AIRCRAFT NOISE IN AUCKLAND CITY, INCLUDING AN AFFECTED RESIDENT'S PERSPECTIVE

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Introduction In the discussion below I will attempt to summarise the science, received wisdom and personal observations which have led me to believe that the current and planned organisation of aircraft movement over Auckland is not just sub-optimal (however you might define that) but in terms of its social consequences, thoroughly perverse.

Aircraft noise is generated primarily by airflow over the plane's surfaces and by its engines. When and how this noise is received on the ground (intensity, duration and fluctuation) is complex: the various sources interact with each other and with external influences such as atmospheric conditions, terrain (topographical and buildings), the type of aircraft involved and whether it is taking off, climbing, cruising, in a low-power descent, or in its final approach to landing.

On the ground, how the noise is received depends not only on the effects mentioned above, but also on the attenuation afforded by dwellings. Again the situation is complex, and compounded by the range of sensitivity of the occupants to noise intensity, suddenness, pulsation, repetition and timing. A particular level of noise is typically perceived to be more annoying at night than during the day.

A brief inspection of the many books in the Architecture library of the University of Auckland on acoustics sound-insulation an socio-economic consequences of noise is sufficient to convince anyone that the science of acoustics and the technology for building sound-proofed dwellings have all been well understood for many years. So has the human response to noise. Despite this there is a need to dispel widespread misconceptions especially about how to reduce noise penetration into domestic buildings. Moreover, it seems there is a convenient disregard for the social impact of unreasonable noise by purely profit-driven businesses (airlines, Auckland Airport) and a tacit neglect of duty to serve the interests of affected ratepayers by Auckland City Council.

I will be as non-technical as possible.

Sound emission and transmission to the ground The regular daily air traffic over Auckland city comprises five main groups of concern regarding noise nuisance:

Large and medium-sized national and international passenger and freight aircraft powered by modern turbofans.

Older turbofan and turbojet-powered large and medium-sized aircraft.

Smaller commercial aircraft plying between regional airports, typically powered by turboprops or, in some cases, piston-engines. These have conventional propellers.

Light commercial and private jets and propeller-driven aircraft.

Helicopters.

The 'signature' sound emission of each of these groups is very diverse and this, combined with the differing altitudes and speeds at which they cruise, take off and land complicates the situation immensely. Under all conditions, the biggest modern turbofans are more efficient and quieter than earlier ones. At the other extreme nothing much has changed with regard to the deafening noise of piston-engines, propellers and helicopter rotors. Their noise rises dramatically and the power efficiency falls as the speed of the propeller/rotor tips hit the speed of sound. This (not the noise itself) limits the speed of such aircraft. (Hence the whip-crack noise of helicopters and roar of the Warbirds' Harvards). Modern technology has refined the profiles of blade tips to minimise these problems, but the inevitable effect has been to lift the adopted operating speeds rather than reduce the noise.

The engine noise of the modern high bypass-ratio turbofan mainly consists of front-end whine or groan, and tailpipe whoosh or thunder depending on whether the plane is drifting in to land with corrections to its flightpath, or 'going for it' on take-off. The take-off noise is much less than that of pure jets. [A Boeing 707 pure jet was deafening enough, but Concorde was off the scale!]

The other noises from the big jets, only noticeable on approach and landing, are mainly due to the deployment of extra lift or braking devices – flaps and slats etc., airbrakes – and finally the undercarriage. These affect the lift and drag of the descending plane and usually involve a need to power up or down, especially in windy conditions, resulting in fluctuating noise levels.

The noise generated by propeller-driven aircraft is quite different: it is dominated by low frequencies rather than the broad spectrum of jet aircraft. Low frequency noise penetrates buildings more than high frequencies and this, coupled with low altitude cruising over built-

up areas is loud enough to swamp conversation outdoors and radio or TV indoors. The sometimes relentless procession of small commercial and private aircraft over suburbs such as Ellerslie and Royal Oak is arguably the greatest source of daytime annoyance for those living close to the flightpath.

Sound reception on the ground Noise reception is complicated by the terrain around the flightpath and atmospheric conditions such as temperature inversions on cold nights under a clear sky and reverberation between buildings. Not much of Auckland is flat. The humps and hollows result in focusing of aircraft noise in particular spots and, conversely, small islands of relative tranquillity. The exact positions of these anomalous locations will be affected by small variations in actual flightpath.

An example of this is where I live in Ellerslie. When the jets are descending along a west-to-east path the noise is variable. I live just east of the Michaels Park playing fields Here the rise and fall of noise is usually smooth, but for a small proportion of incoming jets the approach is silent until the plane is almost overhead, when the noise rises suddenly to its maximum which is much louder than otherwise typical. I suspect that the low-lying playing fields surrounded by higher ground immediately to the west is responsible for hiding the noise on approach and focusing it as the plane passes over the playing fields. If the plane is flying above an inversion layer, sound will be reduced well ahead of it but concentrated just ahead.

