial reaction is to think about innovative approaches for selling a product to a company's customers. Now think about the conditions necessary to apply revenue management concepts. One of the core requisites often cited is the presence of high fixed costs and low variable costs with product sales (Cross and Lieberman, 1991; Kimes, 1997; Shuman, 1991). And it is true that traditional applications of revenue management tend to have this feature.

This paper contends that for some industries there is another side of revenue management, one that has received much less attention. In industries where product sales involve high but manageable variable costs, revenue management opportunities may exist with respect to the company's purchase of goods or services. One such industry, the focus of this paper, is the cruise industry, where 20–25 per cent of a

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cruise line's revenue may go towards the purchase of airfare for its customers.

At first glance, the inclusion of this paper in the *Journal of Revenue and Pricing Management* might seem out of place. The decision support tools and modelling approach presented here are quite different from those found in more traditional revenue management applications. On more careful reflection, however, the techniques presented here will be seen to address a problem similar to the traditional revenue management problem: to maximise net revenue by controlling the use or sale of available inventory in the face of uncertain demand. Techniques for directing demand in a manner that increases profits and leveraging supply and demand forecasts to affect pricing decisions are at the heart of the air planning challenge discussed in this paper. And, to a large extent, this is fundamentally what more conventional revenue management applications are also about.

THE OPPORTUNITY

The primary goal of revenue management in the cruise-line industry is to maximise the net revenue received by the cruise line from the sale of cabins on each sailing. A cruise ship may have a dozen or more cabin categories, each with its own price point. Unlike many other industries, cruise-line revenue management often has a secondary objective of ensuring high load factors — for operational reasons, it may be important to sail with occupied cabins. For example, at some cruise lines many of the staff working aboard ship may depend on gratuities for much of their income. Cruise lines that do not consistently sail with high load factors may have greater difficulty in retaining their shipboard staff. Unlike other industries, such as hotels, where the levels of housekeeping and front-desk staff might be adjusted based on forecast occupancy levels, cruise lines cannot easily vary the level of shipboard staff from cruise to cruise.

Passengers typically book cruises anywhere from one year to only a few days prior to their trip (Dickinson and Vladimir, 1997). For holiday and more exotic cruises, bookings may even occur 18–24 months in advance. Throughout this long booking period, the cruise line may use a variety of inducements to stimulate demand. These include cabin level upgrades, 50 per cent reduction for the second passenger, and regional promotions that include airfare for specific cabin categories on certain sailing dates.

A cruise booking may be termed an *air/sea* booking if it includes roundtrip airfare or a *cruise only* booking if airfare is not included. Air/sea packages are marketed and sold in a variety of ways by the cruise lines, but the cost of airfare to the cruise line is rarely, if ever, an exact pass through to the customer. To do so would require an incredibly complex and problematic pricing structure. The price of an air/sea booking (cabin plus airfare plus other incidental fees) is generally communicated to potential cruise passengers in advance of a booking (eg through cruise-line brochures or advertisements in a newspaper) or at the time of booking. The actual air cost that the cruise line will incur for transporting the passenger, however, is not determined until later.

Cruise lines typically negotiate contract airfares with each carrier on a city by city basis. Negotiated airfares vary by carrier. Consequently, the cost incurred by the cruise line for transporting a passenger by air depends on the airline that the cruise line books for the passenger. Negotiated fares typically include a base fare for each market. Airlines may also provide the cruise line with a set of higher bump-up fares if the base fare or lower bump-up fares are not available owing to inventory control restrictions implemented by the

airline's revenue management department. The bump-up fares would typically be relevant when the cruise line books more passengers on a flight than its allotted seat block.

The assignment of cruise passengers to flights usually occurs well after reservations are made and the total cruise and air price has been communicated to the customer. In part, this is because cruises are not typically paid for at the time they are booked. Passengers may have a week after they make a reservation to make a refundable deposit. If the deposit is not received, the reservation may be automatically cancelled. Depending on the type of cruise, final payment may not be due until 45, 60 or 90 days prior to the cruise. Cruise lines will generally not book flights for passengers until they receive a deposit, and may only begin booking flights nine months or less before the sailing. Given the range of contract fares that a cruise line may negotiate in a market, as well as the occasional need to pay a bump-up fare rather than a base fare, the costs of alternative flights might change the profit margin of an air/sea booking by as much as 5–10 per cent, and sometimes more.

A cruise line's revenue management department will typically have responsibility for setting the prices of a cruise and for determining the types of promotions to run for a cruise. Revenue management staff also set inventory controls on promotions, determining promotion eligibility and how many should be sold. For example, a lower price might be offered for air/sea passengers flying from Detroit and Cincinnati, but not from Chicago. Or a two-cabin upgrade might be offered to cruise-only passengers who book a level-8 cabin. The revenue management department generally does not have responsibility for making the flight arrangements for air/sea passengers. This is the responsibility of the cruise line's air planning department. Consequently, decisions made by the air planning department can have a material impact on the net profitability of a cruise, as its efforts affect the magnitude of passenger variable costs incurred by the cruise line.

A cruise line's air planning function typically consists of several elements:

— negotiating guaranteed access to airline seats for transporting some cruise passengers to and from cruise ships (cruise lines may obtain seat block allocations from airlines on some routes);
— negotiating contract fares with airlines for each route;
— identifying opportunities to schedule charter flights, when sufficient space on regularly scheduled flights might not be available;
— managing airline seat inventory in the optimal manner, including identifying the best flights on which cruise passengers should be flown, considering both cost and customer service factors;
— communicating with sales, marketing and revenue management departments when the availability of seats or cost of transporting passengers from a gateway city for a cruise might affect pricing or inventory control decisions;
— problem investigation and resolution regarding past and upcoming air planning decisions.

