Brüel & Kjær

FOURTH GENERATION AVIATION ENVIRONMENT MANAGEMENT WHITE PAPER

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TABLE OF CONTENTS

1. SUMMARY

There are two types of constraints on airport growth, physical capacity (terminal and runway) and environmental capacity. Environmental capacity can be expressed as the net of the community's tolerance for environmental impact, less the impact already imposed by the airport. Environmental capacity is optimised through a balanced programme of impact reduction and community tolerance building initiatives.

The proactive use of impact reduction approaches has resulted in significant outcomes for many airports and remains an important part of any programme, however the increasing use of sophisticated tolerance-building initiatives is heralding the arrival of the new, collaborative, fourth-generation aviation airport environment management.

This new generation of initiatives will be founded on sophisticated information sharing, feedback and empowerment principles and will demand new approaches and new technologies.

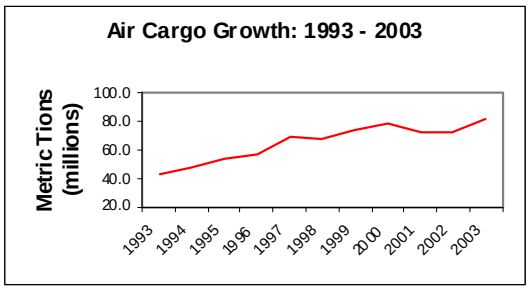
2. INTRODUCTION

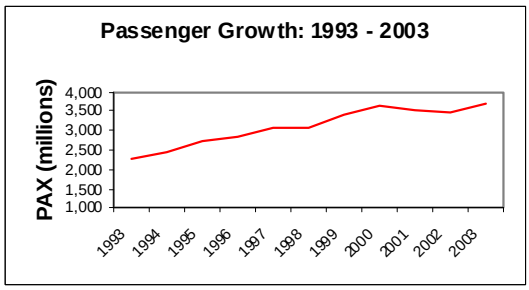
Despite the recent impacts of a series of shocks, the long term outlook for aviation growth remains strong and Airports are increasingly understood to be attractive investments with potential for both short term income and longer term growth.

Many airports worldwide face growing pressure from the combination of a steady growth in airport activity, and increased numbers of noise complaints from surrounding communities. Without an effective strategy for reducing airport noise impact as well as building and maintaining community relationships, noise complaints have the potential to lead to restrictions in airport operations and constraints on future growth.

Whilst traditional noise management approaches have been effective in reducing noise impact they have been less successful in improving community tolerance to noise. A new paradigm for noise management that addresses both noise impact and community tolerance is required by airports in order to maintain current airport operations and minimise potential constraints to future airport growth.

3. AIRPORTS ARE ATTRACTIVE INVESTMENTS





The development of the global economy has been both driven by and fuelled the development of the global air transport industry [2]. With the benefit of air transport, rapid movement of goods and services over long distances has become possible, creating jobs and opening up new market opportunities. Greater affluence and the development of networks linking people, countries and cultures have in turned further fuelled air traffic demand [1].

In 2003, over 3.7 billion passengers worldwide are expected to use the world's airlines for business and leisure travel, over 60% more than a decade earlier. World shipments of cargo are expected to double over the same period to 81 million metric tonnes [1]. Air transport provides 28 million direct, indirect and induced jobs worldwide, and is expected to create an additional 3 million jobs in the next decade.

Whilst the triple shock (September 11th, SARS and the Gulf War) of the last two years has undeniably affected short the aviation industry in the short term, there are clear indications that passenger traffic is already recovering and that the long term trends remain healthy[3]. Whilst acknowledging that 2003 traffic will remain below the 2000 peak, IATA is forecasting a rebound in traffic of around 7% in each of - 2004 and 2005.[6]

Europe and the Asia-Pacific region (notwithstanding the SARS outbreak) are showing the strongest recovery, with the Americas showing the weakest recovery - at this time. [8]

The significant and continuing growth in air transport has in turn driven secondary demand for airport expansion. Airports are a major beneficiary of air traffic growth, generating significant revenues through charges on passenger and air movements and increasingly through associated activities such as retail operations, car parking, and property management. Across its entire survey base, ACI reports non-aeronautical revenues to be over 50% of total revenues and growing. [4]

Across the globe (although notably not yet as a general rule in the USA), the potential value of airports as investment assets is being recognized through a rash of privatizations and public floats and by the emergence of companies specializing in airport ownership and operation (e.g. BAA Plc in the UK, The Schiphol Group in The Netherlands, Macquarie Airport Group in Australia etc.)

