Decision Window
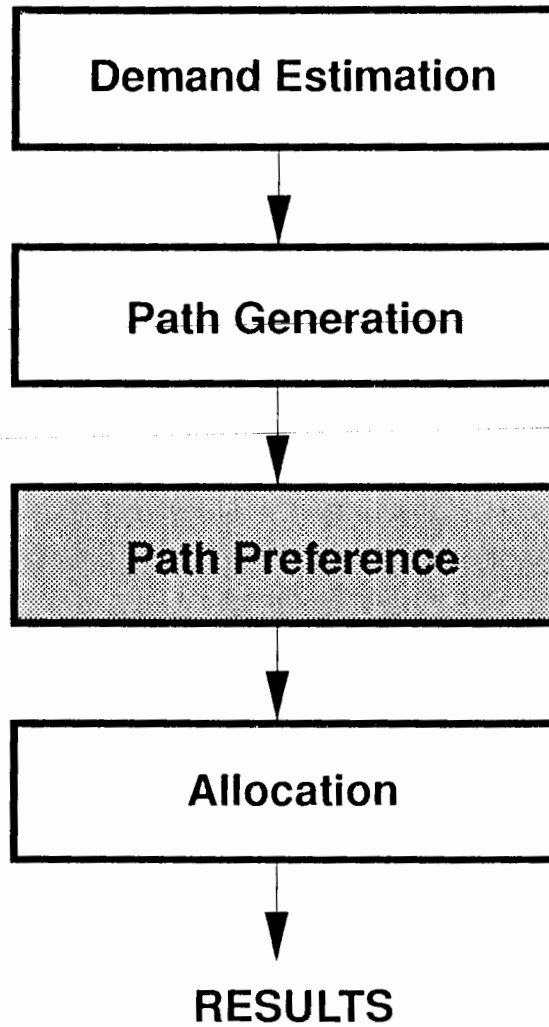# Path Preference Methodology
Time Mode

The Challenge

Predicting How Travellers Choose

Given a choice of ways to get from one city to another, the challenge is to predict how many travellers will want to take each of the ways. To do that requires us to develop a model of the decision making process of the individual traveller. That model is called the Decision Window Model.
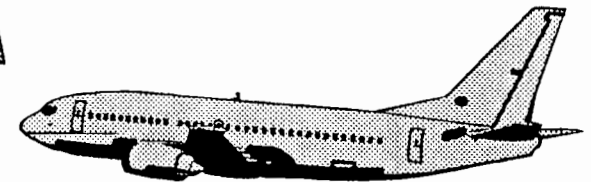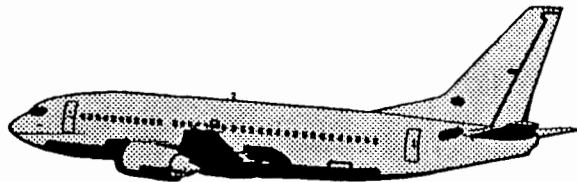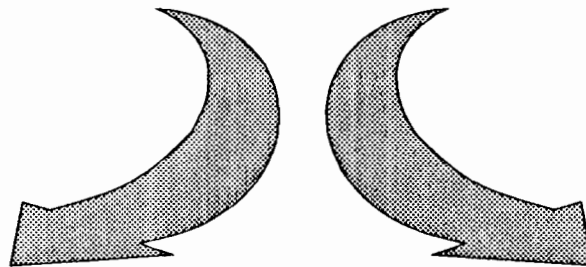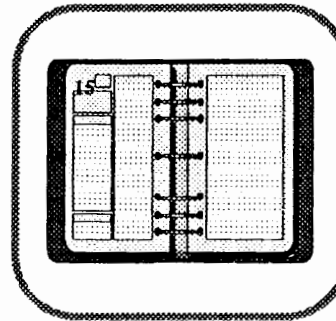
Tasks In Market Share Evaluation

```
┌─────────────────────────────┐
│     Demand Estimation       │
└─────────────────────────────┘
               │
               ▼
┌─────────────────────────────┐
│      Path Generation        │
└─────────────────────────────┘
               │
               ▼
┌─────────────────────────────┐
│      Path Preference        │
└─────────────────────────────┘
               │
               ▼
┌─────────────────────────────┐
│        Allocation           │
└─────────────────────────────┘
               │
               ▼
          RESULTS
```
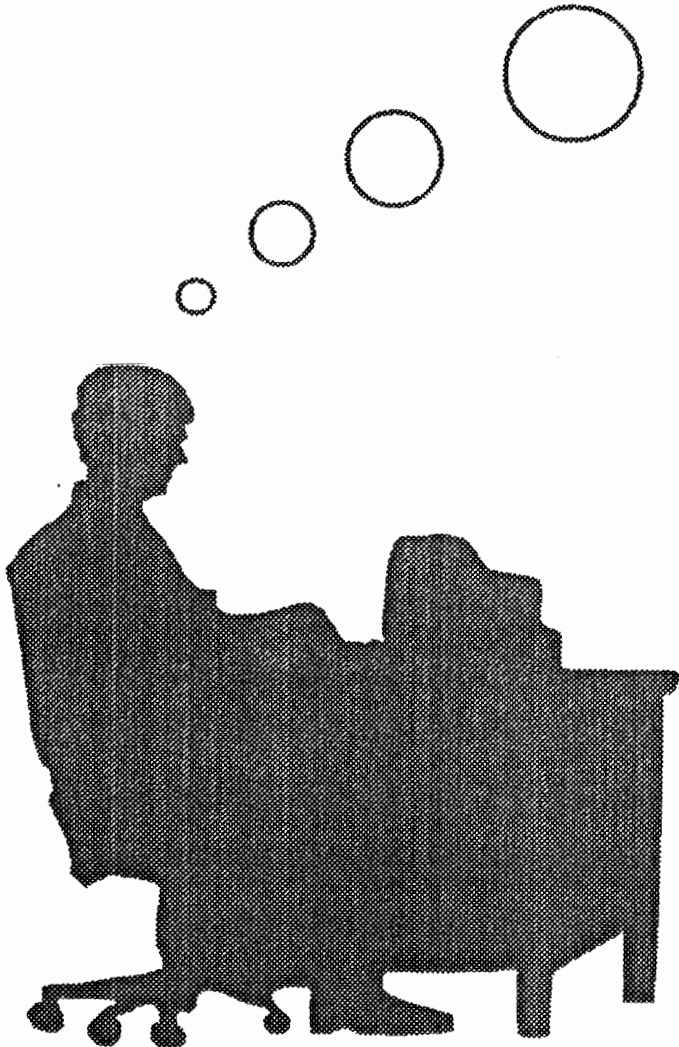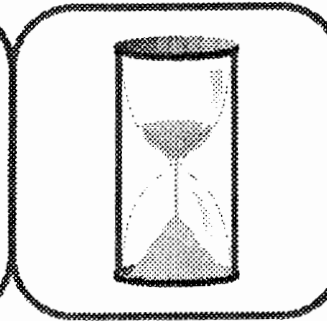
The Traveller Decision Process