Cruise lines are finding that airline seats are becoming increasingly more difficult to come by, especially for some holidays and other popular sailing dates. This problem is getting worse, since cruise-line capacity is increasing faster than airline lift. Indeed, in many markets, airline capacity has been stable or decreasing, while cruise demand grows. Negotiating for additional airline seats has become a true art and builds on long-established relationships at some major cruise lines.

Therefore, active management of air costs provides a major opportunity for cost reduction, and consequently profit enhancement, for many cruise lines (Lieberman *et al*., 1993). To the extent that a cruise line can 'assign' its passengers to less costly flights, while still meeting the cruise line's customer service policies, cruise lines obtain a dollar-for-dollar improvement in profits. And to the extent that a cruise line improves its relationship with an airline and can leverage this improved relationship into negotiating lower contract fares in some gateway cities, its costs are further decreased.

At many cruise lines, relatively low investments in decision support tools were made in air planning departments until the past few years. These departments tended to be thought of as cost centres, rather than as strategic areas where better decisions could lead to dramatic improvements in cruise-line profitability. This has finally begun to change.

Just as many travel companies and some cruise lines have discovered the benefits of a coordinated and comprehensive revenue management programme, similar benefits can be obtained from an optimal air planning programme. An optimal air planning programme consists of six primary elements:

(1) air planning database;
(2) highly active and responsive interdepartmental communications;
(3) route-optimisation decision support;
(4) block space and charter flight planning and acquisition decision support;
(5) contract fare negotiation support;
(6) reporting and performance measurement system.

A complete air planning solution includes each of these six elements, and each element is touched on in this paper. The focus, however, is on the route optimisation and contract fare negotiation elements. It is hoped that focusing on these two elements will illustrate how both advanced operations research techniques as well as relatively simple quantitative modelling made possible by a revenue management perspective can prove insightful and lead to increased profits.

Just as revenue management is not a destination, but a journey, so too is optimal air planning. Consequently, the question cruise line air planning departments should be asking is not, 'Have we addressed each of these six areas?' but rather, 'What could we do better in each area?' 'How?' and 'What would this be worth?'

As each item is discussed below, it is important to recognise that changes to the way in which business is carried out by an air planning department may also lead to increased benefits. Such opportunities are not discussed in this paper, except to note that some air planning departments are not alerted to potential problems or opportunities for managing their air expenses more effectively because they lack the automated tools that facilitate this.

AIR PLANNING DATABASE

The database is at the core of the optimal air planning programme. It should pull relevant financial and operational data into one location for easy access, analysis and manipulation. For maximum effectiveness, the database will include data feeds from the cruise line's reservation system, an airline CRS, the cruise line's back-office system, as well as flight schedule and contract fare data. More specifically, the database would include ship and inventory specifications, sailing itineraries, reservation details (such as booking date, sailing, payment status, gateway city), group booking details, airline contracts' base fares and bump-up fares, airline schedule data, block space held or requested, purchased charters, airline routing assignments and their status, air costs, etc. A comprehensive air planning

database might easily contain 40–50 gigabytes of data.

COMMUNICATION

Equipped with a comprehensive optimal air planning programme, the air planning department can communicate with other departments more effectively and efficiently. Standard reports will alert senior management to unexpected (favourable and unfavourable) air cost trends and potential gateway city problems. Air planning staff can quickly perform *ad hoc* analyses to answer questions from other departments.

While the development of the system components is certainly important, the organisational considerations and processes required to develop active and responsive communications are no less critical (Lough and Pastor, 1999). Once the air planning database and reporting systems are in place, potential barriers to the open communication of this information across the organisation should be reduced, if not eliminated. Air planning staff should work closely to provide needed information to cruise staff in marketing, revenue management, inventory control and other departments.

For example, if the marketing department needs average airfare costs for the top 50 gateways in the last quarter, air planning staff can quickly produce such a report and provide the data in tabular and graphical formats. Alternatively, a marketing analyst could have access to the optimal air planning system, and easily obtain the report him/herself. Air planning staff can provide the marketing department with up-to-date information at the sailing date level on current air costs, problem gateways and gateways where significant additional lift may be available. Marketing staff can use this information to help identify sailings and gateways where promotions should be made available to cruise-only passengers and where promotions to cruise-with-air passengers should be launched.

To help accomplish this, some cruise lines have reorganised reporting relationships so that the director of revenue management and the director of air planning report to the same vice president.

ROUTE OPTIMISATION

As previously noted, passengers are typically assigned to flights after their reservations have been accepted and the price for the cruise and airfare agreed. Some cruise lines have adopted procedures that assign passengers to flights on the lowest contract fare carrier in that gateway city. When space is no longer available on that carrier, passengers are then assigned to flights on the carrier with the next lowest contract fare, and so on. Some of the cruise-line staff spoken to believe that this will typically lead to the least-cost routing of passengers. And that would be the least-cost way to assign passengers to flights, if the assignment of passengers in one gateway city did not affect the assignment of passengers in another gateway city.

Unfortunately, the assignment of passengers to flights in one city can, and often does, affect the assignment of passengers in another city. Many passengers are not routed on non-stop flights, but are routed through airline hub cities. Cruise lines are often limited in the total number of passengers that can be routed through a hub on a specific airline. If all the passengers from Tulsa to Miami are routed on American Airlines flights through Dallas, this might require some Dallas-based passengers to be routed on Delta; or it could require some Austin-based passengers to be routed on Continental through Houston rather than on American Airlines through Dallas.