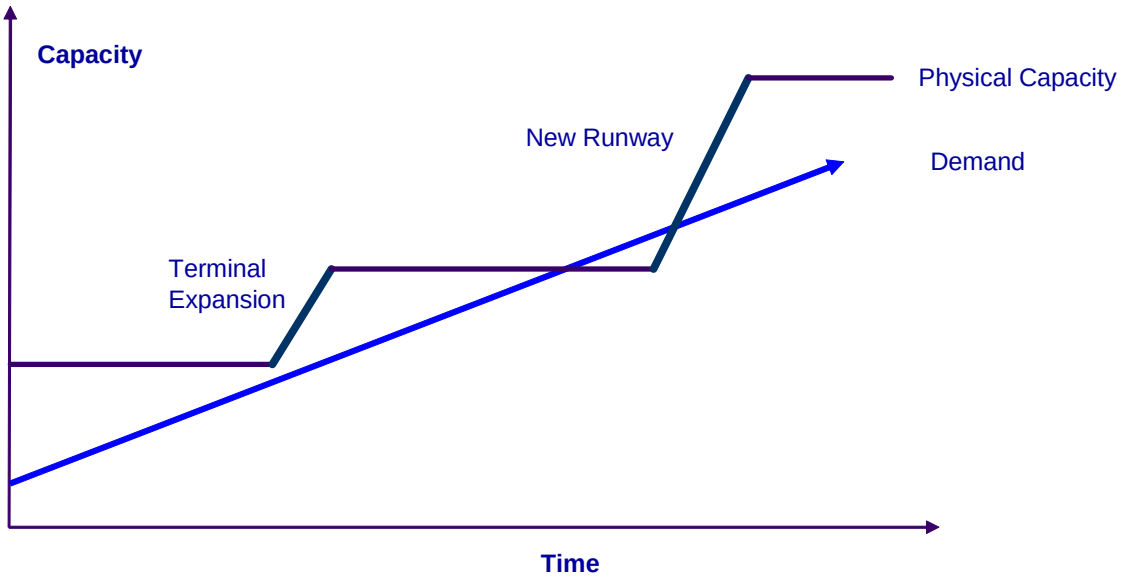
In the last two years, global airlines have come under extreme commercial pressure (sometimes terminally) whilst, with some exceptions, airports, particularly those that have been operating as commercial operations for some time, have weathered the storm comparatively well [2,6,7].

Whilst this resilience has demonstrated the potential value of airports as defensive investments in a long term growth market, the total value of these investments is also dependent on the ability of the airport to achieve long term growth in movements, revenue and profits.

4. PHYSICAL CAPACITY IS CONSTRAINED BY ENVIRONMENTAL CAPACITY

Airports are amongst the most capital intensive organizations on earth, with terminals, ground movement infrastructure and runways all requiring massive expenditure and long lead times for planning and construction.

