Take-off profiles – an introduction

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08\textsuperscript{th} July 2015
Airline Perspective on Noise

• Aim to:
  • Buy the safest, quietest, lowest emission aircraft we can afford,
  • Fly aircraft in safest, quietest, most environmentally efficient way.

• This creates trade-offs as some objectives compete:
  • Some noise saving techniques / designs could lead to larger NOx or CO2 emissions,
  • Some operational techniques could reduce noise further but at the cost of a safe, stable and sensible flight path.
  • Airlines operate to hundreds of airports, procedures must be as standardised as possible.
4 things about aircraft engines….

• Just like a car engine, they are not designed to be used at maximum rev’s (full thrust) all the time.

• For many decades the normal practise has been to minimise thrust on take-off in order to protect the engine and reduce wear and tear.

• By taking care of the engines we reduce the amount of component wear, increase the time between servicing and minimise risk of unexpected engine failure.

• When an aircraft and engine are first certified the maximum reduction in thrust is set (between 25% and 40%)
Normal Take-off (example only):

Take off using 90% thrust

Reduce to “climb” thrust (circa 80%) @1000’ above airport

Lower nose of aircraft to accelerate (so that we can safely retract “flaps”)

Now at most efficient / aerodynamic can climb away
What effects climb rates

- Aircraft weight:
  - The longer the flight the more fuel it needs this can be over 100 tonnes of fuel and greatly affects aircraft performance;
  - More passengers = more weight;
  - More cargo in belly of aircraft = more weight.

- Weather – e.g very hot days reduce aircraft performance.

- Other effects – wind / atmospheric pressure…….
Effect of weight:

“Lightest weight” take-off:
1. Lower thrust setting so less engine noise;
2. Would expect to be higher – especially if still has spare “performance” despite maximum reduction in take-off thrust

Heavy weight take-off:
1. Closer to maximum thrust required to stay above obstacles.
2. Lower altitude.
Items we can vary:

Could vary the thrust reduction altitude:

Early = aircraft lower but less engine noise
Later = aircraft higher but more engine noise

Could vary point at which we lower nose to accelerate:

Delay = higher closer to airport but lower than would normally be further away from the airport i.e. rob Peter to pay Paul...
Factors Affecting Thrust Setting on Each Take-off

<table>
<thead>
<tr>
<th>Thrust</th>
<th>Pro</th>
<th>Con</th>
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<tbody>
<tr>
<td>Full thrust</td>
<td>Uses less fuel.</td>
<td>Creates more noise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Produces more NOx</td>
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<tr>
<td>Reduced thrust</td>
<td>Produces less NOx</td>
<td></td>
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<td></td>
<td>Less wear on engines</td>
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<td></td>
<td>Can be quieter – depending on when thrust reduced</td>
<td>Probably lower than if full thrust used (but noise not louder at ground level)</td>
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Conclusions

• As an industry we once thought “higher was better”…but:
  
  • Recent noise analysis has shown that 1000’ “thrust reduction and acceleration” has some noise benefits,
  • Recent A380 “optimised” low noise departure flights showed engine thrust is even more important than height of aircraft.

• Many variations can be tested – but need to be mindful of time it takes to develop best profile so need:
  
  • Clear guidance on which areas we are trying to reduce noise over (can’t simply reduce noise everywhere - but can refine procedures to maximise benefits)
  • Recognition of trade-offs with other safety / environmental needs.
A380... half the noise footprint on departure with 40% more passengers
Sources of Aircraft Noise

**Airframe Noise Sources**
- Nose Gear
- Flap Side Edges
- Main Landing Gear
- Gear Wheel Wells
- Leading Edge Devices

**Engine Noise Sources**
- Fan
- Compressor
- Jet exhaust
- Turbine
- Combustor