Travellers Have a Concept of Characteristics of Their Trips

Day
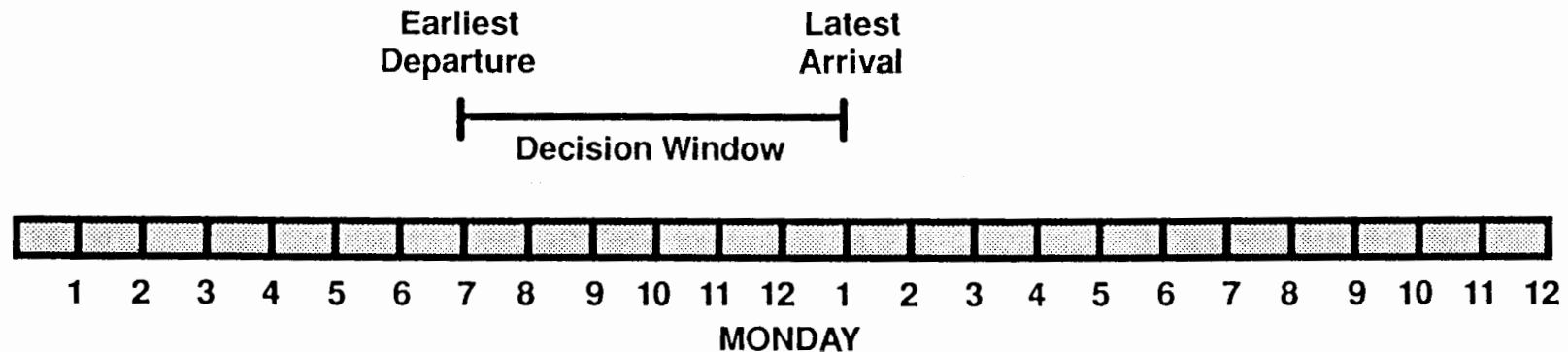~~Departure Time~~

Duration
Airline
Flights

Arrival Time

What Is A Decision Window?

As we define it, the decision window represents the time frame within which the traveller is willing to consider travelling. The window is bounded by the earliest departure time the traveller will consider and the latest arrival time.

```
      Earliest                    Latest
      Departure                   Arrival
          |───────────────────────|
            Decision Window

 ┌──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┬──┐
 └──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┴──┘
  1  2  3  4  5  6  7  8  9 10 11 12  1  2  3  4  5  6  7  8  9 10 11 12
                             MONDAY
```

Characteristics:
- It is situated on the preferred day.
- The window is wider than the perceived path time.
- All departure and arrival times within the window are satisfactory to the traveller.

The Decision Window Model Has Three Steps

Step 1:   Define the individual traveller's decision window.
- **Size of the window**
- **Position of the window**

Step 2:   Determine which paths to consider.
- Paths in the window
- Eliminate paths with non-competitive characteristics

Step 3:   Determine which path is first choice preference.
- Tradeoff between airline preference and path quality

What Are Paths?

Paths are flights and combinations of flights that will take a traveller from the point of origin to the trip destination.

Timetable
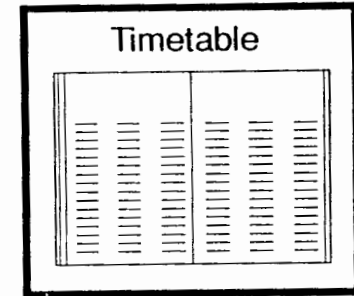
The Schedule

SEA-SFO	YY	08:00-10:00	0

YY

Non-stop

SEA-SFO	ZZ	14:30-17:30	1

ZZ   ZZ

One-stop

SEA-PDX	CC	12:00-12:30	0
PDX-SFO	CC	13:00-15:00	0

CC   CC

Connect

SEA-ODM	EE	20:30-21:30	0
ODM-SFO	CC	23:00-23:15	0

EE   CC

Interline Connect

How Is The Size Of The Window Determined?

Window size is determined by the market Delta-T and the individual's schedule tolerance. We use Delta-T because we discovered (through data analysis) that passenger behavior varies with Delta-T, not range.

Delta-T (or ΔT):
> **The difference between local departure time and local arrival time.**
> **"It takes about two hours to go from SEA-SFO."**
> **"If I leave LON at 10:00, I will arrive in Seattle around noon."**
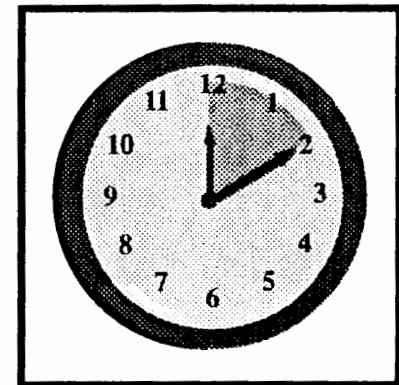
Schedule Tolerance:
> **The amount of time flexibility a traveller has in planning a trip.**
> **"The flight will take two hours, but I will consider flights that leave after noon and arrive before four."**

What is Delta-T?

Delta-T is the difference between the local departure time and the local arrival time. The path Delta-T can be calculated for a specific path. The market Delta-T is the traveller's perception of the travel time in a given market, usually path Delta-T for the best service in the market. In markets with time zone changes, Delta-T is different from the actual trip time (i.e. LON-SEA has a Delta-T of about 2 hours).

MARKET	DEPT. TIME	ARR. TIME	STOPS	PATH ΔT
SEA-SFO	8:00	10:00	0	2
SEA-SFO	15:00	17:00	0	2
SEA-SFO	14:30	17:30	1	3

Market Delta-T for SEA-SFO = 2 hours

What Is Schedule Tolerance?

Schedule tolerance represents the amount of flexibility a traveller has. There are a variety of schedule tolerances for individuals within a given market. The distribution of schedule tolerances has been developed from survey results. The decision window is the sum of the Delta-T and the schedule tolerance.

Earliest Departure ———————————————————————— Latest Arrival

ΔT

Decision Window

ΔT

Schedule Tolerance
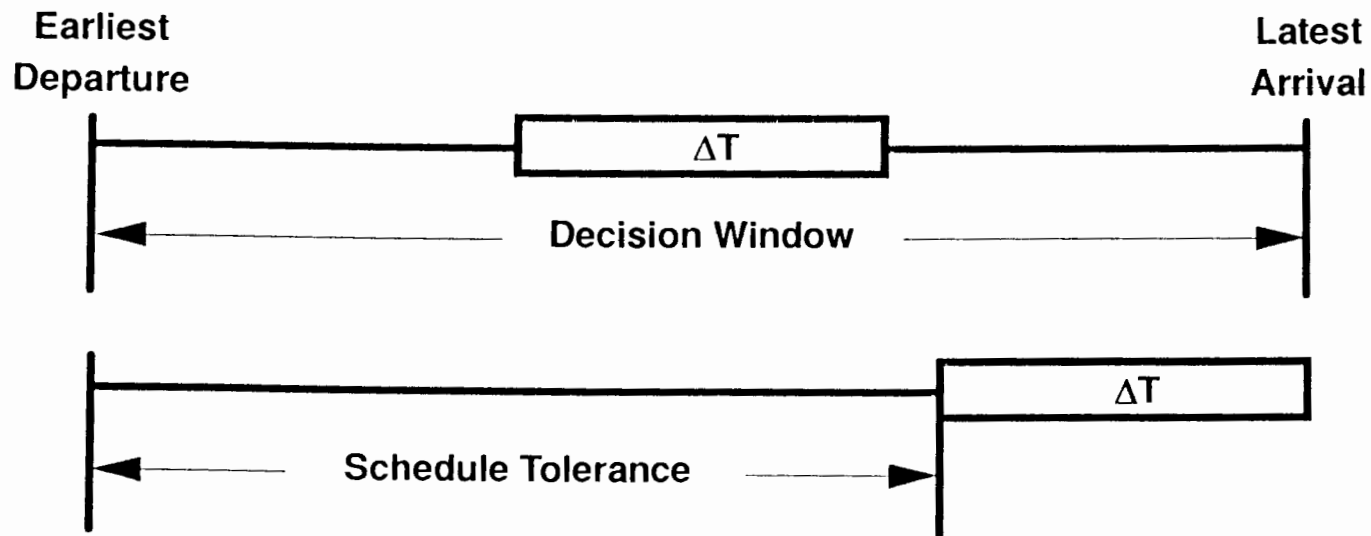
Example: A person in SEA-SFO market (Delta-T= 2 hours)
- Earliest Departure: 07:00
- Latest Arrival: 12:00
- Decision Window: 12:00 - 7:00 = 5 hours
- Schedule Tolerance: 5 hrs. - 2 hrs. = 3 hours

What Is The Location Of the Decision Window?