Routing example

The following example demonstrates how this can lead to increased costs for the

Table 1: Alternative Tulsa and Austin routings

		Leg 1		*Leg 2*		
Route ID	*Routing (Leg 1/Leg 2)*	*Flight No.*	*Capacity*	*Flight No.*	*Capacity*	*Fare ($)*
1	Tulsa–Dallas/Dallas–Miami	180	25	555	20	210
2	Tulsa–Atlanta/Atlanta–Miami	200	25	244	25	230
3	Austin–Dallas/Dallas–Miami	311	25	555	20	200
4	Austin–Houston/Houston–Miami	455	20	883	30	250

cruise line. Assume that there are 20 passengers that need to be routed from Tulsa to Miami and 15 that need to be routed from Austin to Miami. There are two routes available from Tulsa and two from Austin. Table 1 defines the routes and fares. The leg or segment flight numbers are given, as are the leg capacities. The capacity numbers given are the number of seats available to the cruise line.

The lowest cost feasible routing of the 35 passengers is obtained by placing five Tulsa passengers on Route 1, 15 Tulsa passengers on Route 2, and all 15 Austin passengers on Route 3. This results in an airfare cost of $7,500. Note that if all the Tulsa passengers are first routed on the cheapest available routing (Route 1), then the Austin passengers must be routed on Route 4 (because of the limited capacity on Flight 555 of 20 passengers). This alternative routing results in a total airfare cost of $7,950, a 6 per cent increase. While simple to calculate for just two gateway cities and one port, optimizing over 50, 100 or 150 gateway cities and multiple ports is not an easy task.

It is possible to capture such cost savings with a network optimisation routing model. In such models, passenger demand from all gateway cities is considered simultaneously, rather than sequentially. The least-cost routing considering all passengers is then determined. Customer service constraints (eg connection times should not be greater than 90 minutes) can also be specified and factored into the routing decision. It is even possible to include automated decision supports for identifying opportunities to use charter flights to reduce airfare expenses. In our experience, such routing optimisation models might decrease a cruise line's annual airfare expenses by 5–8 per cent. For a cruise line with revenues of $1bn, this could translate into an annual profit increase of perhaps $10–20m.

Routing model

The routing problem is thus to route the cruise line air/sea passengers from numerous gateways to (and from) their port cities. Each passenger desires the best flights, and the cruise line will have preferences with respect to the service level provided to its air/sea passengers. There are a limited number of seats, however, on each routing.

Since passengers often travel together on a cruise, we actually need to route all of these 'travel-with' groups. These travel-with groups can range in size from two people to groups of more than 50. In the case of larger groups, where the cruise line may not have enough space on a single flight to route the entire travel-with group together, the group is split up based on a user-defined maximum number of routings.

Customer service constraints, such as a preference for non-stop over connection flights, are handled through adjustments to the flight costs. For example, if a cruise line is willing to pay $20 more to place passengers on non-stop flights, the connecting flights might be penalised by that amount. So if non-stop Flight A is $250 and connection Flight B-C is $240, the model might use an adjusted cost for Flight B-C of $260, making Flight A the preferred routing. Similar adjustments can be made to flights based on flight times, jet vs propeller flights, and many other service constraints that the cruise line wants to consider. These adjustments can be carried out in a data pre-processor to the model that allows users some leeway in defining how to consider and value interactions of multiple customer service factors.

When cruise lines negotiate contract airfares, there is the possibility that the fare negotiated with an airline will be lower than otherwise possible, if the cruise line agrees to meet certain market share commitments (Anonymous, 1991; Schellenberger, 1991). That is, the cruise line agrees to use that airline for at least a certain percentage of its passengers from a gateway city. The model treats this particular constraint explicitly, where the market share values are user defined. In practice, cruise staff would monitor the cruise line's market share performance over the course of the year and use this information to adjust market share constraints for particular cruise departure dates. There would generally not be a need to honour market share commitments on a weekly basis; rather cruise staff could carry out some sensitivity analysis to estimate the financial impacts of meeting market share commitments for any given run of the model and based on that information determine the most appropriate way to proceed.

A minimum cost network flow model is formulated to solve the least-cost routing problem. The objective is to minimise the total cost of routing all travel-with groups for a given embarkation date.

Let

X_{jkt} = number of passengers sent on route j, in class of service k, from travel-with group t

Y_{jt} = 1 if travel-with t is on route j
0 otherwise

C_{jk} = adjusted cost of one passenger on route j, in class of service k

Pax_t = number of passengers in travel-with group t

$Split_t$ = number of flights travel-with group t can be put on (>1 for large groups)

$Flight_{ik}$ = capacity on flight i, in class of service k available to cruise line

Z_{ij} = 1 if flight i is in route j
0 otherwise

$Route_{jk}$ = minimum seat capacity over all flights i in route j for class of service k (eg if Flight 111 from City A to City B coach capacity is 35 and Flight 222 from City B to City C coach capacity is 45, then the route capacity is min[35,45] = 35)

$Share_m$ = market share commitment made with a specific carrier for a given origin-destination