Another annoying feature on the ground is pulsation of noise level with peaks typically occurring every two or three seconds. Most likely, this is generated by reflected sound from small topographical features and/or nearby buildings combining with sound received directly.

Transmission of sound into buildings As mentioned in the introduction, the knowledge of how to build quiet dwellings is very well established. The bad news is that the vast majority of existing houses in Auckland are extremely poor in this respect and that retrofitting truly effective noise-reducing measures is difficult and expensive. I will explain the problems below, but to give an idea of what we are up against I begin with a quote from a technical book on the subject (McMullan, R, 1991):

“Airtight structures give good sound insulation. People don’t readily accept the fact that small gaps in construction give large reductions in [the effectiveness of] sound insulation. Seals around doors and windows need to be airtight, even the keyholes!”

This may seem paranoid, but it’s true. Compare how a small gap in heavy curtains illuminates an otherwise dark room in daytime. So, in the absence of a curfew on flights you

can forget having a peaceful night with a cool breeze through the bedroom in summer – open windows and fresh air are a thing of the past.

The two main pathways for sound to penetrate houses from above ground are through direct air pathways such as open windows and by vibration of lightweight structures such as 'tin' roofs wall cladding and single-pane windows, or a combination of these. Aircraft noise comes laterally, and from directly above (unlike traffic noise), so consideration of transmission through the roof maybe just as important as it is through walls and windows, especially in houses with attic space converted into bedrooms. Remember that although windows are the weakest link, the area through which walls and ceilings transmit sound is usually much greater than the window area.

The more massive the structure, the more the sound will be reflected (perhaps towards other nearby houses!) rather than transmitted to the interior, thus a brick outer wall will transmit less than timber cladding and a tiled roof will transmit less than a 'tin' one. However, the need for airtightness cannot be overemphasised: a tiled roof is far from airtight.

Sound is transmitted from the roof space to the rooms below via the ceiling, and through the walls, even interior walls, via the timber frame. The beneficial effects of large airspace under a pitched roof and sound deadening by loft insulation are partly negated by the exposure of the tops of the joists, which provide a sound pathway to the ceiling and walls. Nevertheless, windows and external doors are usually the greatest problem.

As mentioned above, air gaps, even tiny ones, leak noise out of all proportion to their size, and single pane windows are ineffective in blocking sound penetration because of their low weight per unit area and their ability to vibrate flexurally. Well-designed and constructed double-glazing can make a big difference. To be effective, the panes must be at the very least 10cm apart, but preferably double that, and the inner and outer panes should be of different thicknesses so that they don't tend to vibrate at the same frequencies. Again, airtightness is crucial.

Human response to noise This is the most complex topic of all and it is where the data from surveys, sound measurements and financial analyses can be selectively and misleadingly used to put forward an apparently rational argument for open slather on flying in and out of Auckland Airport. Without doubt, it is the sleep disturbance which is of greatest public concern and I have seen no analysis of the social cost of otherwise productive people turning up for work jaded due to lack of sleep because their erstwhile peaceful nights have been ruined by regular and/or sporadic overflights throughout the night.

People's temperaments and sensitivity to sound place them into three broad categories in the context of the nocturnal noise problem:

1 Those who can sleep through anything and still do, despite the noise, or who might be partially or awakened by a sudden extreme noise, but who immediately fall asleep again when the noise passes.

2 Those who used to get a good night's sleep despite the odd motorbike going past, or a with a steady background noise, but who have recently become sensitive to nocturnal aircraft noise because of its intensity, duration, frequency and intermittency.

3 Lifelong insomniacs for whom precious sleep does not come easily as soon as they hit the pillow and for whom any sudden disturbance, especially when arriving at the hard-won brink of falling asleep, means they are jolted back to wakefulness and have to start again.

For groups 2 and 3 the disturbance results in anxiety which in many cases just exacerbates their plight. I have no idea of the proportions of the population fall into each group in Auckland. However, given this fairly simple partition, and because only people who live within 2 or 3 kilometres either side of designated flight paths are seriously affected, their voice is always going to be a minority. The fewer the flightpaths over a city, the fewer the people who are affected, but those few are more seriously affected because there are more flights directly above them. An attempt to minimise the *number* of complaints by such flightpath design is thus unlikely to be compatible with a minimisation of the social consequences by limiting the greatest noise intensity.

Decibels (loosely loudness) and perceived noise level cannot be equated in general: the former is precisely measurable, but noise is a subjective experience. All we can say is that *in a given situation*, if the source becomes more intense, any given recipient will inevitably experience more noise. Extensive surveys have repeatedly demonstrated strong positive correlations between loudness, duration, fluctuation and repetition with the level of induced annoyance and distress.