What day is it located in? Demand is apportioned to days based on the day-of-week demand distribution for that market.
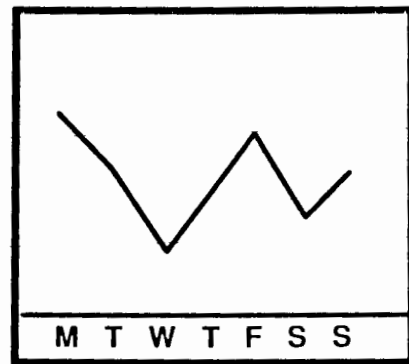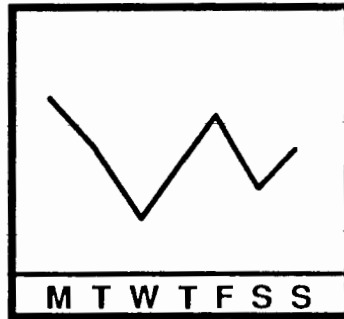

At what hour in the day is the decision window positioned? Demand varies by hour, based on time-of-day demand.
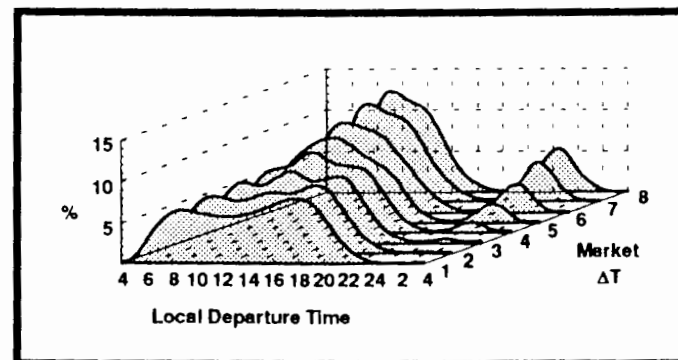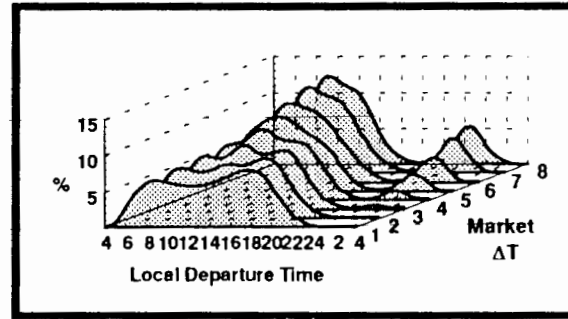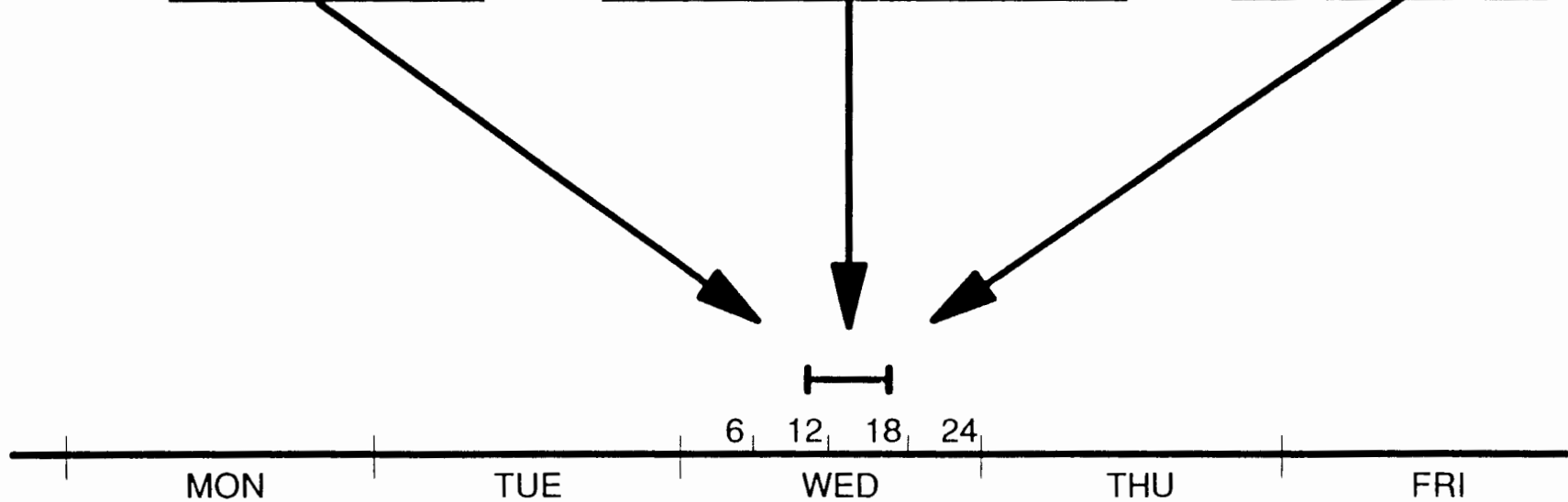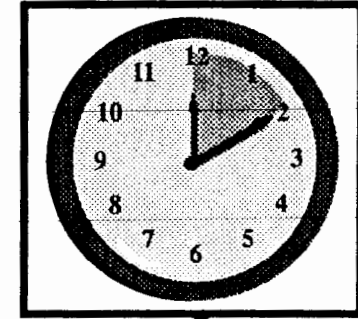
Three Elements Determine Window Size and Position

Day Of Week Demand
Pick the day.

M T W T F S S

Time of Day Demand
Pick the hour.

15
10
%
5

4 6 8 10 12 14 16 18 20 22 24 2 4

Local Departure Time

1 2 3 4 5 6 7 8

Market
ΔT

Delta-T, Schedule Tolerance
Set width/position of window.

6   12   18   24

MON   TUE   WED   THU   FRI

# Many Individuals Make Up Market Demand

The distribution of many individual decision windows within a market might look something like this. Some people have a great deal of schedule flexibility, some very little. The distribution of the decision windows determines how many passengers find each flight satisfactory.

