

Urban Aircraft Design for Low Noise

AIAA AVIATION 2017

Denver, Colorado

June 2017



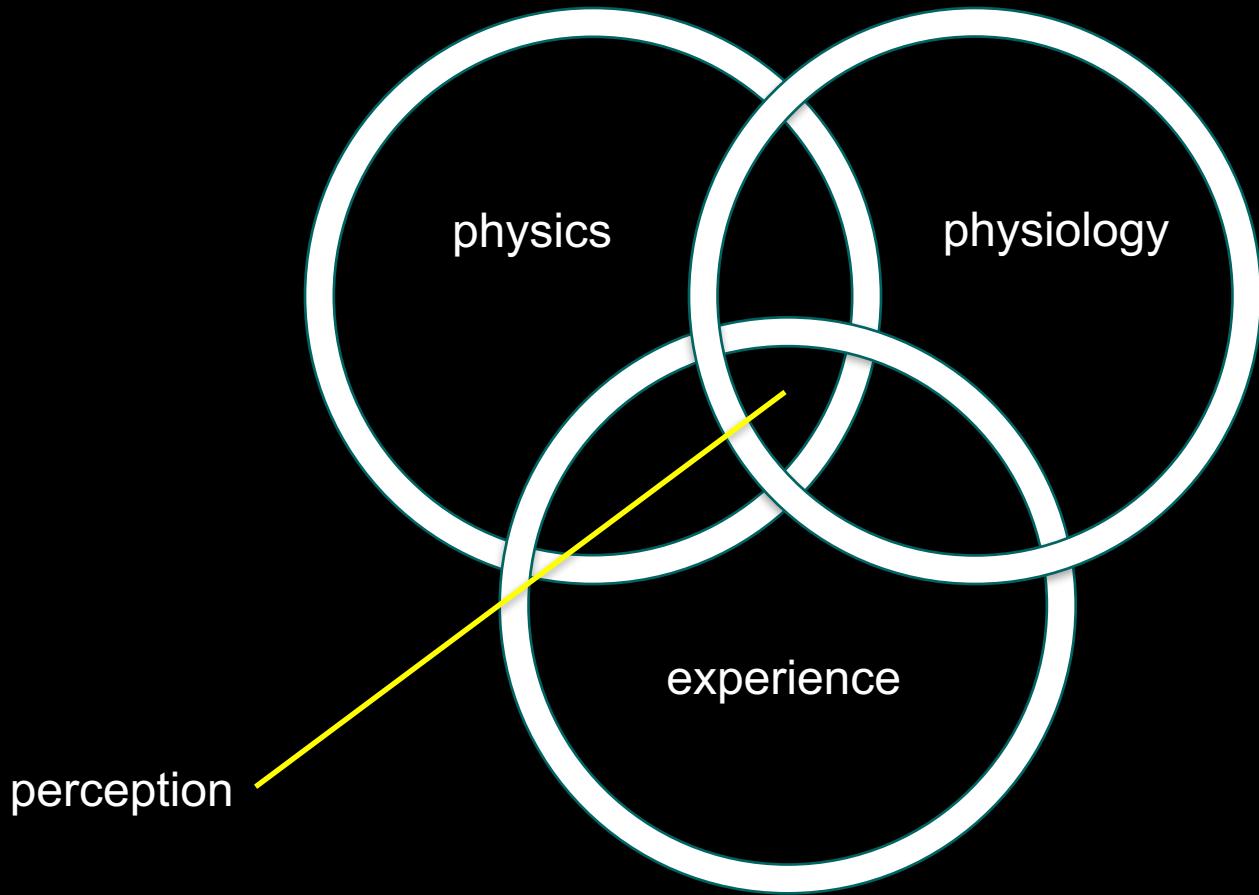
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And by UBER Elevate

Goals

- compare aircraft designs
 - multi-rotor
 - tilt wing/tilt rotor
 - multi-fan
 - entrained or co-flow
- design operations for lowest community acoustic impact

Assumptions

- iterate design for low perceived acoustic signature
- iterate route plans for low community impact

