The Evolution of Aircraft Noise Descriptors in Australia over the Past Decade

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ABSTRACT

In 2000 the Australian Government Department of Transport and Regional Development published a discussion paper entitled 'Expanding Ways to Describe and Assess Aircraft Noise'. The discussion paper was released in response to public concerns about the transparency and comprehensibility of technical aircraft noise metrics. Since the release of the 'Expanding Ways' paper there has been a progressive adoption of flight path based noise descriptors and of 'Number Above' (N70) noise contours both in Australia and overseas. This paper explores the evolution in aircraft noise descriptors and concludes that the skill set of the aircraft noise specialist now needs to be much broader. If the aircraft noise practitioner is to have a real influence on decisions, he/she has to operate at a number of different levels, using multiple noise metrics, and needs to be an effective communicator as well as a technical expert.

INTRODUCTION

Noise descriptors underpin aircraft noise management. Conventionally they have been primarily used to establish standards, assess the impacts of proposed developments and rank competing options. For this reason the descriptors have largely been numeric tools which, in effect, have been used as the language for conversations between noise experts and decision makers. Over the past decade the conventional descriptors have increasingly been overlain by new metrics (often called 'supplementary metrics') which are generally both visual and numeric. These new metrics are increasingly becoming the 'lingua franca' of conversations between parties with an interest in an aircraft noise issue. In many cases they are being used as the basis for decision making. In particular the new metrics are enabling interested members of the public to become engaged in decision making processes.

This paper gives an overview of this process of change. It is not aimed at exploring the merits of these changes.

BACKGROUND

When the third runway was opened at Sydney Airport in 1994 the changed aircraft noise patterns generated an extreme adverse reaction from communities across wide areas of Sydney. This led to the establishment of the Senate Select Committee on Aircraft Noise in Sydney in 1995 which heavily criticised the noise predictions contained in the Environmental Impact Statement (EIS) for the new runway (*Falling on Deaf Ears*, 1995). The publication of the Select Committee's report directly led to protracted discussions between aviation authorities and the Sydney community on the development and adoption of transparent, comprehensive and comprehensible ways to describe aircraft noise.

Over a period of approximately three years a number of new noise descriptor concepts emerged from these discussions. The thinking behind the development of these concepts was described in the Australian Government transport department's discussion paper *Expanding Ways to Describe and Assess Aircraft Noise* (2000). In essence the public objected strongly to the way aircraft noise had been described in the Sydney Airport third runway EIS using logarithmic annual average day metrics and sought that aircraft noise be assessed and reported as a series of discrete noise events. Consequently, a regime emerged which was focussed on reporting on the location of flight paths and on the time distribution, and single event noise levels, of individual operations on the identified flight paths.

In response to the interest generated by the release of the *Expanding Ways* paper the Department commenced development of a software application – *Transparent Noise Information Package (TNIP)* – which enables the rapid production of the new metrics.

DRIVERS FOR CHANGE

During the past decade a range of changes in both community expectations and in technological capabilities has driven the evolution in approaches to describing and assessing aircraft noise. For example:

i. Community expectations of direct engagement in decision making processes have been elevated. The Australian Government has recently put in place an enhanced community aircraft noise consultation regime as part of the implementation of its aviation white paper (*Flight Path to the Future*, 2009).

ii. The increasing sophistication of noise and flight path monitoring systems (NFPMS), and the advent of on-line aircraft noise tracking systems such as *'WebTrak'* (Airservices Australia), have facilitated an increasing interest in considering aircraft noise as a series of single events.

iii. The need to effectively communicate technical advice has become more pressing. Specialist technical advice is being increasingly questioned. This is raising concern within the scientific community and Science & Technology Australia (STA) has recently introduced a website designed to redress the negative sentiment. (*Respect the Science*, 2011)

iv. Environmental justice concepts, specifically noise sharing, have gained acceptance. The question has moved from 'is this acceptable?' to 'is this fair?'. Consequently the interest is commonly more in comparative noise load than in absolute noise load.

v. While conventional noise contours have shrunk at many airports as the result of the introduction of quieter air-

craft, the noise influence area of airports, as judged by noise complaints and community pressure, has expanded (Southgate, 2007).

vi. The advent of the 'connected world', which has been enabled by the introduction of the internet, and accelerated by the rapid uptake of 3G 'always connected' internet devices such as the iPad, has generated expectations of flows of instantly accessible information.