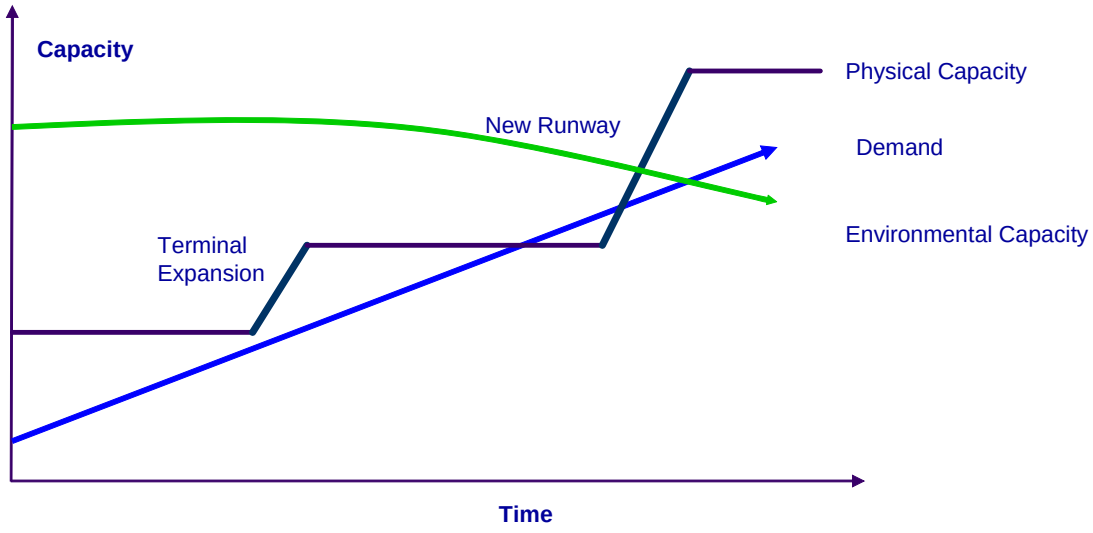
As a result, the process of strategic planning, or “master planning”, is well established in airport organizations and broadly consists of balancing long term (e.g. 20 year) forecasts of passengers and movements with the facilities required to house and support them.



The result is often viewed as a supply and demand graph, where capital improvements are brought “on line” in order to maintain capacity ahead of the demand projections.

Inevitably, the long term predictions of demand and the difficulties in predicting the outcomes of major capital works combine to ensure that no such master plan can be entirely “accurate” after the event, however we argue that most existing planning methodologies omit to completely incorporate a crucial constraint - namely “*environmental capacity*”.

Particularly in mature markets, but also increasingly in emerging markets, the ability of an airport to service demand can be constrained not only by physical capacity but by the airport’s ability to manage environmental impact and community response to environmental impact. Master plans often include an environmental impact study, but do not normally address the notion of an environmental constraint in capacity



Net available capacity will be the lesser of the available physical capacity and the available environmental capacity and therefore, by focusing on physical capacity, and not environmental capacity, there is a risk that many master plans have overestimated the real net available capacity and that forecast growth will not therefore be achievable.

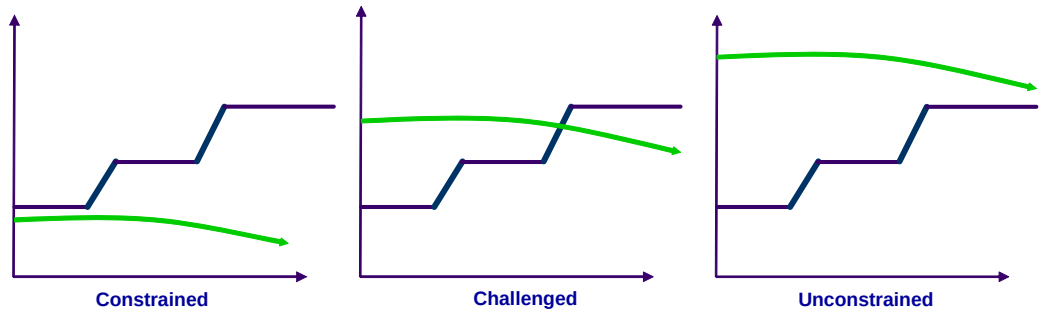
Although it is a real constraint, unlike physical capacity, environmental capacity is impossible to accurately and objectively quantify, although its absence can often be readily felt, such as has been the experience at Düsseldorf where environmental issues have all but prevented use of the new second runway, resulting in an environmental capacity 30% to 40% lower than the physical capacity of the airport [(16)].

Recently, over 80% of airports on ACI's Europe Environmental Strategy Committee reported being currently constrained by environmental issues, with an even higher proportion anticipating such constraints over the planning horizon. (9)

It also appears that environmental capacity, in the absence of any specific capacity increasing activity, degrades over time as a result of a number of factors:

1. The extent to which a community is prepared to tolerate aircraft noise is inversely proportional to the affluence of the community. As community affluence increases, so tolerance, and environmental capacity, decreases. (12)
2. The continuing global development of environmental awareness (the "green movement") will continue to increase focus on environmental impact. This is unlikely to be limited only to aircraft noise, but to encompass all aspect of an airports impact on the environment (e.g. air quality, water pollution, greenhouse gas emissions etc.)

