THE BULLETIN

OF THE

AUSTRALIAN ACOUSTICAL SOCIETY

VOL. 2 NO. 4

1973

Published by Australian Acoustical Society
Science House, 157 Gloucester Street,
SYDNEY NSW 2000

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CONTENTS

A.A.S. ACTIVITIES

NEW SOUTH WALES

SOCIETY DIVISIONAL DINNER AND SPECIAL TECHNICAL MEETING

The final technical meeting of the N.S.W. Division for 1973 was held on Thursday 29 November at The University of Sydney. The evening commenced in the Great Hall with a fascinating talk by Professor H.F. Pollard from The University of New South Wales on "The Pipe Organ and Acoustics". He was assisted by Mr. R.W. Sharp who was involved with the design and construction of the new organ in the Great Hall. The talk was followed by a short musical programme which illustrated the versatility of the organ. The audience was encouraged to move around the Hall during the musical demonstration and although there were over 100 peopoe many took advantage of this opportunity.

The Divisional Dinner that followed the meeting was held in Manning House and was attended by 88 members, wives and guests of the Australian Acoustical Society and the Audio Group of the I.R.E.E.

The dinner was enjoyed by all and provided an excellent opportunity to renew old friendships and initiate many new ones.

FIRST TECHNICAL MEETING FOR 1974

A Symposium on "Noise and the Textile Industry" was held at The University of New South Wales on Tuesday 19 February 1974.

It was an afternoon session covering background acoustic theory and was attended by over 50 managerial and engineering personnel and scientific staff in the textile industry.

Members of the Society were invited to attend the second session in the evening and the Buffet Dinner to follow. The speakers were Messrs. B. Longstaff and H.R. Weston from the Health Commission of NSW, Mr. J.A. Rose from the National Acoustics Laboratory, and Dr. J.I. Dunlop from The University of New South Wales. The topics covered were, "The Noise Environment in Textiles", "Conservation Standards and Compensation Law", "Noise Control" and "Hearing Conservation Measures".

The dinner following the Symposium provided an opportunity for further discussion between members of the textile industry and members of the Acoustical Society.

The proceedings of the Symposium are available from Unisearch Ltd., at a cost of $5 each.

The September Conference and Annual General Meeting

An exciting concurrent conference is developing with this year's Federal AGM, to be held in Sydney, 20th-21st September 1974.

The theme of "Current Acoustics" will exemplify the art/science in Australia at the time of the Conference.

A one-day conference preceded by the AGM is arranged at the North Sydney Club in Berry Street, North Sydney, overlooking the Warringah Expressway, city, harbour and surrounding suburbs.

With sherry beforehand and a dinner/dance following, the AGM on Friday evening, 20th September 1974 will provide a social introduction to the following day's lectures.

No official function is organised for the Saturday evening. The AAS Conference will be completed by 7 pm and delegates will be free to make their own arrangements, but note that The North Sydney Club closes at 8 pm on Saturday nights.

Any offers, queries, or comments will be gratefully received by John Whitlock by mail (if you trust it) at E.B.S., P.O. Box 30, CHATSWOOD, 2067, or through the Society: Australian Acoustical Society (NSW Div.), Science House, 157 Gloucester Street, Sydney, 2000. Telephone contact is 888 2777 9 am to 4.30 pm or 888 2472 at other times; but please try not to call between 10 pm and 7 am.

STOP PRESS -- The International Congress on Acoustics will be held in Australia in 1980. Further details to come.

NEWS AND NOTES

WESTERN AUSTRALIA

The "West Australian" for Tuesday November 20 featured the following article about Professor B.M. Johnstone. M.A.A.S., of the Western Australia Division.

"SCIENTIST GETS $50,000 GRANT

A W.A. University scientist, Associate Professor B.M. Johnstone, has been awarded a $50,000 grant to study the mechanics of deafness.

The grant is the biggest made to an individual researcher in this State.