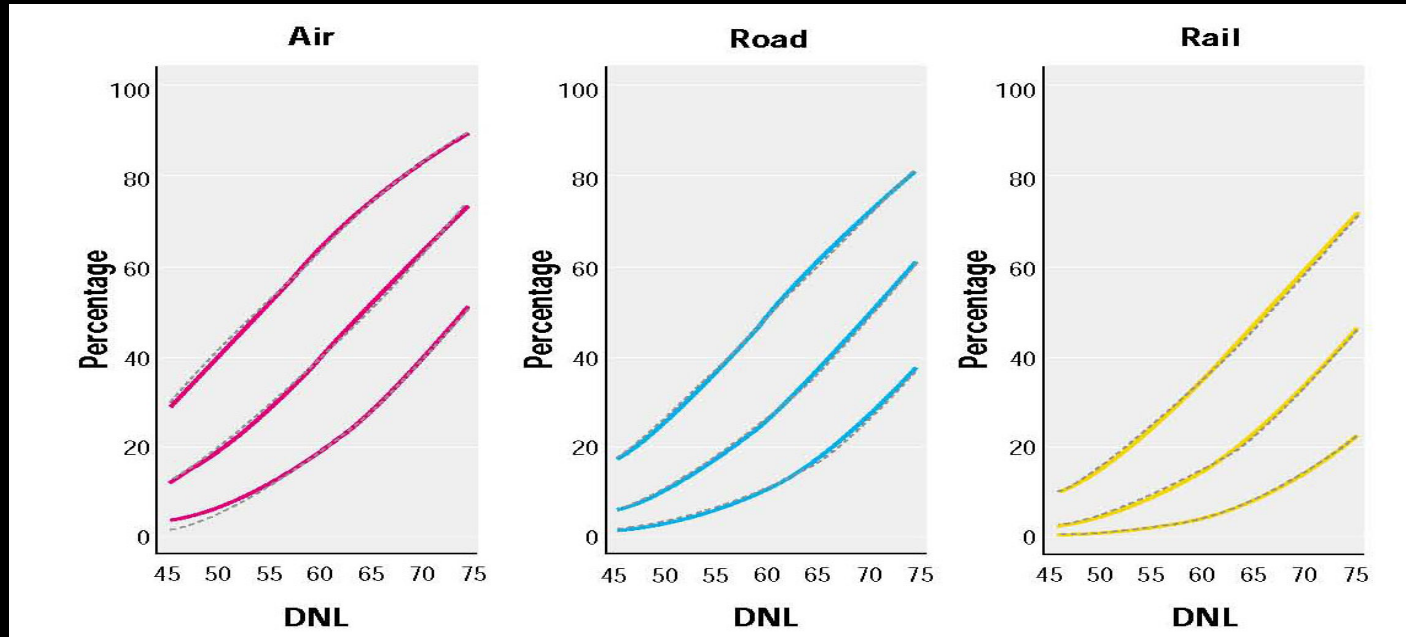


physics

physiology

experience

perception

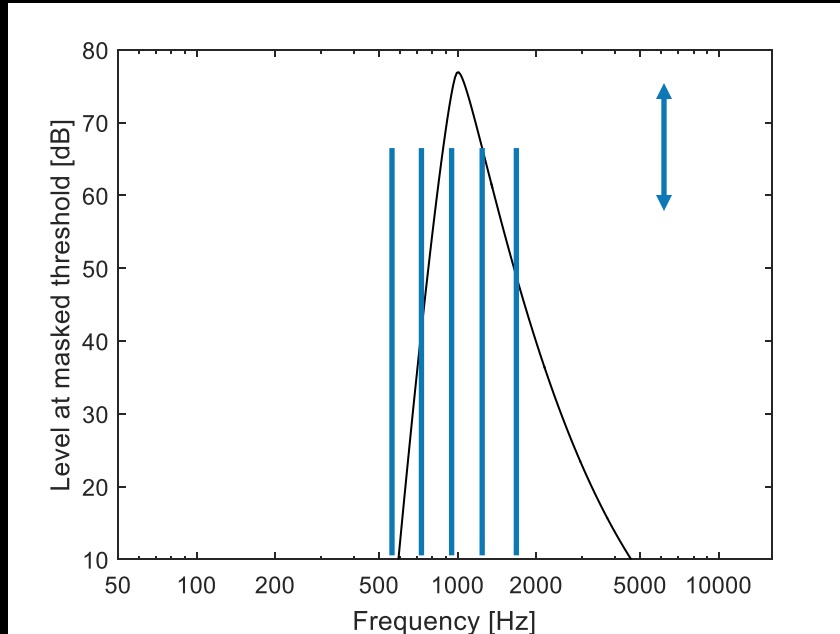


Miedema and Oudshoorn, TNO-PG, Leiden, The Netherlands (2001). *Annoyance from Transportation Noise: Relationships with Exposure Metrics DNL and DENL and Their Confidence Intervals in Environmental Health Perspectives*, 109:4

What determines magnitude?