UPTAKE OF '*EXPANDING WAYS*' METRICS

The *Expanding* Ways discussion paper broadly proposed three new metrics: flight path movement charts; respite; and the N70.

Flight path movements charts

Flight Path Movement Charts (FPMC) and the concepts underlying them have become a more or less the routine way to discuss and report aircraft noise in Australia. Most com-complaints, correspondence to authorities and discussions within community consultation committees relating to aircraft noise are expressed in terms of the location of flight paths and the timing of their use. Describing aircraft noise in this way directly accords with people's experience, and mirrors the way people talk about aircraft noise between themselves. An example of the flight path information given for each flight path in the Sydney Airport FPMC is shown in Figure 1. Examples of full charts can be found in the *Sydney Airport Operational Statistics*.

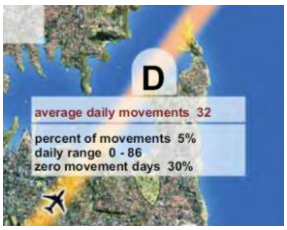


Figure 1. Example of information provided in FPMC boxes

The use of flight path based descriptors has been made possible by the advent of powerful flight path monitoring systems. These systems enable detailed analyses and graphical reports to be generated very rapidly – a significant advance on the time consuming efforts that are required to generate noise contours using conventional noise contouring applications such as the United States Federal Aviation Administration's (FAA) Integrated Noise Model (INM).

The N70

In Australia the use of noise contours for describing and assessing aircraft noise on a routine day to day basis (eg correspondence, discussion within committees) has declined markedly in recent years. However, when contours are used for discussion/information purposes the preferred choices are invariably single event and N70 contours (more correctly termed Number Above (NA) as the term covers a family of contours). In addition, the N70 is a useful tool for reporting measured noise levels and is routinely used by Airservices Australia for this purpose (*Sydney Airport Operational Statistics & Noise and Flight Path Monitoring System (NFPMS) reports*). The N70 is generally the preferred noise contouring metric for non-experts as it is an arithmetic metric and describes aircraft noise in the way people perceive it – as a number of discrete noise events.

Compared to flight path based descriptors, N70 contours are slow to produce and suffer from the fundamental problem of all noise contours – they can give the impression that there is no noise beyond the outer noise contour.

Respite

The concept of providing 'respite' is at the heart of much current thinking in aircraft noise management. It underpins the noise sharing regime at Sydney Airport and, for example, is the principle underlying the runway alternation program at Heathrow Airport. Respite is very commonly raised as an issue by community members, and it is therefore interesting that there has been little community pressure to develop metrics which quantify 'respite'. The respite metric introduced in the *Expanding Ways* paper is used routinely as a monitoring tool for Sydney Airport (*Sydney Airport Operational Statistics*). Nevertheless this information does not appear to attract significant attention from members of the public (most likely because the metric is not yet sufficiently refined).

Role of the ANEF

The Australian Noise Exposure Forecast (ANEF) system remains the fundamental tool for achieving land use compatibility around airports in Australia. However, it is coming under increasing pressure in a number of areas. Early in the decade, following representations from a number of smaller Australian airports, the Department released a discussion paper entitled *Going Beyond Noise Contours* (2003), aimed at generating discussion on ways to address shortcomings in the ANEF system that had become apparent at the smaller airports. At these airports the ANEF system provides little protection from encroachment as the ANEF contours usually do not extend far beyond the airport boundaries. The issue is particularly problematic for housing situated under intensively used training circuits. More recently in its aviation white paper the Australian Government has recognised that there is scope to improve the ANEF system (*Flight Path to the Future*, 2009: p212).

The ANEF/ANEI has also been used as the metric for determining eligibility for inclusion in the noise amelioration programs at Sydney and Adelaide airports.

ANEFs are now rarely used in day to day discussions, correspondence, etc relating to the description and/or assessment of aircraft noise.

AREAS OF APPLICATION

Ongoing aircraft noise management

As indicated earlier, experience has shown that flight path based descriptors (augmented where appropriate with single event noise level information) provide the most transparent, comprehensive, comprehensible and timely picture of aircraft noise. The use of this type of aircraft noise information has progressively grown to the point where it now effectively underpins aircraft noise communication and dialog in Australia. Ongoing informal assessment/tracking of whether an aircraft noise environment is improving or deteriorating is generally gauged using this kind of information.