Two Hour Delta-T Market

4   8   12   16   20
MON

8   12   16
TUE
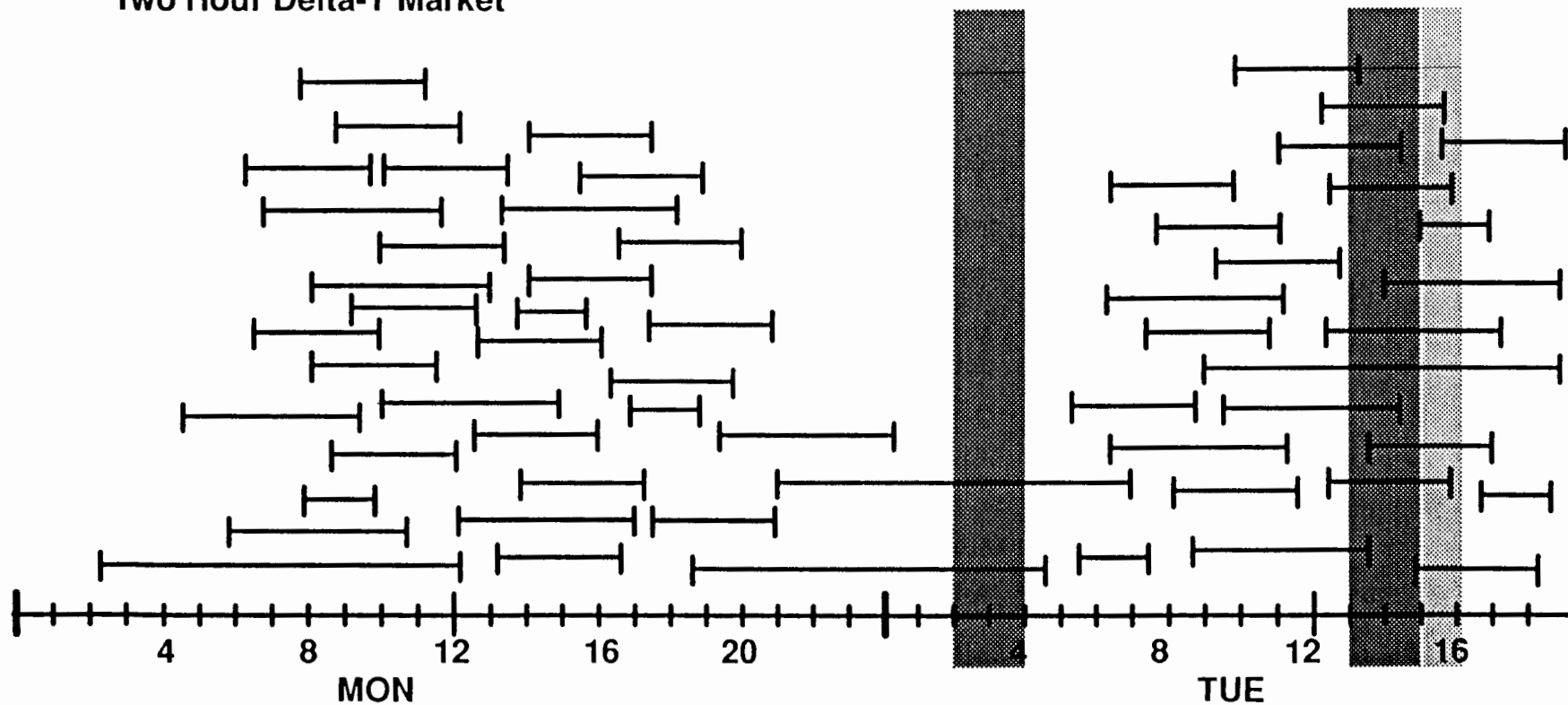
What Is Meant By Coverage State?

Coverage state is a representation of which paths fall within passenger decision windows. For a given market the coverage state is calculated such that the result is the percentage of people in the market who have that particular set of paths within their window. In the example below of Coverage State A, 15% of the people in this market have only flight YY 100 in their decision window.

O——— YY 100 ———O   O——— YY 200 ———O

O——— ZZ 100 ———O———O
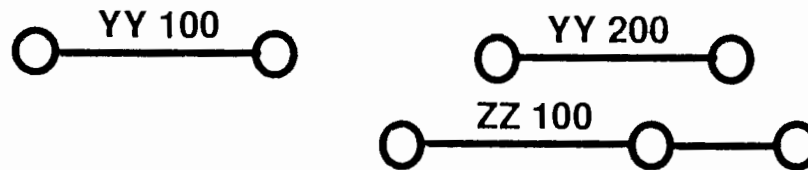
Coverage State	Is Path In Decision Window?			% People
	YY 100	YY 200	ZZ 100	
A	Yes	No	No	15
B	Yes	Yes	No	5
C	Yes	Yes	Yes	10
D	Yes	No	Yes	Impossible
E	No	Yes	No	30
F	No	Yes	Yes	35
G	No	No	Yes	Impossible
H	No	No	No	5

Observations About Decision Windows

The first step of the decision model reinforces key beliefs about the characteristics of airline markets.

- More frequencies are good.
  Frequencies at various times increase the likelihood that each traveller will find at least one flight (path) within his decision window.

- Frequency saturation exists.
  At some point, adding more frequencies satisfies the same people that were satisfied with another flight.

- Short paths (nonstop, direct) are good.
  Long paths are less likely to fit within the traveller's decision window.

- Timing is important.
  Paths beginning at popular times will be within more travellers' decision windows.

The Decision Window Model Has Three Steps

Step 1:   **Define** the individual traveller's decision window.
- Size of the window
- Position of the window

**Step 2:   Determine which paths to consider.**
- **Paths in the window**
- **Eliminate paths with non-competitive characteristics**

Step 3:   Determine which path is first choice preference.
- Tradeoff between airline preference and path quality

Which Paths Are Considered By The Traveller?

- Only paths which fit completely in the window are considered for a traveller's first choice path preference.

- Only the best service for each airline is considered for the first choice path preference. Path quality is called a dominant characteristic. Path quality is dominant only within airline.
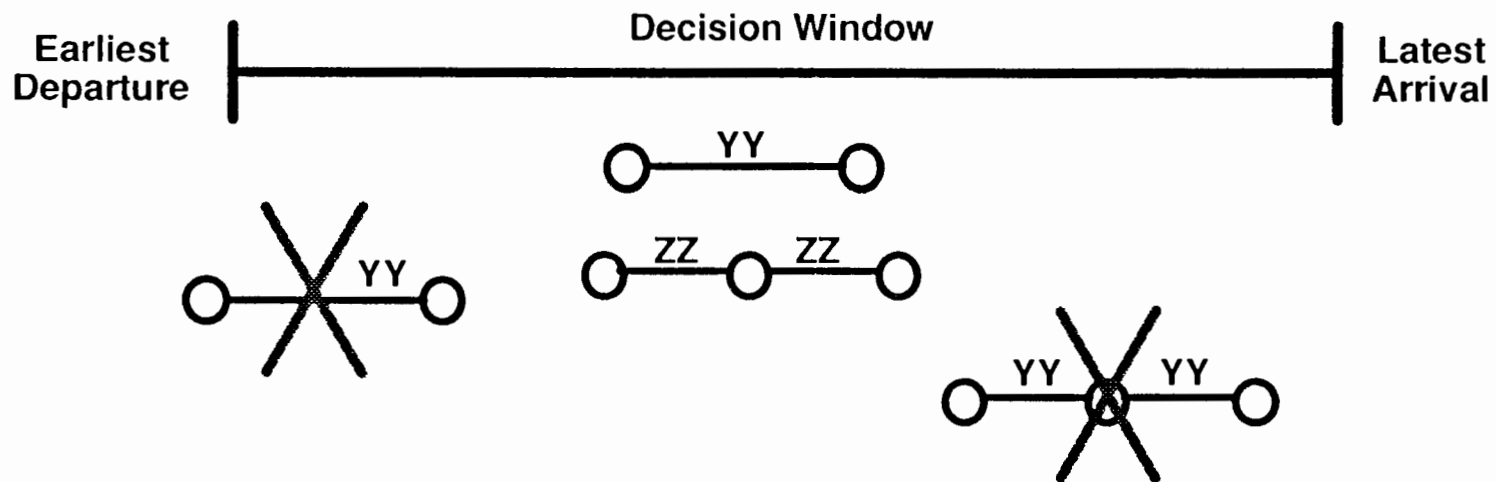
Some Passengers Choose Based on Airplanes