W_{mj} = 1 if $Share_m$ applies to route j
0 otherwise

V_j = 1 if route j is for the origin-destination of $Share_m$
0 otherwise

Then the model is

$$\min \sum_{t,j} Y_{jt} \sum_{k} C_{jk} X_{jkt}$$

subject to:

$$\sum_{j,k} X_{jkt} = Pax_t \text{ for } t = 1, 2, \ldots \qquad (1)$$

$$\sum_{j} Y_{jt} \leq Split_t \quad \text{for} \quad t = 1, 2, \ldots \tag{2}$$

$$\sum_{t,j} X_{jkt} Z_{ij} \leq Flight_{ik} \quad \text{for all} \quad i, k \tag{3}$$

$$\sum_{t} X_{jkt} \leq Route_{jk} \text{ for all } (j,k) \text{in the network} \tag{4}$$

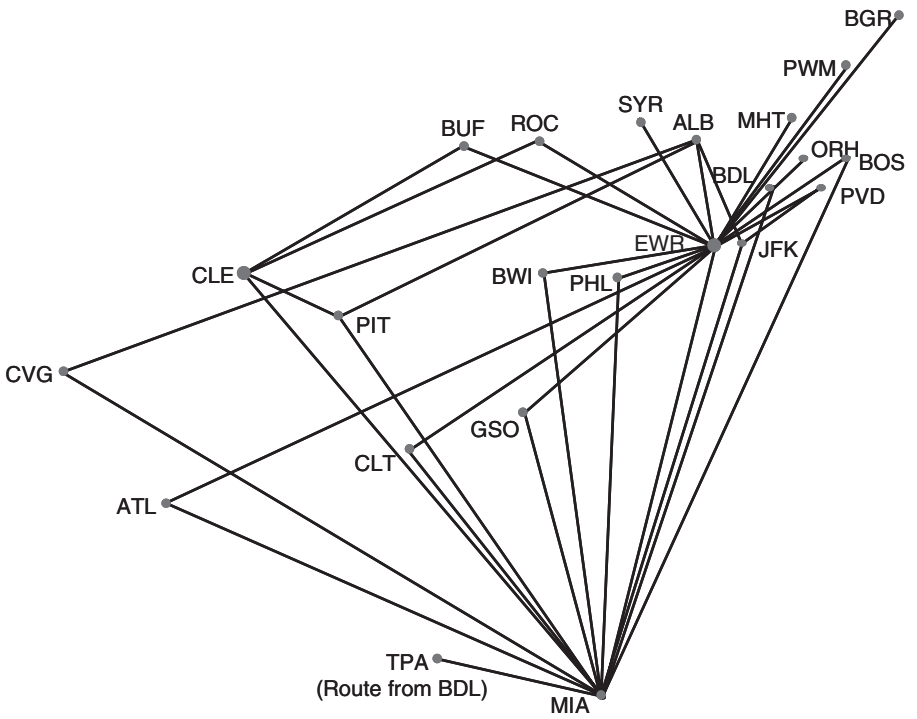
$$\frac{\sum_{j,k,t} X_{jkt} W_{mj}}{\sum_{j,k,t} X_{jkt} V_j} \geq Share_m \text{ for all } m \tag{5}$$

The first constraint ensures that each travel-with group gets routed. The second constraint identifies the maximum number of flights over which a travel-with group can be routed. The third constraint makes sure that for every flight that appears in more than one route, the number of passengers routed on that flight will be less than or equal to the given capacity on that flight. The fourth constraint makes sure that the route capacity is not exceeded. The fifth constraint ensures that each market share commitment is met.

Experimental results

To estimate the value of the route optimisation model, a prototype was developed. A simplified network of gateway cities that concentrated on routings from the north-east USA to Miami was created. The goal was to see how the model would have routed passengers on departed cruises and then compare the airfare cost resulting from those routing decisions to the cost actually incurred by the cruise line. The network included 22 north-east gateways for routing passengers from the New York area to Miami. (Figure 1 illustrates this New York network of gateways.) The model itself was simplified in that no travel-with or market share constraints were considered.

Figure 1: Reduced air cost estimate: The 'Newark Network'



Actual routing options for the selected gateways were chosen based on the following conservative assumptions:

(1) Double connections were not allowed.
(2) Routes into Ft Lauderdale (half an hour from Miami) were not included.
(3) Connecting passengers could only be routed on the next flight to Miami (ie waiting for a later connecting flight was not permitted).

These assumptions helped to ensure that running the prototype would yield a conservative estimate of its potential value. In practice, these assumptions could be relaxed under certain conditions, and additional routing options would be incorporated into the model. The routing model might identify even less costly flights on which to route passengers.

For the selected routes, three scenarios were run, varying the capacity limits on the number of passengers the model could assign to any flight. Although it was known how many passengers were routed by the cruise line on each flight, access was not available to the maximum number of passengers that could have been routed on any of these flights. The scenarios were selected to help evaluate the impacts of acquiring more space than the cruise line thought it could easily obtain, the amount of space that the cruise line usually did obtain, and less space than was usually obtained. These three scenarios, respectively, were

Scenario 1. Assume availability is equal to route capacity (ie assume the cruise line could obtain all seats on the selected flight).
Scenario 2. Assume availability is equal to 30 per cent of the route capacity.
Scenario 3. Assume availability is equal to the minimum of 20 seats or 25 per cent of the route capacity.

Scenario 2 was thought to be the most realistic, in terms of the number of seats the cruise line could actually expect to purchase on a flight.

Historical passenger counts were obtained for eight sailings. For these sailings, the airlines' contract fares in each gateway city and the flights on which passengers were actually routed were known. It was possible to compare the costs of the actual routings with the costs of the routings recommended by the model. For two sailings, the seat availability was too highly constrained by the third scenario and feasible solutions were not found. This finding was consistent with the expectation that Scenario 2 was most realistic, as Scenario 3 underestimated the number of seats the cruise line was able to obtain. For the tested scenarios and sailings, the potential air cost savings ranged from 3 per cent to 16 per cent per sailing, reaching as high as 11.6 per cent when only Scenarios 2 and 3 are considered. Table 2 contains the estimated benefits for the eight sailings under each scenario. Based on the results of the prototype, a conservative estimation is that the routing model could help a cruise line reduce its air costs by 5–8 per cent.