The unique circumstances of each airport will determine the nature of the forces at play in each location, with the result that some airports may not, for the time being, be environmental capacity constrained. However, the issue is always present and likely to become material at some point in the future.



5. FACTORS AFFECTING ENVIRONMENTAL CAPACITY

Traditional approaches to airport noise and environment managed have focussed on measuring *environmental impact* and/or on reducing environmental impact and, whilst ongoing initiatives aimed impact reduction are a mandatory component of any strategy aimed at improving environmental capacity, the most sophisticated approach will also include specific initiatives targeted at increasing *community tolerance* of airport operations.

This concept is expressed as:

$$E = T - I$$

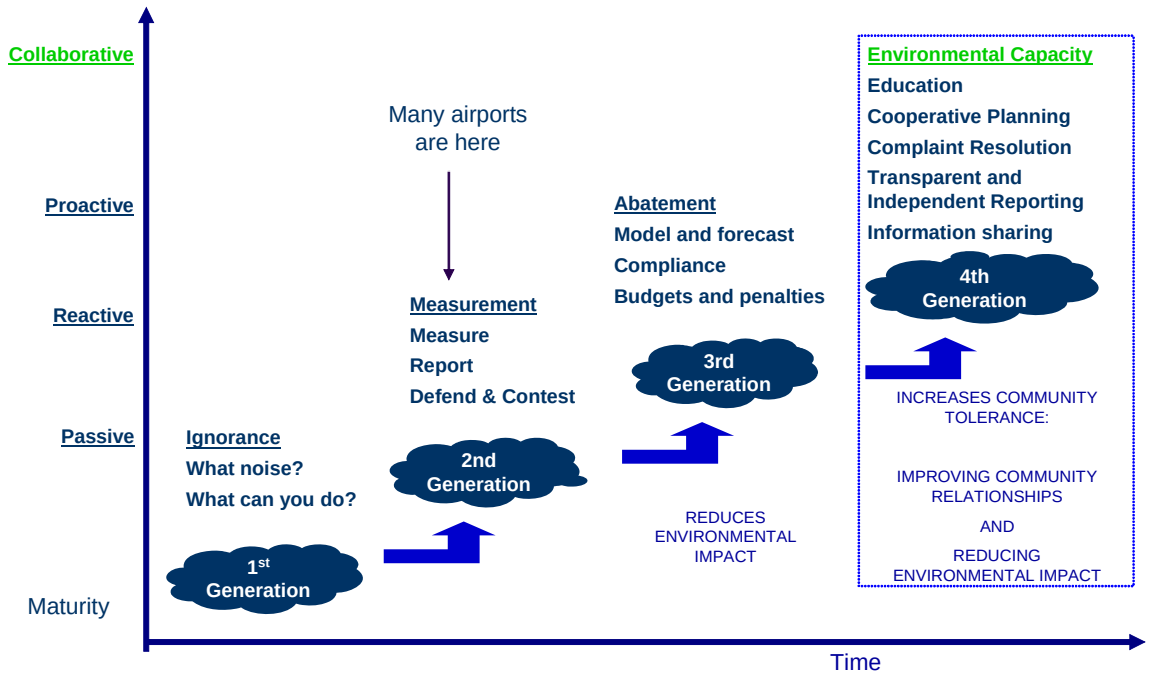
Where: E = Available environmental capacity
T = Community tolerance
I = Current environmental impact

Whilst this construct is admittedly simplistic, it has value in expressing and/or reinforcing two key principles:

3. That the management of community tolerance is an equal partner (with impact reduction) in the creation and maintenance of environmental capacity.
4. That optimisation of environmental capacity is achieved by a balanced program of impact reduction and community tolerance building initiatives.

6. FOURTH GENERATION ENVIRONMENT MANAGEMENT

As these principles are recognised and enacted around the world, we believe that we are witnessing a migration of airport environment management practise into its fourth generation.



