Financing, Managing & Maintaining Engines: Roundtable Summit for Financiers

How to Compare Two Engines?

May 1, 2008
Cost of Ownership

- Engine Acquisition
  - Price

- Engine Operation
  - Maintenance
  - Life Limited Parts
  - Reliability
  - Fuel & Oil
  - Emissions
  - Fleet Management

- Engine Resale
  - Residual Value

EASY TO COMPARE

Should I really care about this ???

Aren’t all engines the same ???

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Shop Visit Rate Reports

Comparable Fleet (Experience, Size, Age and Operations) should have Comparable SVR

Longer Current and Expected Lives for Engine A

Fewer Shop Visit

……Time on wing avoids Shop Visits
Assumptions

➤ Operating conditions:
- 42 A/C
- 3000 hours / year
- Flight leg 2.0
- Derate 15%

➤ Shop visits:
- 25% shorter lives for engine B, due to worldwide fleet dilution effect (conservative approach)
- 350,000 $ advantage on shop visit average cost for engine A vs engine B (excluding LLP’s)
## Operating Cost

### Cost Generated by Shop Visits – 10 years

<table>
<thead>
<tr>
<th>Maintenance Cost Model Analysis</th>
<th>Engine A</th>
<th>Engine B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of SV for 42 A/C within 10 year</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>Average Cost of a SV</td>
<td>1.2M$</td>
<td>1.55M$</td>
</tr>
<tr>
<td>Average Total Cost</td>
<td>Base</td>
<td>+64M$</td>
</tr>
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</table>

> Maintenance cost **savings of 1.5 M$ per A/C**

Over 10 years of operation

($ constant & no inflation)
## Maintenance Cost Model Analysis

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<tr>
<td>Number of SV for 42 A/C within 15 years</td>
<td>117</td>
<td>167</td>
</tr>
<tr>
<td>Average Cost of a SV</td>
<td>1.2M$</td>
<td>1.55M$</td>
</tr>
<tr>
<td>Average Total Cost</td>
<td>Base</td>
<td>+118M$</td>
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</table>

- **Maintenance cost savings of 2.8 M$ per A/C**
- Over 15 years of operation
- ($ constant & no inflation)
### Maintenance Cost Model Analysis

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<tr>
<td># Spare Engine Recommendation</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Cost for spare engines</td>
<td>Base</td>
<td>~ 7 - 8 M$</td>
</tr>
</tbody>
</table>

- **Spare engine savings of ~ 180 K$ per A/C**

  ($ constant & no inflation)
Cost of Ownership

➢ Engine Acquisition
  ▪ Price

➢ Engine Operation
  ▪ Maintenance
  ▪ Life Limited Parts
  ▪ Reliability
  ▪ Fuel & Oil
  ▪ Emissions
  ▪ Fleet Management

➢ Engine Resale
  ▪ Residual Value
Life Limited Parts Advantage

- **QTY of LLPs**
  - Engine A: 18
  - Engine B: 25

- **LLP Set Price**
  - Engine A: $1 830 090
  - Engine B: $2 114 300

- **Ultimate Lives**
  - Fan: 20, 30
  - Core: 20, 20
  - LPT: 20, 25

- **Lower LLP Cost**
  - Cost / cyc *: $105.7 ($2007)
  - Cost / cyc *: $79.7 ($2007)

- **Engine A LLP Cost Advantage:** $26 / Cycle / Engine
  - 780 K$ advantage per A/C over 10 years (3000 hrs/year & flight leg 2.0)
Cost of Ownership

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Reliability Trend

*Engine in Flight Shut Down Trend*  
Engine B (June 2006 / AI March 2007)

IFSD: Delta of 0.001/1000 EFH @ Engine A advantage

*Engine Dispatch Reliability Trend*  
Engine B (June 2006)

D&C: Delta of more than 0.03/100 departures @ Engine A advantage
**Cost of IFSD, D&C**

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<tr>
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<th>Engine B</th>
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<tbody>
<tr>
<td><strong>IFSD rate / 1000 EFH</strong></td>
<td>0.002</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>Number of events over 10 years</strong></td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Average Cost of an IFSD</strong></td>
<td></td>
<td>100K$</td>
</tr>
<tr>
<td><strong>10 year Average Total Cost for 42 A/C (*)</strong></td>
<td>Base</td>
<td>+64M$</td>
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<tr>
<td><strong>D&amp;C rate / 100 departures</strong></td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Number of flight impacted per year for 42 A/C (*)</strong></td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td><strong>Cost of one delay (66% of the D&amp;C)</strong></td>
<td></td>
<td>20K$</td>
</tr>
<tr>
<td><strong>Cost of one Cancellation (33% of the D&amp;C)</strong></td>
<td></td>
<td>50K$</td>
</tr>
<tr>
<td><strong>10 year Average Total Cost for 42 A/C (*)</strong></td>
<td>Base</td>
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(*) based on an annual utilisation of 3000 hours and a flight leg of 2.0

**IFSD & D&C cost savings of about 140 K$ per A/C**

Over 10 years of operation
($ constant & 0% inflation)
Cost of Ownership

- Engine Acquisition
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  - Reliability
  - Fuel & Oil
  - Emissions
  - Fleet Management

- Engine Resale
  - Residual Value
Fuel Burn Comparison

BIG NEWS!!