Some travellers are aware of the airplane used on a particular path and do consider the airplane when making a path choice. The number is small, and varies with range. An individual discriminating between aircraft will eliminate flights that are not of the highest airplane category within the decision window. Categories could be wide body, standard body, and propeller aircraft. For airplane discriminating passengers, airplane category is a dominant characteristic.
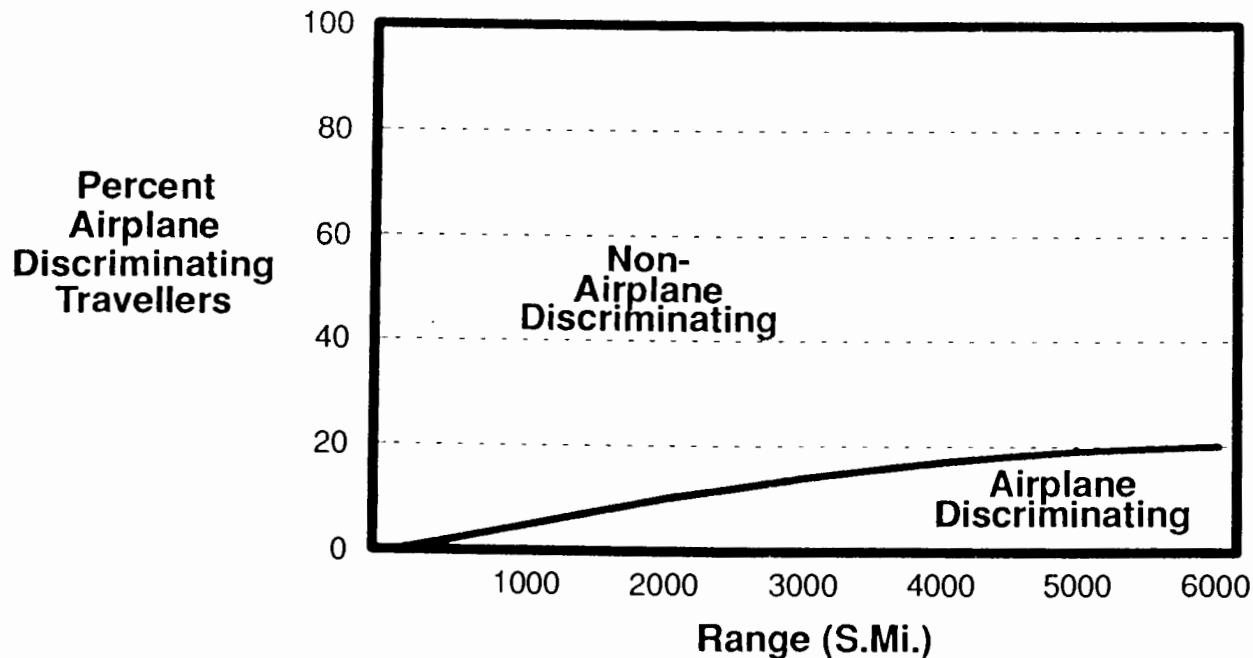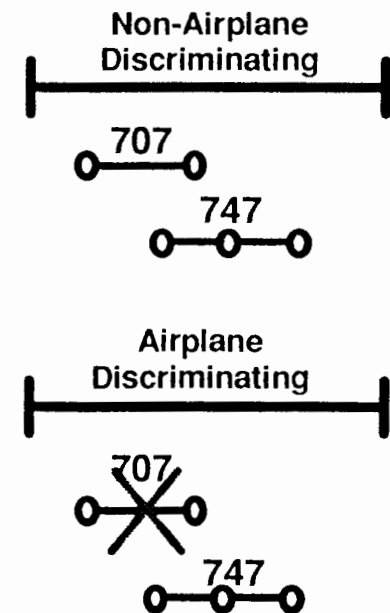
The Traveller Chooses Among Paths In The Window

Decision Window
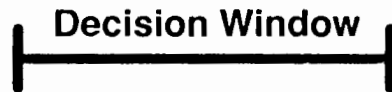
If there are no paths within the window, the traveller must re-plan the trip.

Decision Window

YY 100
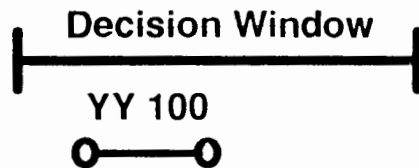
If there is only one path within the window, the traveller chooses that path.

Decision Window

YY 100   YY 200

ZZ 100
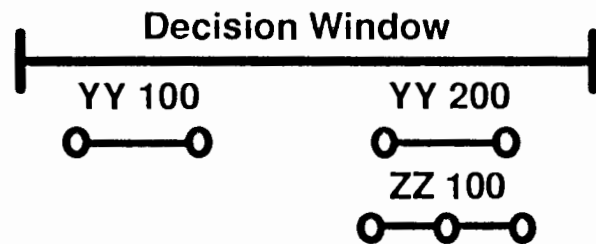
If there are multiple paths within the window, the traveller must make a choice between the paths.

How Does Re-planning Occur?

If a traveller does not find a flight(s) within his decision window he must re-plan his trip. Some people re-plan by considering other flights on the same day. Other travellers look at the same time period but on different days. Surveys are in progress to determine how many travellers are day-of-week flexible.

Day-of-Week Inflexible
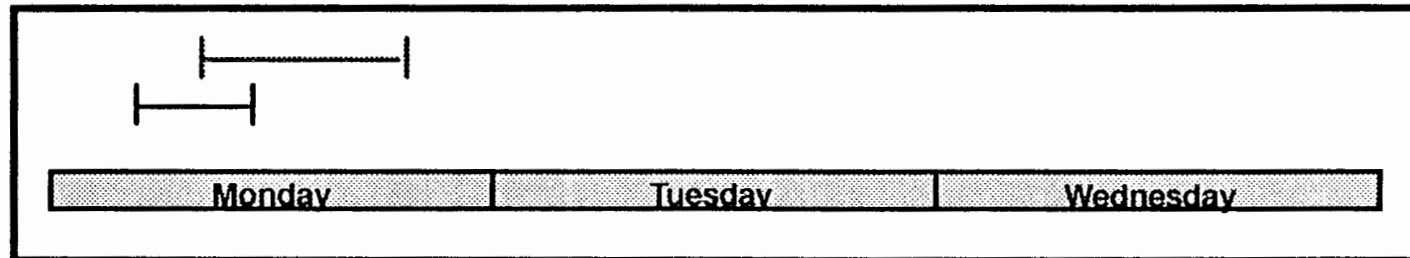
Day-of-Week Flexible

The Decision Window Model Has Three Steps

Step 1: **Define** the individual traveller's decision window.
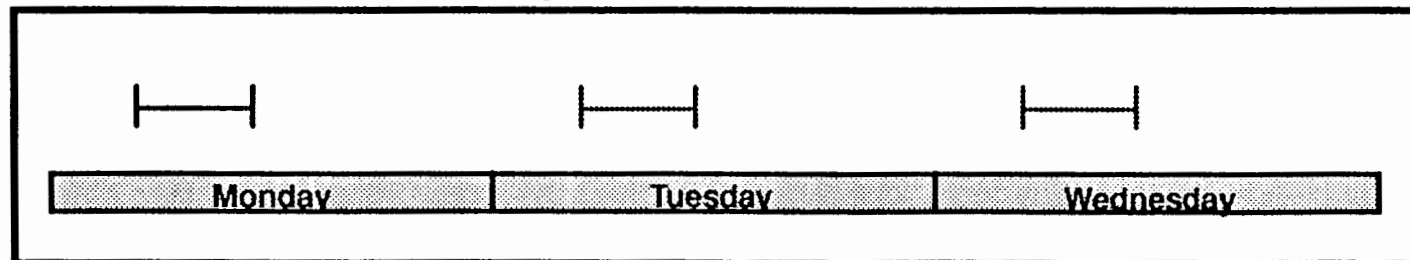- **Size of the window**
- **Position of the window**

Step 2: Determine which paths to consider.
- Paths in the window
- Eliminate paths with non-competitive characteristics

Step 3: **Determine which path is first choice preference.**
- **Tradeoff between airline preference and path quality**

What Elements Enter Into Choice Between Paths?