Professor Johnstone also shared a $16,000 grant with Professor A.J.F. Boyle to study some applications of the Mossbauer effect by using radioactive material to measure the vibrations in the inner ear.

The grants are two of nearly 70 totalling $420,000 made to W.A. scientists by the Federal Government's Australian Research Grants Committee.

Professor Johnstone, who is attached to the University's Physiology Department, has been investigating deafness for the past 10 years.

For the past four years, he has studied the effects of noise on hearing.

He said yesterday that scientists were beginning to have some understanding of the impact of excessive noise on the ear.

He hoped eventually to extend his work to the environmental field.

'We want to determine whether some people are more susceptible to noise than others', he said.

'If we can do this we should be able to devise tests that will enable us to advise them not to work in certain jobs.'

Professor Johnstone said that his team in the Physiology Department had done some work on investigating ways of testing the hearing of young children who could not be tested by conventional means.

These tests, using electrical signals from the scalp, were about 30 per cent successful.

He hoped to bring the success rate up to 80 or 90 per cent with new computer equipment which would be installed next year.

This would allow doctors to analyse the direct effects of loud noises and diseases on the nerve fibres of the ear."

The Division also reports on the activities of its members, as below.

Mrs. M. McCudden, M.A.A.S., Principal, Speech & Hearing Centre, Perth. Mrs. McCudden is the first W.A. recipient of the Rotary Foundation Award for teachers of the handicapped. This is a splendid achievement as there are only 50 such awards conferred throughout the world.

Mrs. McCudden will leave W.A. in August, 1974 for 1 year to study at the John Tracy Clinic, Los Angeles for a Master's Degree in Education of the Deaf with emphasis on preschool education and parent guidance.

Dr. J. McNulty, M.A.A.S., W.A. State Public Health Dept., has left W.A. for Geneva to attend the International Labour Organisation Conference as Australian Govt. representative, to assist in drafting and recommending Standards for the use of asbestos in industry.

INSTITUTE OF ACOUSTICS IN ENGLAND

The following news release was received recently on the formulation in Britain of a single organisation to represent the interests of all involved in acoustics.

"NEW INSTITUTE OF ACOUSTICS FORMED

The Institute of Acoustics has recently been formed. The new body, which is an amalgamation of the former British Acoustical Society and the Acoustics Group of The Institute of Physics, will be the one body in the country which will speak for all those involved in acoustics - the study of noise, sound and vibration, and its effects.

Dr. Raymond Stephens, the first President of the Institute, said: "Acoustics as a science owes much to our own nineteenth century workers such as Rayleigh and Tyndall, and ever since, this country has made many contributions to its technology. The growth and spread of the subject into other disciplines, and the advent of legislation on noise and its implementation has stressed the importance of having a single organization to correlate the various aspects of the subject.

'Architects, musicians, physicists, engineers, medical specialists, etc. are among those involved in the art, science and technology of acoustics, and all are represented on the first Council of the Institute.'

The Institute will hold frequent scientific and technical meetings in various centres in this country, and, it is hoped, will take part in joint meetings with various European acoustical societies. Together with The Institute of Physics, the new body is respons for the organization of the Eighth International Congress on Acoustics to be held in London in July 1974.

Specialist sub-groups and committees of the Institute will be formed as occasion demands and at the present time, the Education Committee is devoting attention to the ever-increasing need for technicians and others with a background of acoustical training.

The headquarters of the Institute are at 47 Belgrave Square, London SW1X 8QX."

INTER-NOISE '74

Inter-Noise 74, the third in a series of international Conferences on Noise Control Engineering, will be held September 30 to October 2, 1974 at the Shoreham-Americana Hotel, Washington, D.C. The Conference will include an equipment exposition, noise clinics, and technical sessions consisting of invited and contributed presentations on world-wide noise control technology and legislative developments. A bound copy of the Proceedings (approx. 600 pages) will be available to participants at final registration, and, to others after the Conference.

