Evaluation of Alternative Aircraft Types

Dr. Peter Belobaba

Istanbul Technical University
Air Transportation Management
M.Sc. Program

Network, Fleet and Schedule
Strategic Planning
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Lecture Outline

• Fleet Planning Evaluation Process
  ▪ Top-down approach to capacity gap analysis
  ▪ Bottom-up micro approach

• Aircraft Selection Criteria
  ▪ Technical and performance characteristics
  ▪ Economics and finances
  ▪ Environmental, marketing and political issues

• Financial Evaluation of Aircraft Alternatives
  ▪ Review: NPV analysis and example
Fleet Planning Evaluation Process

• Fleet planning requires an evaluation process for assessing the impacts of new aircraft (see next slide):
  ▪ Traffic and yield forecasts used to estimate revenues
  ▪ Planning ALF determines ASMs and number of aircraft required
  ▪ Aircraft acquisition has financial impacts in terms of investment funding, depreciation, and interest expenses
  ▪ Operating cost and revenue forecasts provide profit projections
  ▪ Used to predict effects on balance sheet, cash flow, and debt load

• This planning process is ideally an ongoing effort that requires input from many sources:
  ▪ A critical component of a long-term strategic planning process
“Top-Down” (Macro) Approach

- Aggregate demand and cost spreadsheets used to evaluate financial impacts of aircraft options for a defined sub-system, region, or route:
  - “Planning Load Factor” establishes ASMs needed to accommodate forecast RPM growth (e.g., 70% planned ALF)
  - “Capacity Gap” defined as required future ASMs minus existing ASMs and planned retirements
  - Assumptions about average aircraft stage length and daily utilization determine “aircraft productivity” in ASMs per day, used to calculate number of aircraft required
  - Estimates of aircraft operating costs can then be used to compare economic performance of different aircraft types
Capacity Gap Analysis

Available Seat Miles

ASM Forecast

Type 1

Type 2

Type 3

Current Fleet – Retirements

Year

Capacity Gap
“Bottom-Up” (Micro) Approach

• Much more detailed evaluation of routes and aircraft requirements allows “what-if” analysis, but requires detailed future scenarios:
  ▪ Future route networks and schedules must be generated, and airline’s share of total market demand is assumed
  ▪ Forecasts of demand and revenues by origin-destination market are then allocated to each future flight

• With more detailed inputs, bottom-up approach provides much more detailed outputs:
  ▪ Aircraft assignments and operating statistics by route
  ▪ Complete projection of financial results under different fleet plans
Top-down vs. Bottom-up Fleet Planning

• **Top-down approach** allows for rapid evaluation of new aircraft types, given high-level assumptions:
  ▪ Changes in traffic forecasts and/or operating costs (e.g., fuel price)
  ▪ Airline structural changes (e.g., average stage length of flights)

• **Bottom-up approach** uses substantially more detail:
  ▪ Changes to individual route characteristics can be evaluated
  ▪ But, very difficult to incorporate future competitors’ strategies

• **Simpler top-down approach** is commonly used, since detailed 10-15 year scenarios are highly speculative:
  ▪ Likely to be inaccurate in face of changing market conditions
  ▪ Political decisions can overrule “best” analysis of options
Aircraft Selection Criteria

• **Fleet composition is an optimal staging problem:**
  - Number and type of aircraft required
  - Timing of deliveries and retirement of existing fleet
  - Tremendous uncertainty about future market conditions
  - Constrained by existing fleet, ability to dispose of older aircraft, and availability of future delivery slots

• **Aircraft evaluation criteria for airlines include:**
  - Technical and performance characteristics
  - Economics of operations and revenue generation
  - Marketing and environmental issues
  - Political and international trade concerns
Technical/Performance Characteristics

• “Payload/range curve” is most important (next slide):
  ▪ Defines capability of each aircraft type to carry passengers and cargo over a maximum flight distance.
  ▪ Affected by aerodynamics, engine technology, fuel capacity and typical passenger/cargo configuration
  ▪ Typical shape of curve allows trade-off of payload for extra fuel and flight range, before maximum operational range is reached

• Other important technical factors include:
  ▪ Maximum take-off and landing weights determine runway length requirements and feasible airports
  ▪ Fleet commonality with existing airline fleet reduces costs of training, new equipment and spare parts inventory for new types
**767-300ER Payload-Range Curve**

*General Electric Electric Engines*

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**Boeing 767-300ER**

MTOW, 412,000 lb (186,880 kg)

- **Payload, 1,000 lb (1,000 kg)**
  - Maximum structural payload
  - 218 passengers