In the early days of aviation, noise was seen as an inevitable consequence of the presence of an airport and, in many cases, was seen as “the sound of progress”. Community tolerance was intrinsically high, environmental impact reasonably limited, and airports therefore adopted a **passive** approach to managing the issue.

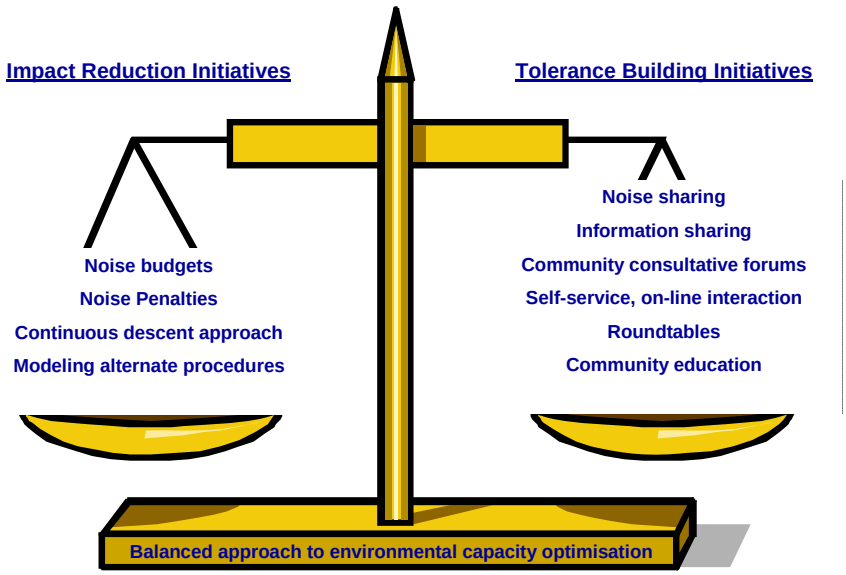
Airports in developing countries often find themselves in this situation today although, as we have observed earlier, the diminishing nature of environmental capacity (e.g. as a result of increasing community affluence) and the growing impact of increased movements will ensure that this is only a temporary position.

The usual first response has been to adopt a **reactive** posture and focus on measuring environmental impact, specifically noise, through temporary or permanent noise monitoring terminals and to use the results to defend the airport’s position against an increasingly resistant community. The resulting adversarial relationship between airports and the communities does not help to improve community relationships and the very technical “acoustic” noise measures create a gulf of language between the two sides that still exists today.

Recognising the long term strategic implications of this situation, often as a result of a particular significant event such as planning for or opening a new runway, many airports progress from this reactive posture to become much more **proactive** in their approach to noise management with particular emphasis on technological and operational approaches to the reduction of noise impact around the airport. As we discuss below, many airports have achieved remarkable results through such measures with resulting increases in environmental capacity.

In some cases, successful pursuit of proactive approaches to impact reduction have reduced, or nearly eliminated, the potential for further improvements – all the low hanging fruit, as well as a good part of the higher-hanging crop, has been harvested.

In other cases, particular circumstances and technological developments (e.g. the advent of the Internet) have highlighted the need to balance impact reduction initiatives with a more direct approach to the management of community tolerance and, as a result, the dawn of the fourth generation of aviation environment management practise, characterised by a **collaborative** approach between airport and community is upon us.



Specifically, we believe that best practise in this fourth generation of airport environment management is characterised by a balanced blend of specific impact reduction and tolerance building initiatives.

The above diagram is not intended to represent an exhaustive list of the various initiatives that have been developed around the world in both categories but to highlight the range of options available to each airport, the need to select the appropriate blend of initiatives for the circumstances, and the potential variety of resulting programmes.

To develop the concept further, it is worth reflecting briefly on the “state of the art” in each of the categories, starting with the more mature impact reduction initiatives.