Table 2: Benefits estimate: Reduced air costs (%) — New York Network

Voyage	*Scenario 1*	*Scenario 2*	*Scenario 3*
1	11.7	7.1	[a]
2	12.6	9.6	3.0
3	10.9	8.8	4.1
4	16.5	11.6	[a]
5	7.7	6.5	4.5
6	9.5	9.3	7.7
7	12.2	10.1	6.5
8	12.3	10.8	6.5

[a] Seat availability too highly constrained

Implementation

As described in this section, there are many ways such a routing model can be used to provide benefits. Taking advantage of these opportunities might require changes to the responsibilities of air planning staff. In some cases, significant changes might be required to how business is carried out. While such changes might not require a large business process re-engineering effort, the 'what is possible' discussion should be to tempered with the reality that successful implementation of a model requires paying attention to the environment in which it is implemented.

As passengers book their cruises, cruise lines face a decision of when to book flights for those passengers who need them. By starting to book flights earlier, cruise lines are more likely to obtain base fares rather than the higher bump-up fares. The 'cost' of doing this, however, is that passengers may ultimately cancel their reservation and if they do, the cruise line will have incurred unnecessary costs, both labour and possibly booking/cancellation fees due to the Global Distribution System (GDS) provider. In addition, booking flights before the full demand for a cruise is revealed decreases the likelihood that all passengers will be assigned to flights that yield a global optimum solution. Cruise lines have adopted different procedures for addressing this situation, but as far as we know there has been little or no systematic analysis to evaluate the cost implications of alternative policies on when it is best to begin booking flights.

The potential costs of these trade-offs have not yet been evaluated, but the routing model provides a strong foundation for doing so. In practice, the routing model is likely to be run multiple times for a cruise departure. It is also possible to run the model with a forecast of final demand in combination with current bookings. Doing so could help air planning staff understand better how additional bookings from certain gateway cities might lead to a significant increase in the airfares paid by the cruise line. Users can run several 'what if?' scenarios and get a sense for how much the optimal solution changes, given various demand values from each gateway. Such information might be communicated to revenue management and influence where promotional air/sea rates are offered.

As additional reservations for the cruise are made and additional passengers are routed on flights, the model also has the potential to provide cruise-line staff with an improved ability to evaluate when rebooking flights is cost effective. As discussed earlier, this can happen when a previously executed flight booking forces a subsequent booking to be on a more expensive airline owing to seat limitations. Using the routing model in combination with a post-processor model, the cost of rebooking flights for passengers could be evaluated. As cruise passengers may not be informed about the flights on which they have been booked until 30 days prior to their departure, there is often a window of opportunity for rebooking flights before the cruise line communicates with their passengers about their flights.

The routing model also facilitates two other types of useful analyses. First, it provides the cruise line with a systematic ability to evaluate the financial and customer service impacts of alternative service policies. For example, if the cruise line is willing to pay $20 more for non-stop flights on routes that exceed 1,500 miles, how much does this policy cost the cruise line? Information is also readily available to estimate how many passengers benefit from this policy and the amount of time they save. Cruise staff can then make more intelligent decisions on whether or not such policies should be maintained, expanded or constricted.

A second benefit of the model is operational in nature. Cruise lines can find it

necessary to assign their staff responsibility for routing the passengers for a specific ship. So, if the cruise line has two departures out of Miami on a Saturday, the passengers for each sailing, as well as management of the airline space, may be separated into two sub-problems that are treated, to a large extent, independently of each other. Such operational decisions are likely to increase the airline expenses incurred by the cruise line. We have observed instances where decisions of how to allocate block space among multiple sailings results in inefficient use of the total airline space available to the cruise line for its passengers. The routing model reduces the need for these artificial divisions of space and facilitates the cruise line's ability to manage the entire routing problem.

For sailings where the cruise line has arranged for charter airline service to supplement regularly scheduled flights, the model facilitates the cruise line's ability to determine which passengers should be routed on the charter flight. When a cruise line contracts for a charter flight, there is a strong financial incentive for the cruise line to fly as many passengers as possible on the charter. The cost of the charter to the cruise line has a high fixed cost component but will not vary much, if at all, based on the number of passengers. For passengers originating in the same gateway city as the charter, there is little or no variable air cost to the cruise line when these passengers are routed on the charter flight. For passengers connecting to the charter, the cruise line's incremental variable cost would be the cost of routing the passenger from the gateway city to the charter origination city. By including viable charter flight routings and their attendant costs in the model, recommendations will be made on which passenger routings should use the charter flight. For some cruise lines, this is a significant advancement over their current manual procedures.

One additional advantage the model provides is the ability to determine easily where airline space is getting tight. Although cruise lines work at not being surprised by difficult air bookings, during their work with cruise lines the authors have become aware of many instances where flight costs for some passengers were surprisingly high, and this was not recognised until it was too late to take any remedial action. As might be expected, cruise lines' procedures tend to focus on facilitating the sale of cabins; communicating that certain factors may reduce the profitability of a sale, such as an expensive airfare, has not received the same level of attention. Availability for air/sea bookings may be shut down for a gateway city when air planning staff realise that they do not have access to additional seats, but staff may not proactively investigate this for all the gateway cities for every sailing. And even if they did, given the lag time between booking and when flights are reserved, flight availability and fares may undergo significant change. This is quite different from tour operators who first obtain specific allocations of inventory from various travel suppliers and then only sell vacation packages when they know they have access to each component of the package and the price at which they can obtain each component.