- loudness (includes bandwidth, complexity and impulsivity)
- duration
- contrast with ambient sound
 - spectral character, not only loudness

Masking

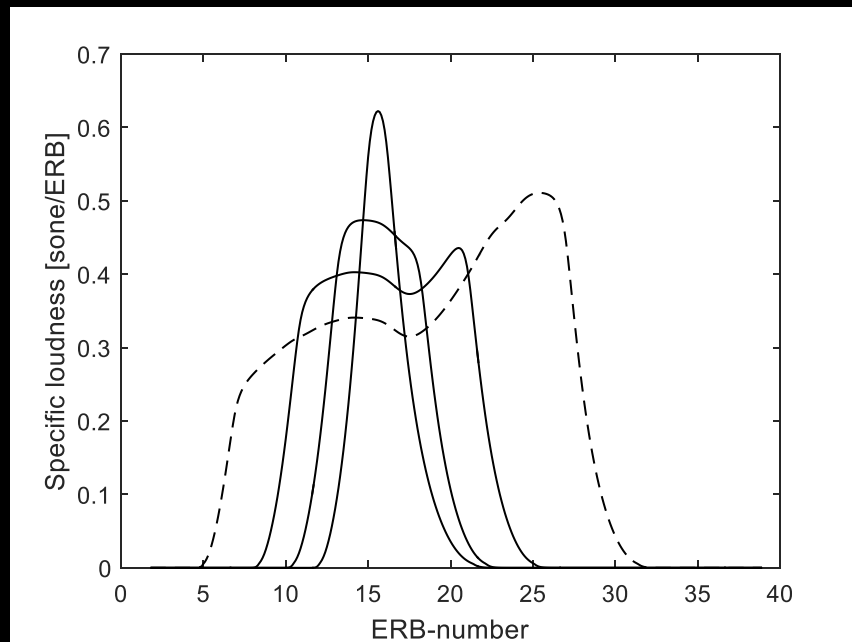


- A tone masks other nearby tones
- The greater the distance in frequency, the lower the level needed to reach the masked threshold
- Slopes depend on masker level
- Upper slope is flatter than the lower slope



Josef Schlittenlacher, "Audibility and Acceptability, Use of the Cambridge Loudness Models." Presented at UBER Elevate Summit, April 2017

Spectral loudness summation



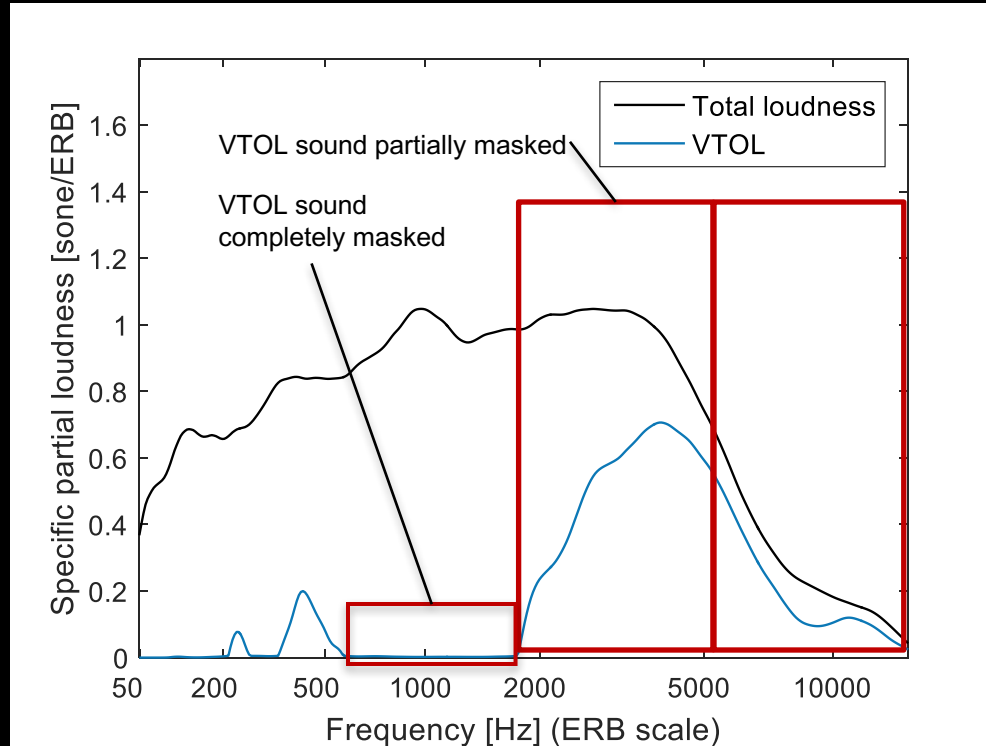
- 4 noises, same Leq, centered at 1 kHz
 - 920-1080 Hz
 - 700-1400 Hz
 - 500-2000 Hz
 - 250-4000 Hz



- 4 sone
- 6 sone
- 10 sone
- 16 sone

Josef Schlittenlacher, "Audibility and Acceptability, Use of the Cambridge Loudness Models." Presented at UBER Elevate Summit, April 2017

Partial Specific Loudness



“I don’t care what numbers you measure, I only care that people see it and say, ‘that’s really quiet.’”

JoeBen Bevirt, 2015

New Tools

- auralization of new aircraft types
- physiological loudness metrics
- real-time ambient sound monitoring
- real-time sound exposure tracking

If you can't measure it,
you can't improve it

Be sure to measure
what you want to improve