7. IMPACT REDUCTION

7.1. Technological improvements

There is no doubt that the biggest contribution to the reduction of noise impact at airports over the last 30 years has been from improvements in the design and performance of engine and airframe design. A Boeing 777-200, for example, produces half the noise impact of the Boeing 747-100, partly due to engine and airframe design, and partly because modern aircraft can climb more steeply at takeoff.(11)

Through legislation and the use of differential surcharge regimes, governments and airports have exerted considerable economic pressure on carriers to migrate their fleets towards more the more modern aircraft. EU regulations have banned Chapter 2 aircraft since 1st April 2002

which for many airports has resulted in a major shift in the mix of aircraft operations. Stansted (UK), for example, had a base of almost 50% of operations using Chapter 2 aircraft as last as 1997. (10)

Some airports went even further and introduced their own even more refined categorisation (e.g. Heathrow's "Chapter 3 - High", "Chapter 3 – Base", and "Chapter 3 – Low" categories).

Sadly, whilst the limitation of environmental impact remains an important objective for aircraft design and further modest improvements are expected over time, no step change technological improvements are expected in the medium term.

7.2. Operational improvements

Over time operational procedures have been refined to also significantly reduce noise impact around airports, with initiatives falling into a number of categories:

- Changing ground procedures (e.g.: locating engine run-up areas away and downwind from noise sensitive areas, setting specific times during which engine run-ups and maintenance were allowed, etc)
- Changing air traffic procedures (e.g.: flight operational procedures such as continuous descent approach or maximum climb on take-off, moving the touchdown point further down the runway, etc)
- Improved track keeping (e.g.: development and enforcement of flight corridors, abatement zones etc.)
- Adopting new operational practices (e.g.: restricting class of aircraft permitted to use the airport, noise sharing, restricting number of air movements, hours of operation, etc)

Airports (and government agencies) adopt a range of approaches to the monitoring and enforcement of these programmes, from legal penalties, to contractual surcharge regimes, to arm twisting, to positive recognition of good performance by fleet operators.

These changes have had a marked effect on the level of noise impact on surrounding communities. At London Heathrow, for example, there were 590,000 people living inside a 57dB contour in 1988, created by about 350,000 air movements. By 2001, although traffic had risen to about 440,000 air movements, only 250,000 people were living in a 57dB contour. Whilst impossible to accurately separate the technological impacts from the operational impacts, there is no doubt that the world-leading work on *continuous descent approach* played an important role.

8. BUILDING COMMUNITY TOLERANCE

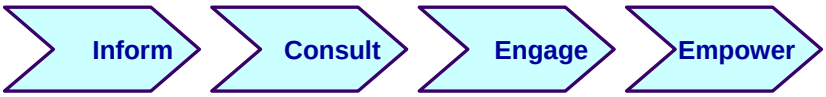
While sound can be measured, noise is a perception. The perceived noise "response" to similar sound "inputs" can vary widely, depending on a range of factors – some of which can be influenced through complex models of interaction between airports and their communities.

The starting point for these initiatives is to recognise that individuals (and therefore communities) are stressed and anxious in any situation where they have a real, or perceived, lack of control or involvement in matters that personally affect them. In contrast, consultation and empowerment are powerful techniques that can help to reduce these symptoms.

Acknowledging this situation, many airports have extended and enhanced their community consultation programmes from the traditional "defend and contest" forum for complaints, towards a more collaborative arrangement based on a number of key principles and best practices which form the cornerstones of "fourth generation aviation environment management":

- Airports need to ensure that issues of environmental impact are addressed in the overall **context** of the role and contribution of the airport within its community. This can be as simple as the implementation of an ongoing public relations campaign directed at reinforcing the positive impact of the airport on the community (e.g. jobs and wealth). In other cases, airports may choose to undertake more proactive context-creation programmes such as sponsorships, community development and charity works.

To develop tolerance, airports will alter their stance with respect to "community liaison committees" from a traditional "inform" posture, where the airport would present (and often defend) its position, along a continuum, towards true **empowerment**. Given the complex nature of airport operations and the range of opinions possible in any public engagement process, this outcome is by no means simple to achieve but, recognising that the objective is to provide the community with at least some control over environmental outcomes, sophisticated tolerance-building airports will strive to identify aspects of the operations that can be managed in conjunction with the community.



