Perception of Aircraft Height and Noise
“Aircraft are often perceived by residents to be lower than in the past”

This is a phenomenon reported elsewhere (in UK and overseas), but not addressed by the literature

“INDEPENDENT ACADEMIC RESEARCH IS NEEDED”

- inform stakeholders,
- validate the reasons behind this perception,
- identify measures to establish the actual facts,
- Involve the community.
**Initial hypotheses**

**Hypothesis 1**
“This may be due to an increase in size of aircraft of similar types. It is also in part because aircraft height and position relative to the observer is highly variable.”

*Arrivals Review*

**Hypothesis 2**
Exposure to aircraft noise is a multi-sensorial experience i.e. a combination of visual and acoustic factors

*Sussex University*

Source: [Pinterest](https://www.pinterest.com)

Source: [State of the Art](https://stateoftheart.com)
1. Perception is typically assessed on long-term memory.

2. The visual and the auditory component of a plane event need to be captured while a plane is passing.

3. “Height” and “size” have not been addressed before.

We need to probe long term judgements

We also need to capture short term judgements

We need to investigate new quantities

Survey considerations

For the first time, we decided to do this by 15-min interviews

Need to design new questions
1. Introduction

Part I

2. What did we do?
3. Results: perception of height and size
4. Analysis: relationships with noise indicators

Part II

5. Results: Is there an effect of height on annoyance?
6. Analysis: Do planes really fly lower than before?
7. Literature: non-acoustic factors
8. Analysis: Who are our participants?
9. Recommendations
Final report, Part I
Key questions for part I

1. Is height perceived by individuals reasonably accurately?

2. Is plane size perceived by individuals reasonably accurately?

3. Is there a correlation between aircraft size and height perception?

4. Is there a correlation between noise levels ($L_{max}$ or other) and height perception or actual height?

5. Does CAP 1498 adequately define people’s view of being ‘overflown’?
Designing our survey(s)

WHAT DID WE DO?
1. Select four locations

Density plot of westerly arrivals, July - September 2016

- **Region 1**: Crowborough
- **Region 2**: Tunbridge Wells
- **Region 3**: Penshurst
- **Region 4**: Cowden

Legend:
- Gatwick Radar Maneuvering Area (RMA): RMA Boundaries
- Rwy 26 Arrivals Density
- July to Sept 16, total number of arrivals per 500m grid squares:
  - 200 - 400
  - 400 - 800
  - 800 - 1500
  - 1500 - 2000
  - 2000 - 3000
  - 3000 - Max

Figure 4.1
2. Learn what to expect

"Average plane"

"Lowest plane"

Source: Figure 9.2
3. Check they are different

The survey areas had different “average plane” heights, when adjusted for ground level.

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<tr>
<th>Region</th>
<th>Survey area</th>
<th>Lowest /ft</th>
<th>Average / ft</th>
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<td>4</td>
<td>Cowden</td>
<td>1748</td>
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</table>
4. Postal survey

Each survey areas contained approximately 300 residential addresses (200 in Cowden).

**Long-term survey:**

1. We randomly selected 550 (50%) of the addresses.
2. We sent them a postal questionnaire on 23/08/17 and a pre-paid envelope.
3. Completion time: 20-40 min
4. Answers were returned in the first 2 weeks of September.

“Postal” sample: 112 respondents
5. Single plane observations

In August and September 2017, we visited the areas unannounced.

**Short-term survey:**

1. We went out only in optimal weather conditions (11 days).
2. We addressed participants (112) outdoors: either in their garden or in the local park.
3. Semi-structured interviews lasted 15 minutes.
4. We also commented on passing planes.

**“Planes” sample:**

243 planes
6. Arranged appointments

In the last two weeks of September, we visited by appointment

By-appointment survey:

1. Participants (11) were randomly selected among volunteers from the postal survey.

2. Semi-structured interviews (in their garden or in a local park) lasted 15-45 minutes.

3. We also commented passing planes.

“In-person” sample: 112 + 11 = 123
7. Measurements and tracking

- Gatwick deployed a NTK monitor in the proximity of each survey area.

- Sussex also used a class I noise-level meter (measurements at 1.5m from ground)

- Recorded only events with $L_{max} > 55$ dBA

- Tracked only planes within 500 m from the NTK.
A summary of our findings

PERCEPTION OF HEIGHT AND SIZE
How was height assessed?

- **Qualitative**
  Asking the participant to compare with the “average” plane or the “lowest” plane.

- **Quantitative**
  Asking to judge the height from ground, based on this chart.
Perception of height

1. A plane passes
2. We ask how its height compares with the “average height” and continue if it is “average”
3. We track the plane’s real height on CASPER
4. We find the mean real height of the planes judged to be “average”
5. We compare the two heights.

**Highlights:**
- The “average” plane corresponds to the “most frequent” plane
- Interviewees distinguished well when a plane is “average”
Highlights:
• Interviewees also distinguished well changes from the “average”
Perception of height 3/4

Highlights:

- Most postal respondents underestimated the numerical height of the “average” plane by at least 1,500 ft.