Contributed Papers

Contributed papers are welcome. Abstracts of 500 words are solicited and should be addressed to the following topics that have been selected for the INTER-NOISE 74 technical program:

Neighbourhood Noise
Regulation of Airport Noise
Jet Noise Reduction
Internal Ship Noise
Traffic Noise Abatement
Effects of Noise on Man
Building Noise
Regulation of Community Noise
Noise Measurement and Instrumentation
Machinery Noise Reduction at Source
Noise Ordinances
Enforcement of Noise Legislation
Construction Noise
Reduction of in-Plant Noise Exposure

Abstracts must be received no later than April 15, 1974 and should be submitted as soon as possible for review and acceptance to John C. Snowdon, Applied Research Laboratory, P.O. Box 39, State College, Pa. 16801.

Noise Clinics

Case histories of noise-control problems will be described by authorities during three tutorial sessions on the topics:

Industrial Noise
Transportation Noise
Community Noise

Further information may be obgained on these noise clinics from the chairman in charge of arrangements: George W. Kamperman, Kamperman Associates, Inc., 1110 Hickory Trail, Downers Grove, Ill. 60515.

Equipment Exposition

A comprehensive exposition of equipment and materials will feature many of the latest technological developments for noise control. There will be opportunities for viewing exhibits and demonstrations and for discussions with manufacturers' representatives.

Intention to Participate/Additional Information

Parties intending to participate in INTER-NOISE 74 or requiring additional information are encouraged to return the coupon below or to contact conference representatives at INTER-NOISE 74, ARL-PSU, P.O. Box 30, State College, Pa. 16801."

LETTERS TO THE EDITORS

"Dear Sirs,

Echoes - Bulletin Vol. 2 No. 3

Your report on 'Sound Absorption in Earlier Times' concludes with a request for information on the meaning of the abbreviation, "d.v." used in V.O. Knudsen's reports and papers published in the 192--29 period.

I believe the abbreviation is for 'double vibration' meaning a complete vibration above and below the neutral position, although I am unable to locate any contemporary papers that confirm my belief.

Strictly speaking, of course, the abbreviation ought to have been 'd.v/s', introducing the time dimension of frequency, although to my knowledge 'd.v.' was the accepted usage.

D.A. GRAY"

"Dear Sir,

The Abbreviation 'dv'

The use of 'dv' by Knudsen in his report reproduced in the previous edition of the Bulletin (Vol. 2 No. 3) under the heading 'Echoes' is interesting and warrants comment.

'dv' is an abbreviation for 'double vibration'. It used to be necessary to specify whether a half cycle or a whole cycle of vibration was meant as there was a difference of useage. I think the French used to mean a half a cycle when they spoke of one vibration. Some writers used the expression "complete vibration" for the same thing as "double vibration", for the same reason. "Per second" was often left out, presumably because while there was some doubt about the "vibration" there was no doubt about the time interval, it being always one second.

We have recently (well, more recently) been subjected to arguments about Hertz versus cycles per second. I would like to take the opportunity of giving support to a proposal put forward in a letter to the Editor of JASA a few years ago, that there should be a simple unit for the commonly used radians per second, and that it should be AVIS (angular velocity: inverse seconds).

John A. Moffatt, M.A.A.S.
13 Wallace Rd.
BURWOOD VICTORIA"

THE PIPE ORGAN AND ACOUSTICS

Howard Pollard
The University of New South Wales

Based on an Address prior to Annual Dinner of the New South Wales Division of the Society.

HISTORICAL BACKGROUND

Modern acousticians spend much of their time and energy in studying problems connected with disorganised sound in the form of noise. In the past it was more fashionable to study organised sound, in particular the form known as music. Musical instruments have always had their fascination as sound sources and even today there are numerous unsolved problems relating to the detailed method of production of the sound. Superficially, an organ pipe is a musical instrument that can be studied independently of the characteristics of the performer. The apparent simplicity of an organ pipe is deceptive since it is only in the last few years that the underlying physical mechanisms involved have come clearly into focus.