Airservices Australia has the capability to rapidly generate a wide range of flight path based information out of its NFPMS. It routinely makes this publicly available through its published reports and the provision of one-off flight path maps to individual members of the public. A recent innovation has been the introduction of *WebTrak* (Airservices Aus-

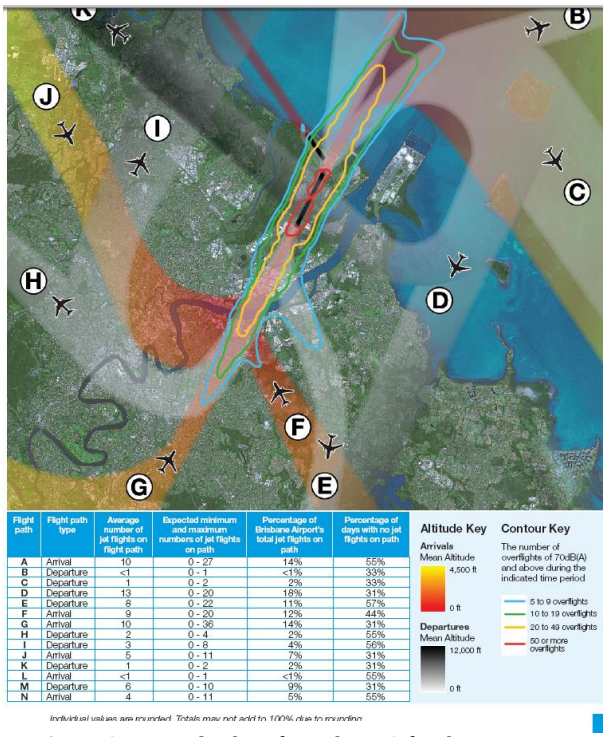
tralia) which is, in effect, a near real time internet based NFPMS which can be accessed by the public.

Cumulative flight path maps for operations at Australia's major airports are provided in the NFPMS reports. The *Sydney Airport Operational Statistics* provide detailed information about the time distribution of runway and flight path use at Sydney Airport on an ongoing monthly basis.

Formal environmental assessments

During the decade one major formal EIS was carried out in Australia for a proposed new runway – at Brisbane Airport. The methodology used in this EIS was in stark contrast to that used in the EIS for the third runway at Sydney and was specifically designed to avoid the problems that had been associated with the Sydney Airport EIS. The concept of assessment based on minimising the number of people within noise contours was no longer appropriate given the Senate Select Committee's finding that noise sharing is a form of discrimination (*Falling on Deaf Ears*, 1995:E2). Given the view that the Sydney EIS had given a misleading picture of noise, the focus of this EIS was to generate a transparent picture of the noise using charts showing a combination of flight path movements and N70 contours (*Brisbane Airport New Parallel Runway Project, Aircraft Noise Assessment*, 2007). A suite of about 50 charts was published - an example is shown in Figure 2. This enabled individuals to gain an assessment of the time distribution of flights near their home. In addition it provided an indication of the aircraft altitude and the number of events louder than 70dB(A) that would occur if the project were to proceed.

In an effort to provide full transparency, members of the public were provided, on request, with a CD containing a specially configured version of TNIP. This enabled individuals to explore the details of the noise modelling which underpinned the charts and also to carry out what-ifs in order to let them understand the sensitivity of the modelling to errors and/or change. As far as is known the TNIP application was only used by a limited number of people but the feedback from the airport and the identified users was positive.



Flight path	Flight path type	Average number of jet flights on flight path	Expected minimum and maximum numbers of jet flights on path	Percentage of Brisbane Airport's total jet flights on path	Percentage of days with no jet flights on path
A	Arrival	10	0 - 27	14%	55%
B	Departure	<1	0 - 1	<1%	33%
C	Departure	1	0 - 2	2%	33%
D	Departure	13	0 - 20	18%	31%
E	Departure	8	0 - 22	11%	57%
F	Arrival	9	0 - 20	12%	44%
G	Arrival	10	0 - 36	14%	31%
H	Departure	2	0 - 4	2%	55%
I	Departure	3	0 - 8	4%	56%
J	Arrival	5	0 - 11	7%	31%
K	Departure	1	0 - 2	2%	31%
L	Arrival	<1	0 - 1	<1%	55%
M	Departure	6	0 - 10	9%	31%
N	Arrival	4	0 - 11	5%	55%

Individual values are rounded. Totals may not add to 100% due to rounding

Figure 2. Example chart from the EIS for the new runway at Brisbane Airport

The EIS applied conventional noise metrics in areas relating to potential specific impacts such as sleep disturbance and interruption to speech (*Brisbane Airport New Parallel Runway, Health Impact Assessment*, 2007).