In one instance, a group requested air/sea fares from a gateway city with limited airline service. No information was available to the reservations agent on the number of air/sea fares that could be sold from the gateway city; the only available information was that sales could be made. The group reservation request was accepted and, because demand for the cruise was low, a large discount was also granted to the group. When the air planning department booked flights for the group's passengers, only first class seats were available for many of the group's members. The airfare paid by the cruise line actually exceeded

the price (for the cruise and airfare) paid by the group's passengers. Using the routing model in a systematic manner could have alerted air planning and group reservations staff to the potential for such a surprise, although this would also have required changes in how information is communicated between departments.

The routing tool also enables air planning staff to provide valuable insights to the marketing department. The cruise-with-air demand by gateway can be adjusted and the routing model can be run under several 'what if?' scenarios, depending on the promotions marketing staff are considering. This may help them to determine, for example, that, although air space is too expensive to offer cruise-with-air promotions in Midwest gateway cities for an upcoming July sailing, sufficient space at low airfares is available in the West.

BLOCK SPACE AND CHARTER FLIGHT PLANNING

Each year, cruise lines estimate where they will need block space. Some cruise lines will also identify opportunities for regular, planned charter service. The process frequently involves a high degree of manual effort and, except for where significant schedule changes occur, decisions may be heavily based on how space was actually used (or planned) in the previous the year. Poor routing decisions may have an impact on space planning in subsequent years. Conducting extensive 'what if?' scenarios to determine how significant revisions to block space or charter flights might benefit the cruise line is difficult at best, and typically not possible. There may be few or no automated supports available to recommend where such changes might help to reduce air expenses. The ability to find such opportunities depends solely on the time and talents of the individual responsible for this task.

Automated space planning and charter flight planning tools can facilitate conducting the above analyses. These tools are similar to the route-optimisation tools, although their implementation is more strategic and less tactical. To identify space planning needs, cruise staff work with a range of booking profile data that typify the bookings for a cruise or a set of cruises and explore the extent to which block space and planned charter flights meet the cruise line's needs. 'Stress testing' based on forecasts of demand can provide air planning staff with insights into where it would be most valuable to acquire additional block space. Using these systems, a cruise line is more likely to be able to acquire additional space where it is needed, *while the space is still available*. This translates into lower airfare costs, since it leads to the reduced use of bump-up and non-contract fares and to higher load factors on charter flights.

CONTRACT FARE NEGOTIATION SUPPORT

At some cruise lines, the process for obtaining contract fares resembles a true negotiation; for others, it is more of a price-taking exercise. These cruise lines may attempt to negotiate fares in a few cities where the airlines have asked for unusually high increases over the previous year's fare level. The contract fares set the foundation for a cruise line's airfare costs each year and are a critical input to the routing model. This section demonstrates how understanding and estimating the value of incremental demand and the potential for revenue displacement, fundamental concepts of revenue management, can help in price negotiations.

Based on our experience in the cruise and airline industries, we believe cruise lines have more negotiating leverage with the airlines than they realise. This has begun to change, as an increasing number

of air planning executives and staff have been hired with airline experience. Although they have a stronger understanding of negotiation opportunities and have improved the air-planning capabilities of their cruise lines, additional opportunities remain.

The extent to which cruise line executives understand cost control opportunities within air planning varies considerably. For example, during work with cruise lines the authors met with a number of senior cruise-line executives who were surprised to learn that, on some airlines, on some flights, the airfares paid by their cruise line were consistently higher than the fares paid by many of the passengers who purchased publicly available fares. The point here is not that the fares paid by the cruise line should necessarily be less than publicly available fares; cruise lines place a premium on having 'guaranteed' access to airline seats. Given this situation, however, cruise lines do have an opportunity to exert leverage during fare and space negotiations if they can draw upon the right information.

Airlines value incremental business and typically offer companies lower prices in exchange for delivering this business in specific markets (eg Seattle–Miami). Indeed, in 2000, Delta Air Lines earned over $2bn in revenue through negotiating market share for fare discounts with corporations. US Airways recently reconfigured its market share-based contracting programme, emphasising share shift in key city pairs (Jonas, 2001). Airlines, however, can be quite sceptical of promises, and need to be convinced that incremental business will in fact be delivered; they are not in the habit of providing discounts for passenger traffic they believe they would otherwise receive.

Cruise lines have virtually complete control over the flights on which their passengers travel. Consequently, they are extremely well positioned to deliver on any market-share commitments they make. So they make a good negotiating partner for an airline — indeed, cruise lines represent the type of company that airlines are most willing to negotiate with.

The authors designed simple decision support capabilities to enable a cruise line to take the initiative in fare negotiations in a systematic and credible way with airlines, producing gains for both the cruise line and the airline willing to negotiate a lower fare in exchange for increased market share. Key elements of the model included:

(1) Use historical information to demonstrate to an airline that some seats are generally available on flights on which the cruise line wants to transport additional passengers.
(2) Estimate the number of additional passengers the cruise line can transport on these flights.
(3) Estimate the additional revenue the airline will receive from the cruise line and the cruise line's savings in airfare expenses if the airline provides the cruise line with a lower contract fare and the cruise line delivers incremental passengers to the airline.
(4) Monitor the cruise line's routing decisions to ensure that the cruise line delivers on its promise.