In determining preference between multiple paths in a decision window, passengers make a tradeoff between airline preference and path quality. The tradeoff is influenced by decision orientation which varies by range. From these factors airline service based coefficients are developed which in turn lead to the determination of path preference.
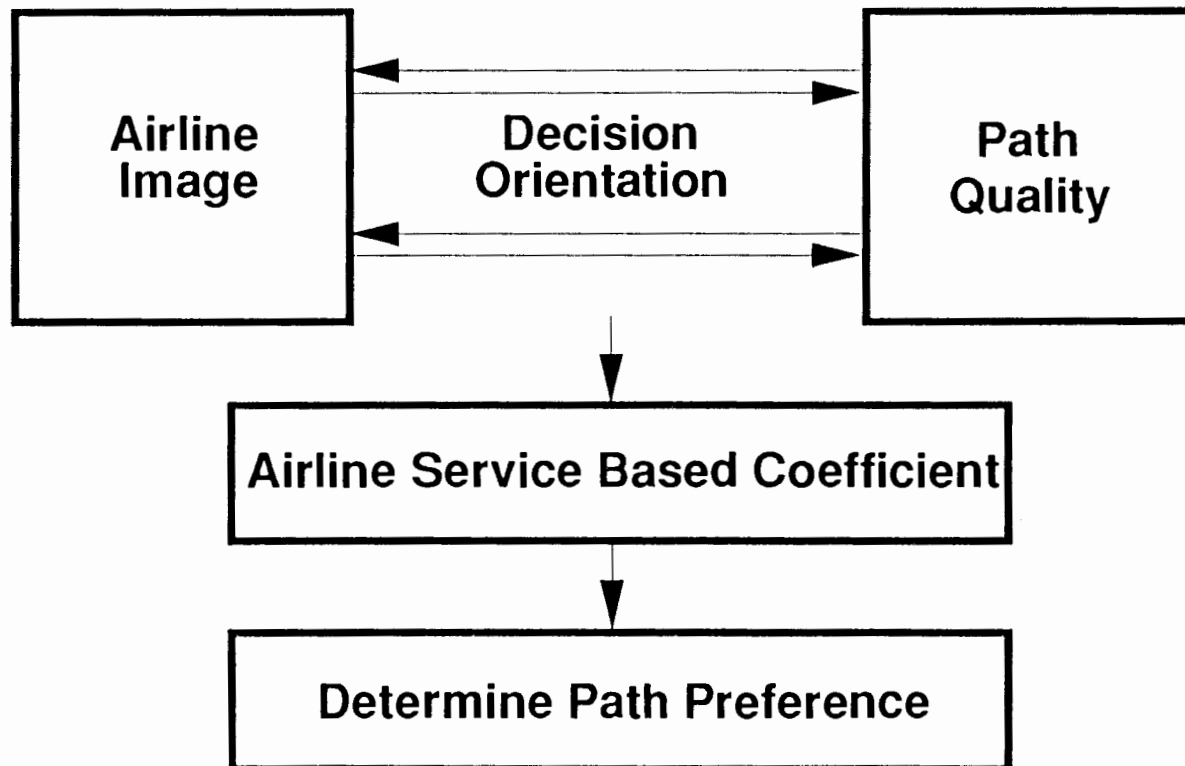
How Is Airline Image Measured?

Travellers evaluate airlines based on a number of factors. The model groups these into four areas. All of these combine to form a single image that a traveller has of a particular airline. This is called the airline integrated image.

Availability and Reliability

Such as:
- Number of cities served
- Number of flights
- On-time performance
- Flight cancellations (rarity)

Marketing Programs

Such as:
- Frequent flyer plan
- Discount fare plan
- Advertising

Service Quality

Such as:
- Reservation services
- Pre-flight service
- In-flight service
- Food and beverage service
- Baggage services

Passenger Environment

Such as:
- Seat comfort
- Cabin spaciousness / decor
- Flight cabin quietness
- Carry-on storage
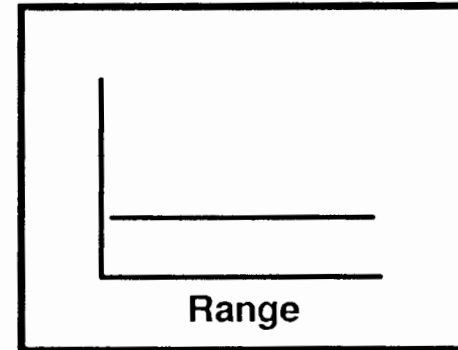- Types of airplanes flown

The Importance Of The Four Factors Vary With Range

The four factors vary in importance depending on the range of the trip.

Availability/Reliability

Range

Marketing Programs

Range

Service Quality

Range

Passenger Environment

Range

AMADWM-1 0993
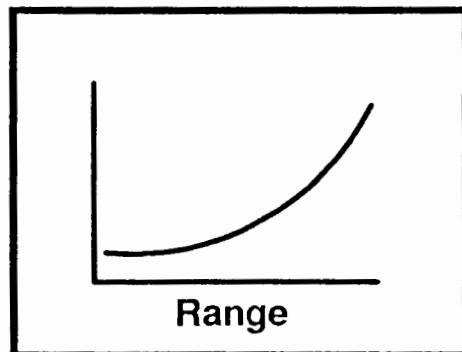
Each Factor Is Assigned An Importance Weight

The relative weight of the factor varies with the range of the flight. On long flights, passenger environment and service quality are more important and availability/reliability is less important. The importance of marketing programs increases with range.

	Short Range < 6 hours	Long Range ≥ 6 hours
Availability/ Reliability	31	11
Marketing Programs	14	18
Service Quality	31	36
Passenger Environment	24	35

Each Airline Has A Rating In Each Category

Each airline rating is relative to an assumed baseline airline where the rating for each category is 4. Airline CC is an example of an airline that is rated primarily on Passenger Environment; other categories are not known specifically and are left at the baseline figure.

Extremely Poor	Very Poor	Poor	Satisfactory	Good	Very Good	Excellent
1	2	3	4	5	6	7
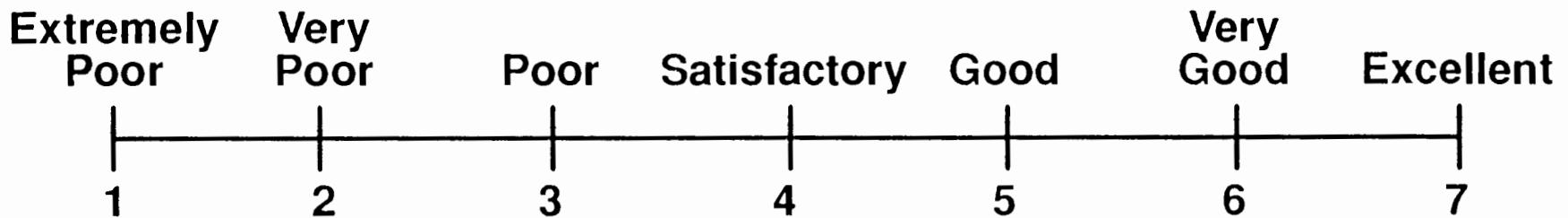
|	Airline YY	Airline ZZ	Airline CC
Availability Reliability	4	5	4
Marketing Programs	4	3	4
Service Quality	4	4	4
Passenger Environment	4	6	5

