

# *Yield Management In The Airline Industry*

By Frederic Voneche

## **INTRODUCTION**

Last month on a trip to Brussels from Chicago, I almost had my 8-hour neighbor have a heart attack when I told him that I bought my ticket for \$380. In fact, the gentleman, a business traveler, had to pay \$1,500 for the same tourist-class round-trip ticket.

Such differences are due to the airline wanting to maximize its revenue or its profits. Some call it revenue management, others yield management. The strategy appears to be rather simple: sell the right seat to the right type of customer, at the right time and for the right price. The key is to find the tradeoff between selling discount ticketing in order to fill up the plane totally, and selling full fare tickets and only filling up a portion of the plane. Since this process involves consumer behavior and past data analysis, it can be very challenging.

## **APPROPRIATE SITUATIONS FOR EFFECTIVE YIELD MANAGEMENT APPLICATION**

Yield management is very well suited for service firms. We will review a few characteristics that make yield management efficient.

### **Relatively Fixed Capacity**

The reason for this characteristic is very simple. If capacity were flexible, there would be no need for a tradeoff. If airlines could add or remove seats or aircraft at will, there would be no reason to try to manage capacity. Unfortunately, the plane cannot be enlarged, the only flexibility allowed is to schedule the passenger on a later flight.

### **Ability to Segment Markets**

Since one of the purposes of yield management is to smooth the distribution of passengers, to be effective, the airline must be able to segment its market into different passenger categories. Keeping in mind that we seek a tradeoff between maximum load factor and highest paying passengers, a very good example is the comparison between the time-sensitive business person and the price-sensitive customer. One is willing to pay a higher fare in exchange for flexibility (open return, cancellation option, schedule change, etc.) the other is willing to give-up some flexibility for the sake of a cheaper ticket (stay overnight Saturday, not come back on Labor Day - which is a peak day). Such a strategy allows airlines

to fill seats that would otherwise be empty.

### **Perishable Inventory**

In the airline industry, plane seats are referred to as inventory. In fact, it is the available Amaterial" for Aproduction@ (the flight itself). If the plane leaves the gate with empty seats, this inventory cannot be stored and is lost. If an airline can minimize the inventory spoilage, then it will operate much more efficiently. Since yield management determines the load level to try to maximize revenue, we see why businesses that deal with perishable inventory can benefit from such a technique. Note the analogy with unoccupied hotel rooms or unrented cars at a car rental agency.

### **Product Sold in Advance**

If all tickets were sold at once, the right tradeoff would be a fixed figure and would not take advantage of customer behavior. Since customer demand level patterns vary continually over time, it makes sense to also try to find the best tradeoff over time. Airplane fares change all the time, some on an hourly basis others on a weekly basis. The tradeoffs occur when a manager is faced with the option of accepting an early reservation from a customer who wants low price, or waiting to see if a higher paying customer will show up.

### **Fluctuating Demand**

Yield management is a tool that can be used to smooth the demand pattern. In peak season, the airline can increase its revenues by increasing the fare on its tickets and in low season, it can increase capacity utilization by offering low prices. Past years data will offer the manager a way to forecast when these peak and low seasons occur. Demand fluctuates seasonally (peak season in the summer and low season in the fall) and also gradually (there is an increase in the demand for reservation until a few days prior departure).

### **Low Marginal Sales Costs and High Capacity Change Costs**

We have already talked about fixed capacity, but it is not enough in this case. In order for yield management to work optimally, additional capacity should be expensive to acquire. In this situation, the cost of a plane is high, moreover, the lag between the order and delivery is significant. On the other hand, the cost of an additional passenger should be low (in fact, airlines have very high fixed costs), such as the negligible cost of drinks and food for a customer. In fact, if there were low capacity change costs, it would be easy to adapt quickly by storing a few airplanes Ain reserve@.

## **THE PROBLEM**

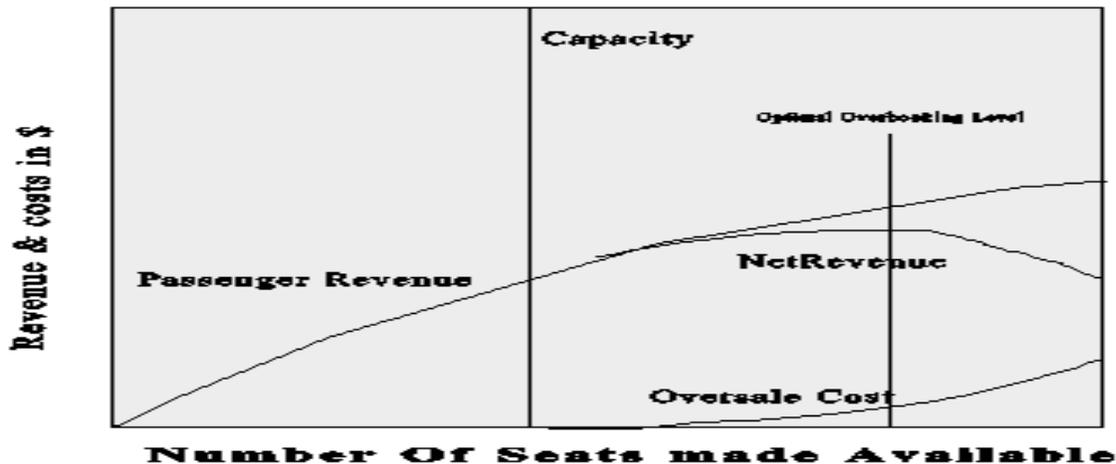
By now, we know that yield management in the airline industry has similar objectives to inventory control for manufacturing companies. The yield management problem is best described as a non-linear, stochastic, mixed-integer mathematical program that requires data such as passenger demand pattern, cancellations, group reservations, cargo load, and other estimates. Solving this problem would require approximately 250 million decision variables! For the sake of feasibility and time, this problem has been reduced to three smaller ones: overbooking, discount allocation and traffic management.

