Sub-sonic Airplanes
Noise Technical Issues

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Noise improvement due to Stage 3 phase-in is gradual

How to reduce noise impact:
- Engine and airframe noise reduction
- Operating procedures
- Land use planning

<table>
<thead>
<tr>
<th>Year</th>
<th>Impacted Population</th>
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<tbody>
<tr>
<td>Stage 3 Phase-in (Stage 2 Phase-out)</td>
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<tr>
<td>Stage 3 Fleet</td>
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Technology Implementation takes a long time and is costly

Stages:
- Identify needs
- Promotion/Funding
- Concept development
- Basic research
- Proof-of-concept
- Implementation
- Production
- In-service
- Noise benefit to community

Developmental Cost vs Year graph:
- Cost increases as the year progresses.
Breakthrough Technologies needed for Cost Effective Noise Solutions

Cost

Noise Reduction

Modest Technical Improvements

Major Technical Improvements

Technical Breakthroughs
Concepts for Achieving Lower Noise

**Quiet Engine Design**
- **Current Plans**
  - Optimum BPR
  - Advanced fan blade design
  - Low noise FEGV design
  - Jet noise suppressors (Chevrons, tabs)
- **Future Plans**
  - Stator bypass and inlet boundary layer control
  - Quieter turbines and combustors
  - Jet noise suppressors
  - Active flow control
  - Compressor noise reduction

**Low Airframe Noise**
- **Current Plans**
  - Flap/slats for low noise
  - Low noise landing gear design
- **Future Plans**
  - Active flow control
  - Low noise slat designs

**Improved Low Speed Performance**
- **Current Plans**
  - Single slotted flaps
  - Improved low speed L/D
- **Future Plans**
  - Drooped ailerons for T/O & landing
  - Active flow control

**Nacelle and Acoustic Treatment**
- **Current Plans**
  - Scarf inlet
  - Maximum acoustic area
  - Lining designs optimized at each location for maximum impact
  - Acoustic treatment for buzz-saw noise
- **Future Plans**
  - Active noise control
  - Treated inlet lip
  - Mode scattering linings in fan duct

**Flight Operating Procedures for Low Community Noise (Future Plans)**
- **Current Plans**
  - Advanced ATC and Avionics for procedures such as steep and curved descent
  - Advanced ATC for optimum noise abatement procedures and flight tracks
  - Modern ATC, FMC etc. to minimize vertical and horizontal dispersion
  - FMC capability to automate cutback based on airport
- **Future Plans**
  - Advanced ATC for optimum noise abatement procedures and flight tracks
Noise Exposure to Service Personnel and Crew are Emerging Issues

- Lower ramp noise standards?
- Flight crew communication/fatigue
- Crew rest environment
- Cabin crew exposure limits
Conclusion

• A balanced approach is needed
  - Engine and airframe noise reduction
  - Optimum operating procedures
  - Land use planning

• Technical areas that need work have been identified - further discussions are needed

• Technology Implementation takes a long time and is costly

• Community realization of the benefit of new technology airplanes is gradual and takes several years to materialize

• The subject of noise impacting ramp crew and airplane crew should also be addressed as an environmental concern