Procedure 2a (postal):

1. We ask a numerical judgement on the “average plane”
2. We compare with the “most frequent” plane (e.g. in Figure 5.10).
Perception of height 4/4

1. A plane passes
2. We ask a numerical judgement on height
3. We track its real height on CASPER
4. We compare the two (e.g. in Figure 7.7).

**Highlights:**

1. The interviews confirm the trend: most of the participants underestimated the height of passing planes by 1,200-1,500 ft.
How was size assessed?

• **Qualitative**
  Comparing with the “average” plane or the “lowest” plane.

• **Quantitative**
  Asking participants to judge the silhouette of the plane, based on a chart to be held 45 cm away.

Source: iStockphoto
Perception of size

Procedure 3b (interviews):

1. A plane passes
2. The interviewer checks the distance of the reference chart
3. We ask a quantitative judgement on size
4. We track its real size on CASPER
5. We compare the two (e.g. in Figure 7.5).

Highlights:
1. Both surveys confirm that participants tend to overestimate the size of passing planes: they were reported to be up to twice larger.
2. It is much easier to get the size wrong for planes further away.
Effects of noise 1/2

Number of planes considered (110 out of 242)

Highlights:

1. There is some evidence that, as a plane gets noisier, it may appear to fly lower than it actually is.
2. We detected no effect of noise on perceived size.
Effects of noise

Day 1
Real: 4,200 ft, 57 dB
Perceived: 3,700 ft, 57 dB

Day 2
Real: 3,400 ft, 58.8 dB
Perceived: 2,400 ft, 58.8 dB

Note: $L_{max}$ decreases by 6 dB if distance is doubled (section 8)
When you would consider a plane to be flying over you?

Highlights:
1. Most of the participants (either by mail or by interview) agreed on a $48^\circ$ angle with the horizontal, in line with one of the definitions proposed by the CAA (CAP1498).
• Participants living below arriving aircraft could correctly describe the “average plane” i.e. the most frequent aircraft in their area.

• **Qualitatively**, participants were also very good at accurately perceiving how a passing aircraft was different from the “average plane”: in height, size and distance from where they live.

• **Quantitatively**, however, most participants underestimated the height of a specific aircraft – including the “average” one – by between 1200ft and 1500ft and overestimated its size by as much as twice.

• For the same height, **louder planes may perceived as lower, but not larger**.

• CAP1498: Most of the participants (either by mail or by interview) agreed on a 48° angle with the horizontal, in line with one of the definitions from the CAA.
With the exception of Cowden, the “lowest plane” is correctly assessed both in height and size.

C1: height of the lowest plane

C5: size of lowest plane

- Perceived height
- CASPER

Graphs showing altitude on ground (ft) for Crowborough, Tunbridge Wells, Penshurst, and Cowden with a bar chart for the postal survey and CASPER 2011-2016.
Interval
Outline for today

1. Introduction

Part I
2. What did we do?
3. Results: perception of height and size
4. Analysis: relationships with noise indicators

Part II
5. Results: Is there an effect of height on annoyance?
6. Analysis: Do planes really fly lower than before?
7. Literature: non-acoustic factors
8. Analysis: Who are our participants?
9. Recommendations
1. Do people react worse to ‘low flying’ (i.e. lower than normal) aircraft, and if so why?

2. Do people react worse to aircraft they perceive as lower, and to what extent is this because they are noisier?

3. Is the response to aircraft perceived as ‘off-track’ worse than those following usual track routings?

4. What other factors affect the perceived impact of noise from individual aircraft?
Impact of height perception on self-reported disturbance

HEIGHT AND ANNOYANCE
Different studies have looked at the correlation between acoustical indicators and community perception.

For the same acoustic level, aircraft-produced sounds produce a higher % of highly annoyed.
• More recent studies have highlighted an increase in the reported annoyance for all sources.

• This effect is particularly significant for aircraft noise.

• +15% highly annoyed at 50 dBA.

Source: NTK measurements (Figure 8.9), approx. value of $L_{DEN}$
Non-acoustic factors

• According to our study, aircraft noise in the four survey areas is very similar…but self-reported annoyance appears quite spread.

• According to recent studies 77-81% of the variation in annoyance is explained by non-acoustical factors.

Source: NTK measurements (Figure 8.9), approx. value of $L_{DEN}$.
Effect of height on annoyance

Highlights:
1. The height of the single plane has little impact on annoyance
2. Perceived changes from the “average” have a noticeable impact, instead.
Perceived changes over the years

**Highlights:**

1. For 40% of either the postal or the field survey, planes are lower (or much lower) than 5 years ago.
2. For 55% of the postal sample, there is no change compared to 1 year ago.
A question that came natural to us while being in the field

ARE PLANES REALLY FLYING LOWER THAN BEFORE?
Are planes really flying lower? 1/2

Highlights:
1. The height of the planes (above Penshurst, in this graph) changes significantly during the 24h
2. There seem to be two distributions of heights.