### **Overbooking**

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Most of us

probably been offered a free pass on any of the airline's flights if we gave up our seat and agreed to leave on the next available plane. Overbooking is the practice to intentionally sell more seats than available in order to offset the effect of passenger cancellations and no-shows. Without it, it is estimated that although a plane is fully booked, at departure, about 15% of the seats would be empty.



Some airlines allow cancellation of reservation without penalty. An astonishing figure is that on average, about half of all reservation

made for a flight are canceled or become no-show. As a result, poor overbooking decisions can be very costly.

On the other hand, the airline should try to assess the price of overbooking. A passenger who is denied a seat despite his reservation can happen to be very expensive. In the short run, it is only a ticket revenue loss, but long term implications include passenger loyalty, airline reputation, etc. Figure 1 shows an example of a typical reservations pattern with and without overbooking. There is no absolute scale on the x-axis since it may vary from one type of flight to another. American Airlines has developed an optimization model that maximizes net revenues associated with overbooking decisions. This model measures the marginal revenue of selling a reservation against the cost of the additional oversell risk. Figure 2 shows that net revenue increase with overbooking until the point where the oversell cost outgrows the passenger revenues. Oversell cost increases rapidly with higher overbooking levels since at a certain point less and less passengers are willing to modify their travel arrangements.

## Discount Allocation

If all passengers on a flight were paying the same price, overbooking would be the panacea of yield management. Unfortunately, as illustrated by the story in the introduction, this is rarely the case. In this section, we will discuss discount allocation, the process of determining the number of discount fares to offer on a flight. The ratio of discount vs. full fares (called buckets) is not fixed during the reservation period and is moved appropriately as the departure date approaches. It varies on the basis of forecast (American Airlines uses exponential smoothing), past experience and special events. Here again, the opportunity cost of selling a discounted ticket instead of a full fare one has to be measured in order to make the best decision possible.

Let's illustrate this concept with an example using the single inventory model. For the sake of the example, we only consider a one-time decision of the number of full-fare seats to reserve:

### Example

Lately, in order to stimulate demand for its Mexican routes, United Airways has decided to offer a special non-refundable, non-exchangeable, one-month advance-purchased ticket on its Chicago-Cancun route for only \$450 instead of the regular \$650 round-trip fare. The DC-10 used by United Airways has a capacity of 150 passengers in tourist class. Past data analysis showed that the demand for full-fare tickets follow a normal distribution with mean of 60 and a standard deviation of 15. Let's use  $C_U$  for the overage cost, that is the cost associated with reserving too few seats at full fare;  $C_O$  for the overage (or shortage) cost, that is the cost associated with reserving too many seats at full fare.  $C_U$  is the lost opportunity of an additional \$200 which is the difference between the full and the discounted fare.  $C_O = \$450$  because we assume the extra seats reserved for full-fare passengers could only have been sold at a discount.

Using the critical fractile model, we get:

$$P(f < x) \leq \frac{C_U}{C_U + C_O}$$

Where  $f$  is the demand for full-fare tickets and  $x$  the number of seats reserved for full-fare passengers. The critical fractile value  $P(f < x) = 200/(200+450) = 0.31$ . From the Normal distribution table, we find that the corresponding  $z$  is  $-0.50$ . We then calculate the number of full-fare seats to reserve  $= \mu + z\sigma = 60 + (-0.50)(15) = 53$ .

## Traffic Management

In the 1970's, after deregulation, most of the airlines adopted the hub-and-spoke concept in order to serve more markets. Instead of having point-to-point connections between cities, all flight (at least most of them) and therefore passengers would connect to a hub and be dispatched toward their final destination onto another flight. This has increased the complexity of the whole system drastically; flights that once served one single market now serve several dozens. It has made the demand pattern more difficult to forecast and the variability of revenue within a fare class has become large since one flight does not typically represent the whole trip of a passenger. If an airline only had point-to-point routes with no connecting passengers, traffic management would not be an issue in this discussion because for a given flight, overbooking level and discount allocation problems alone could be used to maximize revenue. If we take into consideration connecting flights, the complexity of the problem increases drastically. For example let's consider passengers traveling from Florida to California. Let's assume there are four flights from four different cities in Florida, which must connect in Las Vegas where passengers take their flight for any four California cities. This alone gives us 16 virtual routes (nested rate classes) for only 8 flights. Managing yield at this point is quite a challenge. What kind of decision should be made if a discount seat is available from Tallahassee to Las Vegas but only a full-fare seat is available from Las Vegas to Sacramento?