Weightings And Ratings Form Combined Ratings

The weighting of the importance of the four factors is combined with the rating each airline has in each of the four categories. The result is an airline combined rating.

$$\begin{array}{ll}
& \textbf{Weight (Avail./Reliability)} \quad \textbf{X} \quad \textbf{Rating (Airline YY, Avail./Reliability)} \\
\textbf{+} & \textbf{Weight (Marketing Prog.)} \quad \textbf{X} \quad \textbf{Rating (Airline YY, Marketing Prog.)} \\
\textbf{+} & \textbf{Weight (Service Quality)} \quad \textbf{X} \quad \textbf{Rating (Airline YY, Service Quality)} \\
\textbf{+} & \textbf{Weight (Pass. Environment)} \quad \textbf{X} \quad \textbf{Rating (Airline YY, Pass. Environment)}
\end{array}$$

= Combined Rating for Airline YY

Combined Ratings Used To Develop Coefficients

The combined ratings are then compared relative to the baseline airline. A coefficient is created such that a comparison between an airline and the baseline airline results in the probability that the airline is rated higher than the baseline airline. The baseline airline has a rating of 4 in every category.

Baseline   **Airline YY**

Probability

4   5
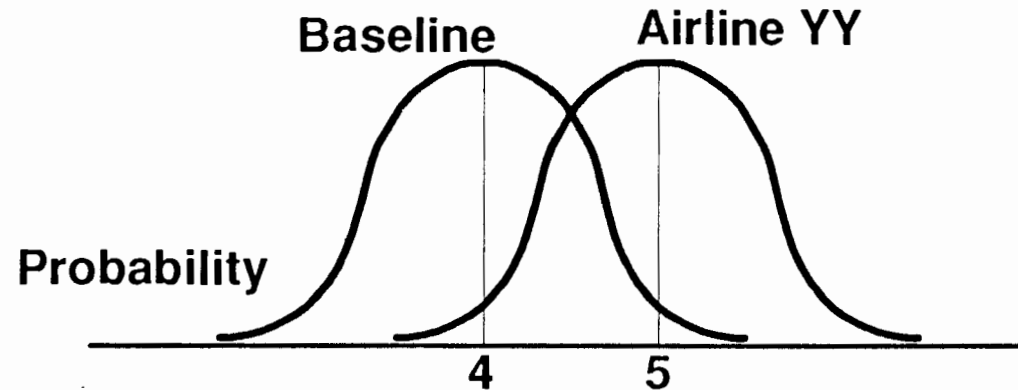
$$\frac{\text{Coef.(YY)}}{\text{Coef.(YY)} + \text{Coef.(Baseline)}} = \text{Probability Rating YY} > \text{Baseline}$$

The Coefficients Determine Airline Choice

The airline coefficients are compared to determine the probability that the traveller will select a given airline*. This comparison of the coefficients is called the market share equation.

$$\frac{\text{Coef.(Airline YY)}}{\text{Coef.(Airline YY) + Coef.(Airline ZZ) + Coef.(Airline CC)}} = \begin{array}{l}\text{Probability}\\ \text{(Airline YY is selected)}\end{array}$$

* Includes all airlines with paths in the individual's decision window.

The Results Of Integrated Image Calculations

Ratings and weights are joined to form combined ratings. The ratings are used to determine the coefficient of preference. And finally, the coefficient of preference is used to determine the probability that a given airline is selected.

	Airline YY	Airline ZZ	Airline CC
Combined Rating	4	4.65	4.24
Coefficient Of Preference	100	309.52	150.60
Probability Of Selection	.1785	.5526	.2689

Path Choice Is Determined After Airline Choice

In the following example, the traveller is faced with a choice between three nonstop flights. The traveller prefers YY and ZZ equally, and is indifferent to the three flights in the window. Since the market share equation is between airlines, YY gets half of the demand, but each YY flight only gets 25%.

Probability a given flight is selected.

Flight	Probability
YY	.25
ZZ	.50
YY	.25
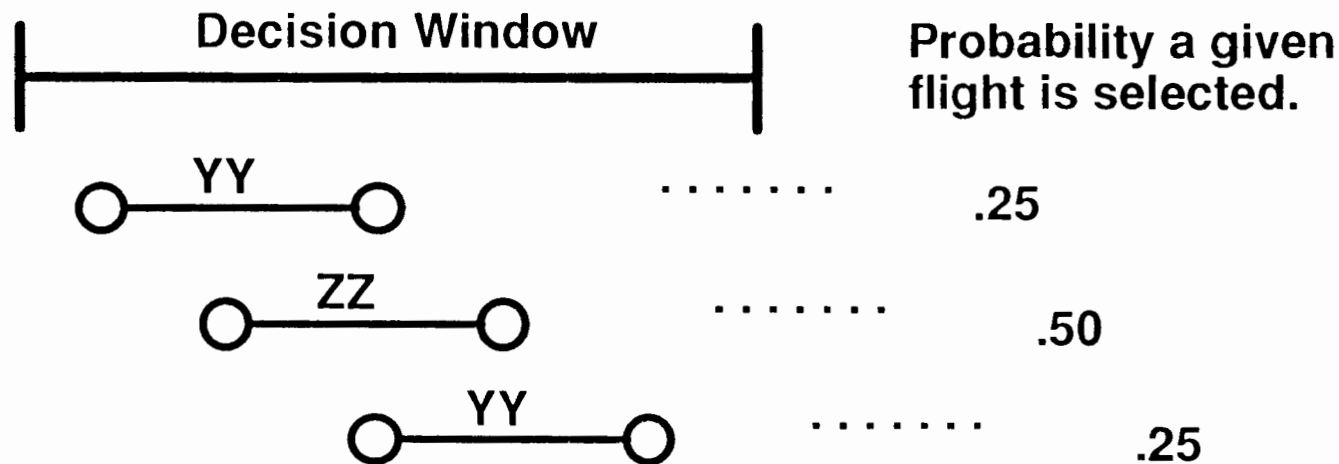
Probability (YY is chosen) = .5
Probability (ZZ is chosen) = .5

How Is Path Quality Determined?

Path quality is measured by the number of stops and connects on a path.
The best path quality is non-stop service, and has a Path Quality Index of 1.

Path quality is decreased by: Stops
                                     Connects
                                     Interline connects
                                     Other (excess time, ..)

Example:

Route/Airline	Best Class		Stops		Connects		Interline Connect		Path Quality Index
o—YY—o	1	+	0	+	0	+	0	=	1
o—ZZ—o—ZZ—o	1		1		0		0		2
o—YY—oo—YY—o	1		1		1		0		3
o—YY—oo—ZZ—o	1		1		1		1		4
o—YY—oo—ZZ—oo—CC—o	1		2		2		2		7