An Ellerslie resident's perspective In 2000 my wife and I bought a house on a back section away from traffic noise because we like peace and quiet and to be able to enjoy being outdoors in the summer. The big jets came in during the day and once or twice a year the Warbirds flew over, but that was all. Only occasional circling by the police helicopter disturbed our sleep – a necessary inconvenience. That was until 2004 (as I recall) when we began to get incoming flights during the night about twice a week around 4am.

Since 2004 the noise disturbance has become progressively worse. Nowadays we have a much intensified flow of incoming or outgoing international flights around the clock, seven days a week, with clusters of incoming flights around 11pm to midnight and 4am to 5am. Typically the incoming planes are at 4000 ft to 6000ft, deploying flaps and slats, adding to the noise not least because the extra lift needed for low speed flight is at the expense of additional drag, requiring a power-up. Beneath all this activity, during the day there is a two-way NE/SW procession of low-flying and extremely noisy propeller-driven light commercial and private aircraft at cruising speed. On summer weekends the racket (sufficient to stop conversation, even indoors) can be almost unrelenting. If this weren't enough, also above us is a regular SE/NW route used by helicopters almost invariably flying at or even below the legal 1000ft minimum altitude. A few of these are emergency helicopters travelling to hospitals, but do they need to be so low?

In terms of sleep disturbance, I am firmly in Group 3 of the previous section. My wife was until a few years ago in Group 2, but she has been sensitised by the rising night-time noise and is now Group 3. Her job involves the responsibility for correct recording and communication of the results of diagnostic medical procedures, along with associated supervisory and training duties. If disturbed during the night she now worries about her ability to cope the next day, which inevitably impinges on her being able to fall asleep again. It's a self-reinforcing problem which is not resolved by sleeping pills or tranquilisers – indeed quite the opposite.

What needs to be done? First of all, the approach and take-off paths need to be modified. Watching the airport radar, I could easily come to the conclusion that existing flightpaths are the result of a conspiracy to *maximise* the distance the planes fly at low altitude over residential areas. I jest not – a donkey could do better given a modest sense of social responsibility.

An 8-hour curfew from (say) 10.30pm to 6.30am would be the decent solution. If planes from Australia and Asia must land east-west, only a few kilometres and even fewer minutes would be added if their route east over the city were a gentle, steady descent at an altitude of 9000ft or more with the turn west into the final approach made over the sea rather than the eastern suburbs.

If a plane must overfly residential areas on take-off, there should be a 'low noise' phase until it clears the city. Recently I watched on radar the middle-of-the-night east-west take-off of a flight to China. The plane did a sharp right turn and passed, climbing rapidly, over Titirangi and Henderson at about 4000ft. It then continued over land all the way up Northland. The route could easily have been level 'low-noise' over water until the Manukau Heads before the right turn. To my mind, this lack of consideration for those below is unforgivable and uncivilised.

I am sure that the long-standing regulation that planes flying over built-up areas must keep above 1000ft wasn't passed with any vision of the often relentless procession of light aircraft over Ellerslie and indeed all suburbs from Howick to Onehunga. The intense low-frequency noise emitted by cruising propeller-driven aircraft and helicopters carries a long way. If the jets can be kept higher, then surely the cruising altitude of the smaller planes can be lifted to 2000ft. This would spread the noise around rather more thinly, as would a variation in flightpaths. In addition, if the worst offenders were also required by statutory regulation to ease back on the cruising speed over the city, the effect would be substantial.

I wonder how much the clustering of night flights, with the occasional plane belting in around 11.30pm or 4am seemingly to meet some deadline, is influenced by the differing day/night airport landing fees here. Also, are there financial arrangements to accommodate airlines whose flights originate from countries that have stricter noise limits or curfews, thus dumping their problems on us? A strict curfew at Auckland Airport is essential.

A final thought The famous Dutch psychiatrist Jan Foudraine said in 1974: "We have a crisis in mental health today, all over the world, because technology has thrown humanity out of the window". He was way short of the mark in today's context. Now, at every opportunity, unrestrained international big business hi-jacks almost every big advancement in technology (or obstructs it) for the financial benefit of a few at the expense of the well-being of the rest of humanity and consequent degradation the global environment in general. It is also capable of controlling national and local decisions by small-country governments, based on short-term national financial benefits or losses via inducements or threats. In terms of a 'liveable city' Auckland City Council should clarify where its loyalties lie before the next election for mayor.

Selected bibliography

Relster, E., 'Traffic noise annoyance', Danish Academy of Technical Sciences, Lyngby, 1975

Croome, D.J., 'Noise, buildings and people', Pergamon Press Ltd., Oxford, 1977.

Cunniff, P.F., 'Environmental noise pollution', John Wiley & Sons, N.Y., 1977.

Jones, D.M. & Chapman A.J. (eds.), 'Noise and Society', John Wiley & Sons, Chichester, 1984

McMullan, R, 'Noise control in buildings', BSP Professional Books, Oxford, 1991.

Appendix attached.