Most of the data and information needed to conduct these analyses are likely to be contained within the cruise line's databases and should be fairly accessible. Perhaps the most interesting element of the data-capture programme is obtaining information on airline seat availability. Typically, this would not be information that an airline would be willing to share with a cruise line and would not be contained in the cruise line's databases.

It is possible, however, to capture availability information from the reservation systems that display flight availability. Understanding how the cruise line can use

this data goes to the essence of how a revenue management way of thinking provided air planning staff with negotiating leverage they had not previously recognised. In that regard, it is important to realise that this information had been accessible to air planning staff, but no one had understood its potential value. As you begin to understand the revenue management needs of the airline, however, it becomes clear how these data can be converted to negotiating leverage.

Typically, reservation systems have a maximum limit they will display, such as seven or nine. So, while there may be 15 or 65 seats available on a flight, the reservation system will only show this lower maximum limit. When flight availability dips below this level, the reservation system displays actual availability.

Fortunately, for purposes of negotiating lower contract fares in exchange for greater market share, this provides much of the information needed by the cruise line to make a credible argument. While a cruise line may not be able to determine the exact number of seats that have gone unsold in a market on the flights of interest, there are sufficient data to estimate the frequency with which additional passengers could have been accommodated (eg what percentage of the flights were really full). Beyond that, the frequency with which at least five or seven additional passengers could have been accommodated can also be estimated. Based on personal experience, if these estimates are sufficiently high, this would provide a strong basis for further discussion between the airline and cruise line for increasing market share in exchange for a fare reduction.

For example, suppose a cruise line can demonstrate that all the flights in a market on the days of the week that it wants to transport passengers depart with empty seats, even though the average load factor on these flights is 85 per cent. In such a situation, the likelihood of displacing higher revenue passengers is much less than if 40 per cent of these flights were full. Thus, if the airline's load factors in that market are low, the airline might have a strong interest in negotiating for incremental passengers. By presenting such detailed knowledge on the airline's flights, airline staff would be less likely simply to look at the average load factor and then assume a high likelihood of displacement, as they might otherwise do. By demonstrating an understanding of the airline's revenue management needs, the cruise line might ensure that negotiations reach the next level. In short, the cruise line can demonstrate that the airline has sufficient space for incremental passengers and will thus earn incremental revenues.

It is vital for the cruise line to establish that seats are typically available on the flights it wants to use. Otherwise, as noted above, airline staff may falsely believe that these flights are full and that it would not be profitable for the airline to provide the cruise line with a lower fare in exchange for incremental demand. Airline staff would reason that if the flights are full, or nearly so on average, additional passengers from the cruise line might frequently displace other higher-paying passengers.

If a basis for negotiating additional market share in exchange for fare reduction is established, the cruise line then has the opportunity to exert leverage over the airline. Using historical passenger demand as well as demand forecast data, in combination with the cruise line's growth plans, allows a cruise line to take the initiative in demonstrating to an airline how it is well positioned to deliver incremental revenues and passengers to the airline, even into the future. Fortunately for the cruise line, it can simultaneously reduce its total airline expenses.

Tables 3 and 4 illustrate one form such an analysis might take. In this example, it

Table 3: Year 2000 flown and cost data for a gateway city

Carrier	*Passengers*	*Mkt SHARE (%)*	*Capacity Share (%)*	*Fare ($)*	*Airfare expense ($)*	*Fare ranking (1 = Highest)*
A	5,300	72	20	140	742,000	3
B	120	2	10	135	16,200	4
C	1460	20	40	150	219,000	1
D	460	6	25	145	66,700	2
E	40	< 1	5	125	5,000	5
Total	7380	100	100		1,048,900	

Table 4: Potential benefits by directing market share ($)

Carrier	*Total benefits per incremental market share point delivered in 2001*	*Approximate fare reduction required to achieve equal sharing of benefits*	
		1 Incremental Point of Market Share	*5 Incremental Points of Market Share*
C	10,346	3.85	10.25
D	10,475	16.10	32.95

is assumed that there is no year-on-year growth in the number of passengers transported from the gateway city, no year-over-year changes in the level of airline service from the gateway city, and that the fares proposed by the airlines for 2001 are identical to the ones paid by the cruise line in 2000. While these assumptions make the analysis easier to explain and follow, they can be easily relaxed.

In this example, the cruise line spent more than $1m on airfare to transport the passengers from this gateway city. Several observations can be made:

— Most of the passengers were flown on carrier A.
— Carriers B and E have the lowest negotiated fares, but transported few passengers (this may have been because carriers B and E do not offer desirable schedules).
— If additional seats are available on their flights, carriers C and D may have a strong interest in reducing their airfare in this market in exchange for incremental market share. Both airlines transport less than their 'fair share' of passengers (market share < seat capacity share).

Table 4 highlights the potential benefits available if the cruise line were to direct additional market share to either Carrier C or D. For example, for each incremental point of market share that the cruise line delivers to Carrier C, more than $10,300 of incremental revenue would accrue to Carrier C, if Carrier C obtained these additional passengers without reducing its fare.[1] By negotiating a reduced fare, the airline and cruise line are basically determining how this benefit will be split between the two firms. If Carrier C were to reduce its

fare from $150 to $146.15, and the cruise line transported 21 per cent of its passengers on Carrier C (rather than 20 per cent), both firms would earn benefits of almost $5,200. Carrier D would need to reduce its fare by more than $16, from $145 to less than $129 for a similar benefit split. As shown in Table 4, the fare discrepancy between these carriers increases when additional market share is directed to these airlines.