Decision Orientation Varies By Range

Different travellers evaluate paths differently. Some people are more concerned with the schedule aspects of the flight. Other people are more concerned about airline factors when choosing paths. This data allows us to model how people make the tradeoff between airline image and path quality in different markets.
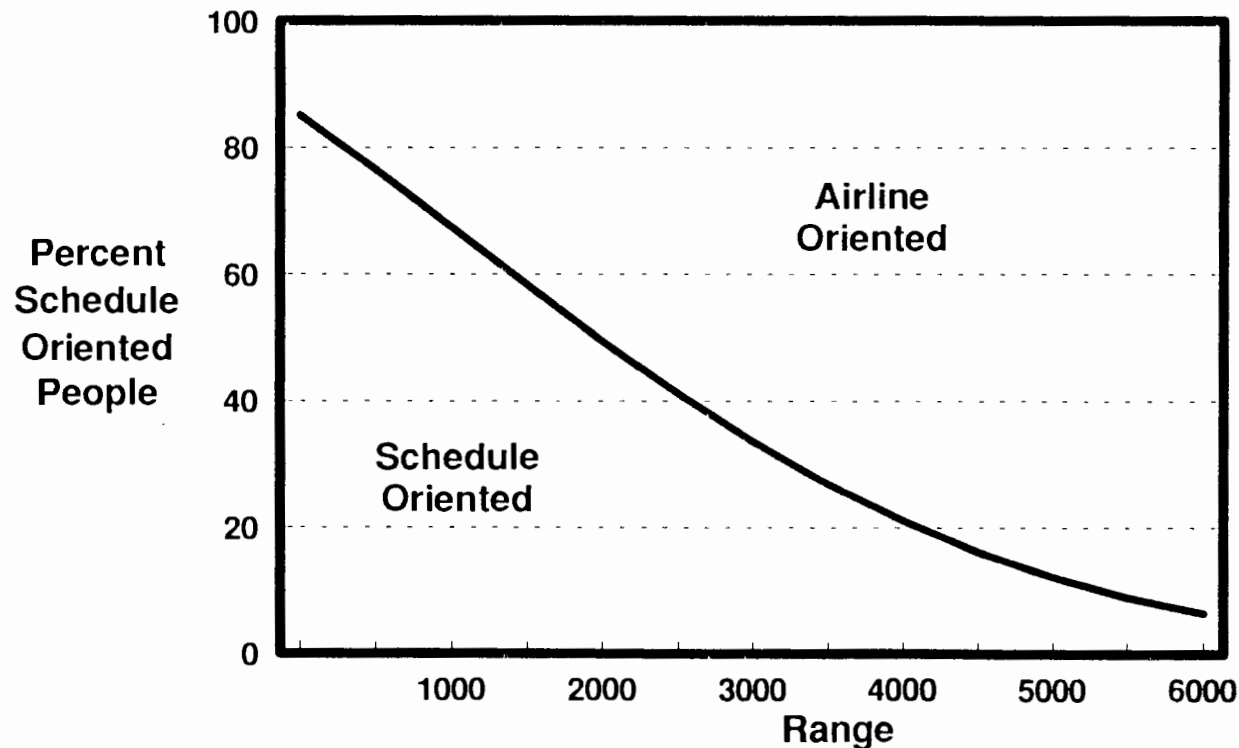
Decision Orientation Affects Path Choice

People who are schedule oriented look first for the best path quality. They consider only paths with the highest path quality in the market, such as non-stops. If there are multiple non-stops, they then consider airline. The airline oriented traveller first chooses the preferred airline, and then chooses the best path for that airline.

Schedule Oriented

Airline Oriented

- Chooses the best path quality
- Chooses preferred airline
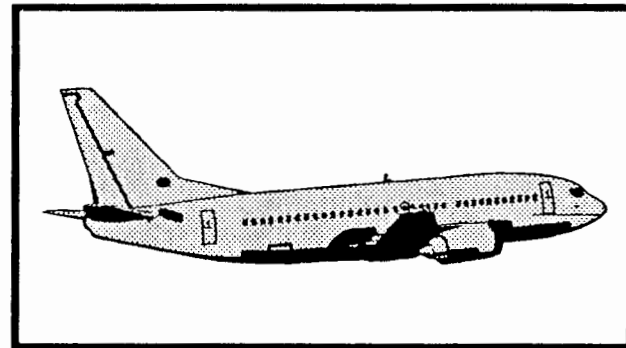
- Chooses preferred airline
- Chooses best path quality

What Are The Service Based Airline Coefficients?

The result of the trade-off between airline image and path quality is depicted in the airline service based coefficients. Both airline and schedule oriented people are represented in the coefficient. The table demonstrates how the importance of path quality index decreases as the range increases.

Airline Service Based Coefficients

Path Quality Index	Range (S. Mi.)					
	1000	2000	3000	4000	5000	6000
1	100.00	100.00	100.00	100.00	100.00	100.00
2	19.45	33.86	49.82	65.28	78.28	87.73
3	3.78	11.46	24.82	42.62	61.28	76.96
4	.74	3.88	12.36	27.82	47.97	67.52
5	.14	1.31	6.16	18.16	37.55	59.23

Example: Probabilities Calculated Two Ways

Fraction Schedule Oriented People (FSOP) = 0.674
Preference for Airline YY = Preference for Airline ZZ

Range = 1000 miles
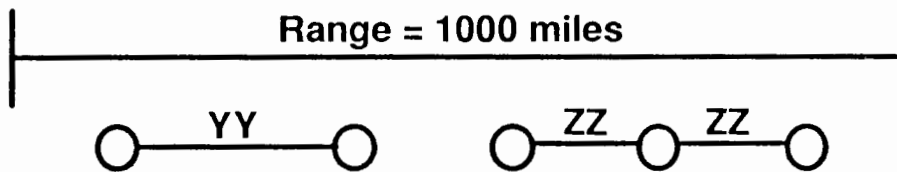
	Choose Airline YY	Choose Airline ZZ
Schedule Oriented 67.4%	67.4%	
Airline Oriented 32.6%	16.3%	16.3%
Total	83.7%	16.3%

Airline
	YY	ZZ
PQI 1	100.00	100.00
PQI 2	19.45	19.45

$$\frac{100.00}{100.00 + X} = 83.7\%$$

$$X = 19.45$$

Example

Situation:

Range = 3000 miles
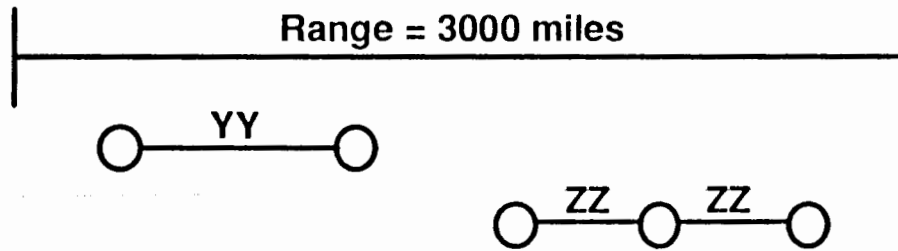
	Airline	
	YY	ZZ
PQI 1	**100.00**	100.00
PQI 2	49.82	**49.82**

$$\frac{\text{Coefficient(Airline YY)}}{\text{Coefficient(Airline YY)} + \text{Coefficient(Airline ZZ)}} = \begin{array}{c}\text{Probability}\\(\text{YY is selected})\end{array}$$

$$\frac{100.00}{100.00 + 49.82} = .6675$$

The probability that YY is selected is 66.75%

More Observations About Decision Windows

For airlines faced with trying to attract as many passengers to their flights (paths) as possible, what do decision windows suggest?

- Path Quality is important.
  Paths that have a lower path quality index (PQI) are less likely to be the first choice preference of a traveller.
    - Time factor
    - Image factor

- Range determines the importance of different factors.
    - The longer the range, the more important airline service quality and passenger environment are.
    - A difference in path quality is less important at longer range.

How Does It All Fit Together?

Step 1:
- Day-of-Week Demand
- Time-of-Day Demand
- Schedule Tolerance and Delta-T

→ Determine Decision Window Position and Sizing

Step 2:
- Schedule

→ Determine Paths Within Window

Step 3:
- Path Quality
- Airline Image Weights
- Airline Image Ratings
- Decision Orientation

→ Develop Service Based Airline Coefficients → Evaluate Paths Within Window → Make First Choice Path Preference