## CONCLUSIONS

Issues that managers face when making decisions in yield management deserve some more consideration.

- Measuring performance of yield management is a major issue. Load factor, yield (revenue per passenger mile) are measures affected by external competition. In assessing performance,

American Airlines uses the discount allocation revenue opportunity model. It measures where the airline stands in comparison to its maximum revenue possible and the minimum revenue possible (no yield management).

- Customers seem to be resigned to the fact that airlines discriminate on price but many find it very bitter and it sometimes leads to customer alienation. In industries with only a few competitors it works fine, but where competition intensifies like in the hotel business, it no longer works. Again, we emphasize the tradeoff between short-term which focuses on profits and long-term which focuses on delivering good, reliable service.
- From a managerial point of view, employees morale is at stake here. Since yield management takes much of the guess work out of how many seats to sell at what price, less decision power is left on their shoulders and as technology is more and more present in their professional lives, it may reduce them to being simple operators rather than decision makers. In addition, some employees are paid a percentage of the sales they make, fostering them to make group sales which in turn may be contradictory with the objective of yield management, that is maximizing revenues for a whole flight. As an example, a sales person might be denied by the system to sell discounted tickets to a group of 30 people more than 45 days in advance. As a result, this employee may lose the sale.

## **YIELD MANAGEMENT AT *AMERICAN AIRLINES***

American Airlines were the pioneers in automated reservation systems. In the 1960's, they developed the first on-line reservation system. Later on, they became so specialized that they formed SABRE Group originating from the software they first implemented called SABRE (Semi-Automated Business Research Environment) that dealt with centralizing and controlling reservation activity. Still today, SABRE Group is the leader in terms of methodology and technology in their field. They react quickly to any change in the industry. For quite a while now, they have been selling access to their reservation systems to other airlines for huge fees.

At American Airlines, almost everything is automated because the yield-management decision-making process is too large and therefore too complex to be processed manually. It is SABRE Group that first decided to split this problem into three smaller ones that we have already talked about. Today, the module aggregating these three issues dealing with yield management at American Airlines is called DINAMO (Dynamic Inventory And Maintenance Optimizer). It was fully implemented in 1988; this was the latest step of a development process that spans the past 25 years. Using this system, it was calculated that spoilage was only three percent; which mean that only three percent of the seats were empty on sold-out flights.

We said that almost everything is automated because still a little part is done manually. When a flight is critical, that is it does not meet yield-management control parameters (because of the Superbowl or an input error), it is manually reviewed by yield-management analysts. After the implementation of DINAMO, the productivity of these specialists has increased by 30%. This was due to the fact that these people could make better revenue decisions because the job changed from spotting problems and solve them quickly to having the machine point them and have the analyst fix it well with the help of another American Airlines=s software that allows for flight specific analysis and re-optimization.

Since 1987, American Airlines Decision Technologies has applied yield-management techniques to other industries. The first non-airline applications were with passenger railroads with the major difference that this was not a hub-and-spoke network. Then, it expended to the lodging industry, car

rental companies, broadcasting industry, etc. Management estimates their benefits from automated yield management program at half a billion dollars per year.

## **REVENUE MANAGEMENT AT *AMERICAN TRANS AIR***

Recently, I had the chance to go to Indianapolis to visit the headquarters of American Trans Air and I got to talk with different people there. I was astounded when Jim, who has been working in the airline industry for over 10 years and who is now the Pricing Manager at American Trans Air put it: AHere, you are light years away from what you=ll find at American or United. To get some reports it takes us six months, over there, they get it almost overnight thanks to their technology!@ In fact, when you walk through American Trans Air=s facilities at Indianapolis, you find a lot of friendly faces, but very few computers. American Trans Air was formed in 1973 and has been decreasingly relying on charter contracts for its business. Today, it remains under the leadership and ownership of their CEO, J. George Mikelsons. They caught the train very late in the race of technology and now as they are growing very fast, in order to sustain their competitive advantage, they are trying to bridge the gap with other airlines where the decision making in terms of revenue management and yield management it highly automated..

Where DINAMO deals with yield management at American Airlines, people deal with revenue management at American Trans Air. When Stanley was showing me how they operated, I was quite surprised. Throughout the day, he monitors flight reservations, and if seats in a given flight are being sold rapidly, he comes with a higher price and changes the parameters of the bucket (a price class). Prices are changed based on past data which he can find in a folder on his desk and on some market research.

Like many airlines, American Trans Air subscribe to different CRS (computer reservation systems). One of them being SABRE, once every night, all the pricing modifications that were made during the day are uploaded in one of the mainframes at American Airlines. In case of a critical problem, they have an overriding permission into the mainframe in real time.