The methodology used in the Sydney Airport third runway EIS had essentially been aimed at assessing whether the project would have overall benefits (specifically would there be less people affected?). By way of contrast, the key aim of the Brisbane EIS was to provide individuals with information that would enable them to gain a picture of what the aircraft noise exposure patterns would be like for them, at their home, if the project were to proceed.

Later in the decade the Department of Defence applied a similar EIS methodology to that used by Brisbane Airport when it undertook a formal assessment of the noise impacts of the introduction of the Joint Strike Fighter (JSF) at a number of its bases (*Operation of the JSF Aircraft as the New Air Combat Capability*, 2010).

It is important to recognise that while these new EIS approaches received positive feedback at the assessment stage, their merits cannot be fully assessed until the projects commence and the new noise exposure patterns are established.

Land use planning

As indicated earlier, the ANEF system is still the key tool for determining land use compatibility around Australian airports. However, this approach is coming under pressure and during the decade there were a number of examples where planning regimes adopted different approaches, particularly for proposed developments in the vicinity of smaller airports.

In Western Australia the planning policies around Busselton (*Busselton Airport Noise Management Plan*, 2011), Jandakot (*State Planning Policy 5.3 Jandakot Airport Vicinity*, 2006) and Geraldton (*Greater Geraldton Structure Plan 2011)* airports all include concepts that go beyond the ANEF system. In essence all of the regimes give cognizance to the fact that training circuits do not usually get captured by the 20 ANEF contour and hence developed some form of buffer which was defined around the location of flight paths and/or on N70s. As an example, Figure 3 shows the ANEF contours inside the

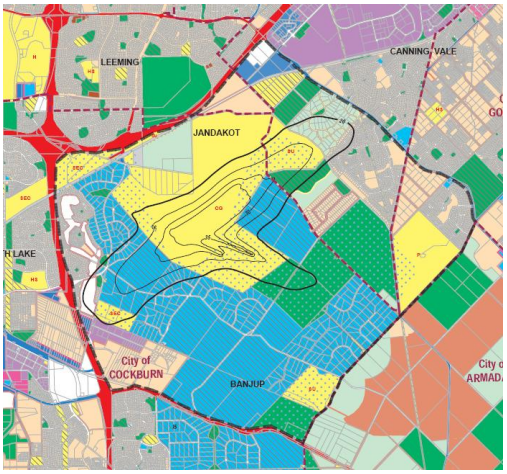


Figure 3. Jandakot Airport – ANEF contours within the aircraft noise buffer (black dotted line).

'Frame Area', a buffer zone concept, around Jandakot Airport designed to capture the area under the training circuits.

In a similar manner in Queensland, the Planning Scheme for an area adjacent to Caloundra Airport refers to the N70 as a descriptor that will be taken into account in determining approval for proposed residential development (*Caloundra South Urban Development Area*).

For much of the decade Canberra Airport strongly promoted the use of a 'High Noise Corridor', rather than the ANEF system, to define noise compatible areas around the airport (*Canberra Airport High Noise Corridor*). It used this tool to oppose a proposed major residential development to the south of the Airport. In May 2011 the NSW Planning Commission recommended against the re-zoning necessary for this proposal to proceed (*Draft Queanbeyan local environmental plan*, 2011). This issue has yet to be finalised.

Some Councils are now requiring new residential developments outside the 20 ANEF, which would formerly have been treated as 'acceptable', to comply with the LAmax indoor criteria for sleep disturbance specified in Australian Standard AS 2021 (*Reviewer comment*).

Noise disclosure

A common cause of aircraft noise complaints is people buying properties in ignorance of the fact that they are purchasing a house under an active flight path. However, it is interesting to note that while a wide array of tools for describing aircraft noise is now readily available, only rudimentary attempts have been made to use these in a formal sense for property noise disclosure in Australia.

Brisbane Airport is probably the best example of an airport that has attempted to broadly communicate noise exposure patterns through its physical *Brisbane Airport Experience Centre* and its online equivalent. Formal noise disclosure remains largely confined to certain States where notices are placed on titles of houses situated in the 20 ANEF. The effectiveness of this approach is limited since the advice given on the notices does not convey a useful description of the noise exposure patterns and, probably more important, this approach does not provide advice to people contemplating buying a house in an area outside the 20 ANEF contour. It is particularly important to consider areas outside the 20 ANEF since experience has shown that when people buy a house some distance from an airport, they are likely to be surprised, and angry, if they discover they have unknowingly moved in to an area exposed to aircraft noise.