Fuel Burn starts at the gate ...
Oil Consumption Comparison

➢ Oil Consumption comparison … Easy !!!

➢ … but also reliability of oil system and impact on SV and D&C
Cost of Ownership

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Gatwick airport NOx charges for A320 Family

From the ICAO certification data sheets

Charges per landing ($)
Cost of Ownership

**Engine Acquisition**
- Price

**Engine Operation**
- Maintenance
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**Engine Resale**
- Residual Value
Engine commonality for the entire A/C family

- CFM56-7B for the B737NG family
- CFM56-5B/P for the A320 family

Engine Rerating:
1. Change the engine rating plug
2. Engrave the name plate

Excellent Marketability – Extensive Commonality
Reduced cost through commonality for Spares/ Training/ Fleet Management/ …
Shop Visit Benefit

► No EMO

28 Shop Visits

68 Shop Visits

40 Shop Visits

► With EMO

23 Shop Visits

5 transfers 5B3 → 5B6

42 Shop Visits

65 Shop Visits
Cost of Ownership

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- Engine Resale
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Aircraft Residual Value depends mostly on engines

- Aircraft/Engine value relationship

<table>
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<tr>
<th>Percent of Aircraft Value</th>
<th>Scrap value for the Aircraft value</th>
</tr>
</thead>
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<tr>
<td>Airframe</td>
<td>On older Aircraft, engines maintained with OEM parts &amp; repairs hold the value</td>
</tr>
</tbody>
</table>
Market Share

Number and location of Operators in service

- N&S America
  - Engine A powered A/C: 2256
  - Engine B powered A/C: 587
- Europe & CIS
  - Engine A powered A/C: 2260
  - Engine B powered A/C: 341
- Africa & Middle East
  - Engine A powered A/C: 318
  - Engine B powered A/C: 106
- Asia Pacific
  - Engine A powered A/C: 1425
  - Engine B powered A/C: 456

Marketability & Liquidity
CFM & IAE Engine Depreciation

Information from appraisers:

- Engine resale value stay constant until the end of production
- CFM engine at half life is about 70 to 80% of new engine’s price
- Market demand can make these trend vary

Higher resale value for CFM56 engines:

- for one engine at half life CFM56-5B4/P vs V2527-A5:
  + $360,000 from Avitas
  + $470,000 from IBA
CFM56 Residual Value Advantage

Higher market value, from different appraisers

Base Values, from *Avitas BlueBook*, 2007

<table>
<thead>
<tr>
<th>Thrust rating</th>
<th>CFM56</th>
<th>V2500</th>
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<tr>
<td>22k</td>
<td>6.0 M$</td>
<td>5.5 M$</td>
</tr>
<tr>
<td>23.5k</td>
<td>5.5 M$</td>
<td>5.5 M$</td>
</tr>
<tr>
<td>27k</td>
<td>5.5 M$</td>
<td>4.5 M$</td>
</tr>
<tr>
<td>30k</td>
<td>4.5 M$</td>
<td>4.0 M$</td>
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CFM56 engine market value advantage: up to +9%

Base Values, from *IBA (Engine Value Book)*, 2007

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<tr>
<td>27k</td>
<td>4.5 M$</td>
<td>3.5 M$</td>
</tr>
<tr>
<td>33k</td>
<td>3.5 M$</td>
<td>2.2 M$</td>
</tr>
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Upgrade Kits improve the asset value

- IBA and ASCEND each performed an independent assessment of the Tech Insertion Upgrade.
- Small differences are explained by the use of slightly different assumptions.
- Report represents the opinion of IBA and ASCEND and is intended to be advisory only.
Potential impact of non OEM materials on residual value

... and up to 65% if the whole engine need to be put back to the OEM standards

Estimated by independent appraisors between 10% to 26% on a mid-life CFM56-3 engine ...
OEM support

CFM genuine parts
OEM support

PMA blades Source 1

- CFM genuine parts
- PMA blades Source 1
CPU blades Source 2

CFM genuine parts

PMA blades Source 1

PMA blades Source 2
No One has the Data to Support this Configuration
When comparing engines, see global!

- Can’t see the forest for the trees?

- Don’t hesitate to ask questions …
CFM

The Power Of Flight