- **Range, 1,000 nmi (1,000 km)**
## B767-300ER Performance Summary

<table>
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<th>CF6-80C2B4F Basic</th>
<th>CF6-80C2B7F Maximum</th>
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<tr>
<td>Sea-level takeoff thrust*/flat-rated temperature</td>
<td>56,500/90</td>
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<td>Maximum taxi weight</td>
<td>381,000</td>
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<tr>
<td>Maximum takeoff weight</td>
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<td>Maximum landing weight</td>
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<td>Maximum zero fuel weight</td>
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<tr>
<td>Operating empty weight</td>
<td>199,700</td>
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<td>Fuel capacity</td>
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<thead>
<tr>
<th></th>
<th>CF6-80C2B4F Basic</th>
<th>CF6-80C2B7F Maximum</th>
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<tbody>
<tr>
<td>Passengers, 18 FC, 46 BC, 154 TC</td>
<td>218</td>
<td>218</td>
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<tr>
<td>Cargo</td>
<td>4/14</td>
<td>4/14</td>
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<td>Design range, MTOW, full passenger payload</td>
<td>5,225</td>
<td>6,150</td>
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<td>Cruise Mach</td>
<td>0.80</td>
<td>0.85</td>
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<td>Takeoff field length, SL, 86°F, MTOW</td>
<td>8,300</td>
<td>8,300</td>
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<td>Initial cruise altitude, MTOW, ISA +10°C</td>
<td>35,100</td>
<td>33,400</td>
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<td>Engine-out alt. cap., MTOW, ISA +10°C</td>
<td>14,800</td>
<td>12,900</td>
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<td>Landing field length, MLW</td>
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<td>Approach speed, MLW</td>
<td>145</td>
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<tr>
<td>Approach speed, 3,000-nmi mission</td>
<td>129</td>
<td>129</td>
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<tr>
<td>Fuel burn/seat, 3,000-nmi mission</td>
<td>295.6</td>
<td>295.6</td>
</tr>
</tbody>
</table>

* Reduced at higher altitudes or temperatures
* Can rule out operations to certain airports

Source: Boeing Commercial Airplanes
Cabin Configurations for B767-300

Source: Boeing Commercial Airplanes
Flexibility of Cargo Payload Capacity

Source: Boeing Commercial Airplanes
Financial/Economic Issues

- Required financing from internal or external sources:
  - Cash on hand, retained earnings, debt (loans) or equity (stocks) for aircraft purchases
  - Leasing can be more expensive, but also more flexible, allowing for more frequent fleet renewal and requiring less up-front capital

- Financial evaluation to determine costs and revenues:
  - Up-front costs include purchase price, spare engines and parts, ground equipment, training
  - Newer aircraft offer lower operating costs at higher initial purchase price (vs. older aircraft that have been depreciated)
  - Increased revenue potential from larger and/or newer aircraft
Other Aircraft Selection Criteria

• **Environmental factors:**
  - Noise performance has become a major concern (Stage 3 noise requirements and airport curfews on louder aircraft)
  - Air pollution regulations likely to ground older aircraft

• **Marketing advantages of newer aircraft:**
  - Typically, most consumers have little aircraft preference
  - However, first airline with newest type or airline with youngest fleet can generate additional market share

• **Political and trade issues can dominate fleet decisions:**
  - Pressure to purchase from a particular manufacturer or country, especially at government-owned national airlines
Objective: Maintain Fleet Flexibility in the Face of Uncertainty

• Massive uncertainty over 5-30 year time horizon
  ▪ Estimates of economic growth, passenger and cargo, competition, revenues and costs all subject to error
  ▪ Detailed route/market forecasts not appropriate, use of scenario evaluation and sensitivity analysis instead

• Fleet plans try to maximize future airline flexibility
  ▪ Increase use of leasing (vs. owning) aircraft can provide greater fleet flexibility (but higher costs)
  ▪ Fleet retirement plans can be adjusted with changing fuel prices
  ▪ Orders of multiple types in common rated family
  ▪ Negotiations with manufacturers to minimize firm orders and increase future options with alternative types
Financial Evaluation of Aircraft Alternatives

- Comparisons of aircraft economic performance based heavily on DOC (cash flow) analysis
  - Profit/loss approach includes aircraft depreciation
  - Averages training, financing, maintenance costs over aircraft life

- Net Present Value (NPV) analysis can be used to incorporate time value of money
  - Depends on discount rate assumptions: Tendency is to assume too low for government-supported airlines; assume too high by private airlines trying to compensate for anticipated volatility

- Cash flow NPV models combined with Monte Carlo simulation of uncertain variables
  - Probability distributions of fuel prices, exchange rates, traffic growth and yield assumptions
  - Result is a range of possible outcomes and expected value NPV
Review: NPV Analysis for Evaluation of Capital Investments over Time

• Most capital investments accrue benefits and/or costs over a multiple-year time period:
  ▪ Net Present Value analysis applies a “discount” to both benefits and costs expected in future years
  ▪ Discount rate captures uncertainty of future gains/losses as well as opportunity cost of alternative investments

• Evaluation of aircraft options is a good example:
  ▪ Initial up-front capital investment, followed by many years of higher revenues, lower operating costs, etc.
Example: NPV Analysis

The basic question: How can we compare two alternative aircraft?

The basic answer: By weighing the value each aircraft provides.

We measure the earning power of a capital asset such as a commercial airplane by estimating its future cash flows and discounting them back at the airline’s cost of capital.

787-8  Versus  767-300ER

Source: Boeing Commercial Airplanes
Example: NPV Analysis

10-year study
10% discount rate
Pretax analysis
7,480-km average trip length
625 trips per year
Number of seats
- 787-8
- 767-300ER
- 224 seats
- 218 seats
Age of aircraft
- 787-8
- 767-300ER
- new
Aircraft will be leased
- 787-8
- 767-300ER
- $1,000,000 per month
- $650,000 per month

Source: Boeing Commercial Airplanes
Example: NPV Analysis

Passenger Revenue

6 more seats \[\rightarrow\] despill \[\rightarrow\] 1.9 more passengers

\[\rightarrow\] $0.082\text{ yield,}\]

\[\rightarrow\] $1,168\text{ more net revenue per trip}\]

\[\rightarrow\] \text{10 years, 10% discount, 2% esc}\]

\[\rightarrow\] $4.8m \text{ NPV}\]

\[\rightarrow\] $730K\text{ more net revenue per year}\]

\[\rightarrow\] 625\text{ trips}\]

Source: Boeing Commercial Airplanes
Example: NPV Analysis

Source: Boeing Commercial Airplanes