INTERNATIONAL INTEREST AND UPTAKE

The release of the *Expanding Ways* paper in 2000 initiated a number of studies and interest in alternative aircraft noise metrics both in North America and Europe. These new descriptors were generally termed 'supplementary metrics' as there was widespread concern that examining other noise metrics may raise questions concerning the robustness and applicability of the established noise metrics (generally some form of logarithmic annual average day metric).

Interestingly, in contrast to Australia the focus overseas has largely been on alternative noise contouring concepts rather than on flight path based descriptors. In particular the N70 (Number Above) metric has attracted a great deal of attention and it is now quite commonly used in both the US and Europe. Given the recent surge in interest in the N70 that has arisen out of the Sydney Airport debate, it is often erroneously referred to as an Australian 'invention' – as far as can be ascertained the N70 was first proposed as an aircraft noise descriptor in the early 1970s in Sweden (Rylander et al, 1972).

Examples of studies

The interest shown in examining the metrics that had emerged out of the Sydney debate came from diverse bodies. In 2002 the US Federal Interagency Committee on Aircraft Noise (*FICAN*) held an investigation into supplementary metrics including those which arose in Sydney. The UK CAA carried out, and informally reported on, an examination of the *Expanding Ways* metrics (*ERCD Newsletter Issue* 4, 2003). The metrics were the subject of a number of academic studies. For example, Manchester Metropolitan and Southampton Universities tested the metrics on focus groups (Hooper, P et al, 2009). A number of postgraduate theses also examined the metrics, for example Burton (2004) in the UK and Goldschagg (2007) in South Africa. The French aviation authorities recently carried out an investigation of the N70 (*Étude de sensibilité de l'indicateur de bruit NA «Number Above»*, 2010).

Examples of application

There have been a number of direct applications of the new descriptors deriving from the above studies. Primarily the descriptors have been used in environmental assessments and/or as communication tools. In North America the N70 is now in relatively common use as a 'supplementary metric'. Even though it cannot be directly computed using the FAA's Integrated Noise Model, it is cited on an FAA funded website, NoiseQuest, as being "the most popular supplementary noise metric [in the United States]" (*Supplemental noise metrics*).

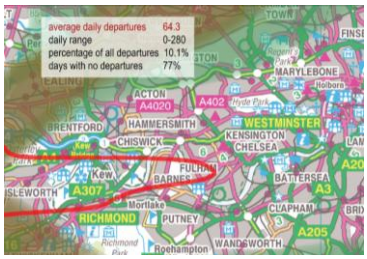


Figure 4. Extract from a Heathrow Airport flight path movement chart

The UK Government's 2008 consultation on a proposed new runway at Heathrow Airport contained eight flight path movement charts (*Revised future aircraft noise exposure estimates for Heathrow airport*, 2008). An example of one of the boxes on these is shown in Figure 4 – it can be seen that the descriptors used exactly match those that arose out of the Sydney debate.

There are examples where the metrics have been used for more formal applications. In Austria the mediation agreement for the expansion of Vienna Airport uses N65 metrics as one of the agreed controls (*Results of the mediation process*, 2005). In Sweden, the LFV is proposing to adopt the N70 and N80 as formal legislative tools for aircraft noise management (*New environmental permit for Arlanda*, 2010).

WHAT ARE THE KEY LESSONS?

It is becoming increasingly apparent that we now need to base our aircraft noise management regime on multiple noise metrics. This means the required skill set for the aircraft noise specialist has grown significantly over the past decade.

Conventionally the aircraft noise expert solely spoke the language of ANEF. Invariably now conversations on aircraft noise with airports, decision makers and the community will be spoken using a different language. When engaging in a conversation about a particular airport the aircraft noise expert now needs to be broadly familiar with the location of the main flight paths; the heights of aircraft along the flight paths; and the numbers and times of flights by aircraft category. While these conversations rarely involve pure noise metrics, in order to be able to translate between 'noise languages', and to be able to understand the likely noise impacts of particular options, the noise expert will generally need to be aware of noise exposure patterns around the airport, to a reasonable distance, at least in terms of LAmax, N70 and ANEF/ANEI.