Although the total incremental benefits are similar in each case, it might be far easier for the cruise line to negotiate an acceptable arrangement with Carrier C. For the cruise line and airline to split the benefits equally, the cruise line would not need Carrier C to reduce its negotiated fare as significantly. As noted in Table 4, if Carrier C agreed to reduce its fare from $150 to just under $140, and the cruise line increased Carrier C's share of passengers from 20 to 25 per cent (five incremental points of market share), Carrier C could earn more than $26,000 in additional revenue, and the cruise line could also reduce its airfare expense by a similar amount. Each additional point of market share yields benefits of more than $10,000 to be split between the companies.

If this analysis is repeated for a variety of gateway cities, a strong potential emerges for the cruise line to reduce its airfare expenses significantly. In the above example, increasing Carrier C's market share by five percentage points would have reduced the cruise line's airfare expense from this gateway city by approximately 2.5 per cent.

REPORTING AND PERFORMANCE MEASUREMENT

All too often, air planning staff are not able easily to investigate anomalous situations or answer questions posed to them by other departments or senior management. Or, information systems staff must be relied upon to provide air planning staff with *ad hoc* reports. Given the current state of online analytical processing (OLAP) and reporting technologies, this should no longer be the case.

A key aspect of the reporting system should be to provide senior management and departmental staff with insights into the air planning department's performance. Critical elements of departmental and staff performance might include:

(1) How successfully did the air planning department negotiate contract fares with the airlines?
(2) How well did the air planning department identify the routes on which it needs block space and the number of seats it needs? How successful was the cruise line in obtaining this space?
(3) To what extent is the use of charter flights reducing air costs and affecting customer service? To what extent have charter flights been mistakenly contracted for?
(4) To what extent are cruise passengers being routed on the best flights? How would alternative routings have compared?
(5) What is the quality of information being provided from the the air planning department to revenue management staff with regard to flight availability and flight cost for passengers booking future cruises (this information could be valuable in estimating the potential profitability and desirability of implementing alternative promotions)?

Specific performance benchmarks should be established in each of these areas. In addition, a well-designed reporting and performance measurement system, as part of an air planning programme, should leverage reservations data, airline seat block allocations, demand forecast information, if available, and cruise-line schedule data to

provide air planning staff quickly with information on many of the questions that they typically need to answer in these areas. For example:

(1) Is there sufficient lift from a gateway city to transport a group at a contract fare? What is it likely to cost?
(2) Given current reservations holding for a cruise, how much additional lift is available from a gateway city? Is there enough lift available to profitably launch a pricing promotion in that city?
(3) Would it be cost effective to operate a charter flight from Chicago to San Juan on 8th August?
(4) How much block space should be released? What level of risk does this involve?

It is clear that these tools can also provide critical information to cruise staff in marketing, revenue management, inventory control and other departments.

Broadly speaking, information could be obtained easily and quickly on a wide variety of areas including: block space availability, block space utilisation at various dates to departure, passenger volume by gateway city, airfare cost by gateway city, frequency and use of non-contract fares, air cost analyses, air statuses of groups and group air needs, charter flight availability and usage, routing analyses, etc. Such information would be available prior to sailings, so corrective actions could be taken when necessary. To facilitate user analysis, information should be easy to display graphically and users should be able to 'drill down' from high-level information to detailed data, even to the transaction level, to facilitate problem discovery and resolution. At cruise lines where such investigations have a heavy manual component, these capabilities will turn a several-hour, or even a several-day job, into an effort that can be completed in minutes.

Performance measurement is often thought of as an 'after-the-fact' capability. While valuable in this capacity, it can be even more timely if it can facilitate managerial control by enabling better decision making for future sailings. Exception reports, or alerts, can be designed to notify cruise staff when action needs to be taken quickly in response to developing trends, *prior to a sailing's departure*. For example, an alert might be triggered when airfare costs from a gateway city exceed a specified percentage above the lowest contract fare in that market. Or when the number of passengers forecast to be routed on specific flights out of a hub exceeds a certain percentage of the block seats on those flights. Such information can give the cruise line the ability to manage the assignment of passengers to flights and gateway city availability more profitably.

SUMMARY

Improvements in the air planning capabilities of a cruise line provide significant opportunities for cost reduction as well as customer service improvements. Based on experience, cruise lines can reduce their airfare expenses by 5–8 per cent. Further, the systems described above can probably even lead to cost reductions of at least 3 per cent for those cruise lines that have made significant improvements to their air planning departments in the past few years.

As cruise-line capacity in key markets continues to grow at a faster rate than airline capacity in those markets, it will become more and more imperative for cruise lines to pay greater attention to their air planning areas. The drive for higher levels of profitability will demand it. As with revenue management, it is not a question of whether a cruise line is carrying out air planning. Of course they all are. Key questions to continually ask are, 'How can air planning be done better?' 'What additional level of benefits can be derived?' and 'To what extent will these benefits exceed the investment

required to earn these benefits?' The authors believe the tools described here can enable cruise lines to reduce their costs and earn significantly greater profits, improve customer service and increase their ability to plan for future growth.

At a broader level, it is hoped that this paper provides an impetus for revenue management professionals to cast a wider net as they consider where and how to apply their craft. There may be many non-traditional opportunities for revenue management to provide value. Based on experience, the authors believe the search for such opportunities will be exciting, and addressing them highly rewarding.

Note

1 This analysis assumes that the additional passengers flying on Carrier C are taken from the other carriers in proportion to the number of passengers they carry. In fact, if the cruise line could disproportionately reduce the number of its passengers flying on the more expensive carriers, its airfare expenses could be further reduced.

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