- As airports and their communities seek to establish a more informed and active dialogue, it is increasingly clear that traditional acoustic metrics such as Decibels, Ldn, EPNdb etc. are not ideally suited to providing meaningful information to the non-expert. (13,14) As a result new descriptors and metrics are being developed and adopted which seek, not only to make existing noise management principles (such as single event energy levels representing the noise made by a single operation) easier to understand, but to create a

set of metrics that comprehensively represent the aspects of noise that result in disturbance and annoyance. For example, as communities become more affluent, it has been noted that frequency of operation can become a more significant issue than the level of the sound.

New descriptors and metrics [13,14]	
Movement Charts	Summarised indication of operations by arrival or departure route. Closely identified with airport operating mode and used to discuss compliance with mode guidelines and to discuss alternative modes. Expressed as average movements per period of time, optionally incorporating information on days where no movements occur.
Respite Charts	Indications of the number of hours during which no movements occur on a specific flight path. This reflects the desire of communities to have some "time off" from aircraft disturbance.
N70 Contours	Whilst traditional contours have produced maps showing areas in which specific aggregate levels of noise can be expected (using metrics such as Ldn, ANEF etc.), for many non-experts, it is difficult to understand the real nature of the resulting noise effects within a contour. Based on the working assumption that a single event level of 70db is perceived as "loud", N70 contours produce maps which show how many loud noises can be expected within specific zones around an airport.
Measured N70 charts	As with traditional contours, N70 contours are not completely "trusted" by community groups as they are built using mathematical models of aircraft behaviour. As a result, airports also report the number of events actually measured to exceed the 70db (or alternative) single event level. These reports and charts are based on the permanent noise monitor fleet installed around the airport.

- Finally, an informed and empowered community requires more sophisticated **feedback mechanisms and information sharing**, not only so that dialogue can be informed and factual but also to provide the community with regular reassurance that the airport is earnest in its desire for an enriched relationship. Whilst there remains some debate about the value and desirability of sharing airport information with community, many airports have enthusiastically grasped the opportunity presented by the Internet as a means to share information such as live and near-live flight tracks [15], and other information such as reports incorporating the new descriptors and metrics outlined above.

9. CONCLUSION

Environmental issues, particularly the impact of aircraft noise, comprise the most significant constraint on the growth potential of attractive airport businesses. These "environmental

capacity" constraints are at least as important as the traditionally-planned physical constraints such as runway and terminal capacity.

Environmental capacity can be expressed as the net result of the community's tolerance for environmental impact, less the impact already imposed by the airport and therefore environmental capacity is optimised through a balanced programme of impact reduction and tolerance building initiatives.

The proactive use of impact reduction approaches has resulted in significant outcomes for many airports and remains an important part of any balanced programme, however the increasing use of sophisticated tolerance-building initiatives is heralding the arrival of the new, collaborative, fourth generation aviation airport environment management.

This new generation of initiatives will be founded on sophisticated information sharing, feedback and empowerment principles and will demand new approaches and new technologies.

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REFERENCES

5. Albatross online
6. “Investors ride the storm” – Janes Airport Review – April 2003
7. “On the rebound” - Airport World – Aug/Sep 2003
8. Sixth annual Airport Economics Survey – ACI, 2001
9. “Fast facts” – Communiqué Airport Business – Jun/Jul 2003
10. “Securing air transports future” – Giovanni Bisignani – CEO, IATA, - Sep 2003
11. AEA yearbook 2003
12. “Airline industry recovering” – OAG Sep 2003
13. “The concept of airport environmental capacity” – Manchester Metropolitan University – October 2002.
14. “BAA Stansted implement EU ban on noisy aircraft” – BAA Plc March 2002
15. “Noise: terminology and regulation” – BAA Plc
16. “A good practise guide to the assessment and management of aircraft noise disturbance around Northern Ireland airports” – ARIC – July 2003
17. “Guidance material for selecting and providing aircraft noise information” – Department of Transport and Regional Services (Australia) – 2003
18. ERCD Newsletter – CAA (UK) August 2003
19. www.oakland-tracks.com
20. “Dusseldorf airport faces problems” – Flug Revue Online – 3/2000