In the past, the noise expert provided advice that a particular noise dose was, for example, 'significant' or 'acceptable' or determined that certain areas were 'noise affected'. The use of these essentially subjective terms was at the root of a great deal of the communication breakdown around aircraft noise in the 1990s – the expert defined these terms in technical language while the non-expert used the everyday interpretation. Experience has shown that the use of these terms can largely be avoided. The aim is now to describe aircraft noise in a way that lets the non-expert form an individual view whether a certain amount of noise is 'significant' or whether a particular area will be 'noise affected'.

The focus of noise description and assessment has moved on from thinking in terms of impacts generated by the airport as a whole, to providing information which enables the individual to understand the noise exposure patterns at their home. The introduction of aircraft noise management based on noise sharing has resulted in there being little interest in whether the overall environmental impact of an airport has improved or deteriorated. The more likely question now is – what is happening, or going to happen, to the aircraft noise exposure in the vicinity of my home? As a result of this change in thinking, decision making now commonly involves a flight path by flight path, community by community, noise optimisation approach.

THE FUTURE

At one level it could be argued that there has been disappointing progress in the development of aircraft noise description over the past decade. Logarithmic annual average day noise metrics are still commonly used throughout the world despite the patent shortcomings of many aircraft noise management strategies built on these metrics. On the positive side technological advances have enabled niche application of a suite of other aircraft noise descriptors and there does now seem to be general acceptance that we are going to have to work with multiple descriptors if aircraft noise is to be effectively managed into the future.

As a general observation the aircraft noise group of the next decade will need to have access to experts in both 'numbers' and 'pictures'. The communication aspects of providing aircraft noise advice are likely to be equally as important as the computational aspects.

The question now is – where will we go in the next decade?

Focus on flight paths?

It would appear that the trend toward focusing aircraft noise analysis on examination of aircraft flight path patterns will continue. The software and hardware computing capabilities in this area continue to be enhanced. Community interest in this area is becoming more informed and sophisticated. For example, in Sydney, advances in navigational technology are leading to a reduction in the spread of some flight paths. The consequent concentration of noise has led to requests from community representatives for the introduction of a flight path categorisation system similar to that used for roads (eg freeways, highways, distributor roads, etc) (*Sydney Airport Community Forum*, 2011).

The introduction of WebTrak has provided almost real time internet information about aircraft operations in the vicinity of major airports. The advent of new navigational equipment is now making it possible to make this type of information freely available to members of the public across whole aviation networks (*Plane Finder*, 2011).

Growing move toward noise sharing?

As the number of aircraft operations at airports grows there is likely to be increasing requests for noise sharing to be considered as a tool for aircraft noise management. Under these regimes the fundamental noise descriptor requirements are that published noise information must enable a member of the community to readily ascertain to what extent the noise is being shared and what their share is compared to others.

Growing airport noise influence area?

Over the past decade, as the number of aircraft operations has increased, the aircraft noise influence area of many airports has expanded to capture land up to say 50km away. It is not uncommon for aircraft noise complaints to be generated by aircraft operations with a maximum sound pressure level of around 60dB(A) when there are relatively high numbers of operations.

It is therefore likely that there will be a increasing benefits in producing aircraft noise information on an 'area wide' basis – systems which solely provide aircraft noise information for the high noise zones immediately adjacent to airports are delivering an incomplete picture of noise. The audience with an interest in aircraft noise issues is potentially very large.

Greater interest in noise disclosure?

This is a very fertile area for development. As indicated earlier, it is very common for people to feel aggrieved if they have unknowingly bought a house under a busy flight path even if the flights are comparatively high (eg > 6,000ft). The capability to provide area wide aircraft noise information to potential home owners, prior to purchase decision, via the internet is already with us. However, there are a number of institutional/administrative questions to be resolved. It would appear that great gains would be made in aircraft noise management in Australia if effective noise disclosure systems were established.

Some lateral thinking?

In the past two or three years the pace of personal connectivity has accelerated rapidly. The advent of 3G enabled tablet computers, coupled with the growth in social media such as Twitter and Facebook, has resulted in large parts of the community living in an instantly connected world. On the one hand these new capabilities may pose a threat to airports on aircraft noise issues – will it mean that aviation opponents can now more effectively campaign on issues such as aircraft noise? On the other hand, do these tools open up opportunities for airports to more effectively communicate with their communities? The challenge is for the aircraft noise specialist to keep abreast of technological developments and to identify and promote new aircraft noise descriptors that can result in more effective aircraft noise management both in Australia and overseas.

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