Source: NTK measurements
Are planes really flying lower? 2/2

Highlights:
1. Even our small sample of aircraft shows the presence of some planes which are flying lower than the others.
2. GAL decided to look further into this.
Looking at the whole picture

Cowden (51.148, 0.039) (51.139, 0.145)

Penshurst (51.163, 0.132) (51.181, 0.234)

Tunbridge Wells (51.126, 0.212) (51.137, 0.317)

Crowborough (51.078, 0.108) (51.052, 0.205)

Distance across each gate
4 NM (7.4 km)
A small dent in the distribution
A small dent in the distribution

There are indeed planes that fly lower than the “average”
• These planes have always been there, but their role has become more prominent over the years.

The table below shows the altitude above local ground (ft) for different locations and years.

**Altitude above local ground (ft)**

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- a) Penshurst
- a) Crowborough
- a) Tunbridge Wells
Why are they so important?

- When asked about a period where they most noticed planes, almost everyone had a story to tell, with the oldest dating to July 2017.

**Highlights:**

1. The recalled event hits the top of the personal annoyance scale for 35% of the interviewees.

2. Size and height are often not seen, so the only effective control parameter seems to be the loudness.
Is this enough?

10) How many extremely low or noisy planes do you tend to notice in a day?

Amount: ____________

Highlights:
1. Most of the interviewees only notice a limited number of planes each day.
2. The presence of a small quantity of planes flying repeatedly lower than the “average plane” may be sufficient to justify the perception that “planes are flying lower than before.”
Lessons from the literature review

ACOUSTIC AND NON-ACOUSTIC FACTORS
Non-acoustic factors 1/4

- In practice, however, annoyance data from surveys come with a large spread.

- According to recent studies **66-81% of the variation** in annoyance is explained by non-acoustical factors.

Source: NTK measurements (Figure 8.9), approx. value of $L_{DEN}$
Non-acoustic factors

- Effects of self-reported sensitivity and expectations

Source: SoNA (2017).
• Effect of airport changes

Top 6 non-acoustic factors

- Self-reported sensitivity
- Age
- Gender
- Feeling of being in control
- Living conditions (e.g. house type, employment status, presence of a garden)
- **Type of survey**

Source: NTK measurements (Figure 8.9), approx. value of $L_{DEN}$
Knowing better their opinions

WHO ARE OUR PARTICIPANTS?
Highlights:

1. Gender and age distribution very similar to the one in CENSUS 2011. Differences may be due to actual population in the survey areas.

2. No effect of age or gender could be seen on annoyance.
Highlights:

1. Employment status and house type are similar in the two surveys.
2. No effect of these two parameters was detected on annoyance.

- 40% of the participants is retired
- 80% of the respondents live in a house

Graph and pie chart showing distribution of employment status and house type.
16) When you are indoors at home, how much control do you feel you have over the impact of outside noise? (e.g. shutting windows, using headphones, or visiting quieter rooms)

- Not at all
- Slight
- Moderate
- A lot
- Complete control
- Don’t know

Highlights:

1. For our participants, the more they felt in control, the less they felt annoyed (indoors).
2. We could link feeling “in control” to the presence of insulation.
Disturb from planes (indoors)

- When you are indoors at home, how much does noise from planes, **bother, disturb or annoy you?**
- When you are indoors at home, how much does noise from planes **disturb your sleep?**

**Highlights:**
1. 40% of the interviewed (and a quarter of the postal respondents) reported not to be disturbed by plane sounds during the day.
2. The number of participants who reported not to be disturbed during their sleep is even higher, in both surveys.
3. There was a wide divergence of perceptions between individuals.
Disturb from planes (outdoors)

Highlights:

1. At least 40% of the postal respondents reported not to be disturbed by noise in their daily activities indoors.

2. The number of people “not at all disturbed” decreases to 30% when moving outdoor, and there is a corresponding increase at the maximum of the scale. Outdoors activities are determinant for these respondents.
• We identified a small proportion of planes (between 2% – 5% in 2016) that have started flying much lower (more than 1,000ft below) than the “average plane”.

• The number of these planes has increased over the past 5 years. This finding may be sufficient to justify the comment, reported in the Arrivals Review, that “planes are flying lower”.

• We found evidence that participants’ long term perceptions on arriving aircraft may be based on their experience of these lowest, noisiest planes – and not on the average plane.

• In these context, addressing these ‘outlying’ aircraft could potentially reap large benefits for local communities.
The study highlighted that annoyance indoors was reduced for the participants by the feeling of “being in control”, linked to the presence of sound insulation. We did not find effects of sensitivity and demographics, present in other studies.

The study found that the impact of planes on their life outdoors determined the feeling of being “bothered, disturbed or annoyed” for approximately 1 participant every 10.

Conversely, almost 40% of the interviewed (and a quarter of the postal respondents) reported not to be disturbed by plane sounds by day. This percentage gets even larger for sleep disturbance, highlighting a wide divergence of perceptions between individuals.
Recommendations

1. Track the lowest planes also in 2017.
2. Understand and address the causes underpinning their presence, especially in particular hours of the day.
3. Extend the survey. Even if our samples are representative (respectively of the demographics and of the airlines present at Gatwick), they are still small.
4. Look at other hours. We were in the field between 11:00 and sunset, while participants also reported noticing planes at night and in the early morning.
Questions?

Thanks for your attention!