One of the first scientists to study problems connected with the pipe organ was the French Franciscan friar, Marin Mersenne (1588-1648) who is credited with writing the first scientific text dealing with acoustics (L'Harmonie Universelle, Paris 1635). Although he is usually credited with the discovery of the laws of vibrating strings it is now known that these were deduced two years earlier by Galileo. Mersenne was however the first worker to measure the frequency of a long vibrating string.

Hermann Helmholtz (1821-1894) made considerable advances in the theory of resonators, summation and difference tones. His major findings are published in the remarkable book 'Sensations of Tone' published in 1862 and available once again as a Dover reprint. Some of the most spectacular theoretical advances in acoustics were those of Lord Rayleigh (1842-1919) who developed in great detail the theory of a variety of acoustical systems in his 'Theory of Sound' published in 1877. He is also the inventor of a device for measuring the absolute intensity of sound (now called the Rayleigh disc) which consists of a lightly suspended disc which sets its plane perpendicular to the direction of propagation of the sound wave. Rayleigh produced a theory giving the end corrections for an open organ pipe that allows its effective length to be determined.

The earliest form of pipe organ was the hydraulus which dates back to the third century BC. The pipes were mounted on a wind chest and supplied with air under pressure from hand-operated cylindrical pumps. The compressed air was forced into a dome containing water which stood in a larger vessel partly filled with water. A pipe from the top of the dome led to the windchest. The wind pressure was determined by the amount of water in the device and the water level in the dome adjusted its level according to the wind demand. Up to four stops were common on these organs which also had a balanced keyboard and a stop system similar to that in the later slider chest.

The pneumatic organ, using a bellows system, is also old, there being a record of one in Constantinople in 395 AD. The Arabs in the middle ages developed the hydraulus, pneumatic and hydraulic organ, the latter using a water system to compress the air. There was even an automatic version of the hydraulic organ in which the operation of the pipes was controlled by a drum with projections which was driven by a water wheel (Sumner 1962).

During the 12th century in England the portative organ was developed for use in processions. This consisted of a small instrument having only about two octaves which was carried by means of a strap round the shoulder, the performer playing the keys with his right hand and operating a bellows with his left hand. It is recorded that portatives were suitable for both 'infernal' and 'heavenly' music. By the early 15th century some large instruments had been developed consisting of one wind chest with many ranks of pipes sounding at octave and fifth pitches and called the Blockwerk. There were no separate stop controls so that for each note on the keyboard a large number of pipes played. During the 16th century a small Positive organ was added, located behind the player, and containing separate ranks of pipes with a light playing action. At first it was necessary for the player to play on the Blockwerk and Positive by means of physically separated keyboards. However the modern type of console was soon developed which contained two or more keyboards in front of the player. As the size of organs increased and the effort to play them likewise, foot pedals became common in order to control the largest pipes.

THE ORGAN MECHANISM

The basic elements of a pipe organ are:
(1) a wind supply (blower, wind chests, etc.),
(2) a number of sets or ranks of pipes,
(3) the playing action (all the mechanism connecting the performer's fingers to the pipes).
In a modern organ there are two or more manuals with pedals each of which controls a separate division of the organ. Each manual contains 5 octaves of keys (61 notes) and the pedals cover 2½ octaves (32 notes). The wind supply to each rank of pipes (a row of 61 pipes on the manuals) is controlled by a stop mechanism which is basically a simple mechanical gate which admits or closes off the air to a given rank of pipes.

The basic traditional control mechanism (or action) is the slider chest system, shown in plan in Fig. 1. In Fig. 2 is shown a cross-sectional view of a slider chest. During the 19th century the urge to build bigger and louder instruments led to much experimentation in the development of new forms of control for the organ action. The older mechanical system became heavy to operate when more pipes were added to each chest and wind pressures were raised. Among the new systems developed were tubular pneumatic, Barker-lever, electropneumatic, direct electric and Pitman. In recent years the mechanical system has been redeveloped with the aid of new materials and construction methods. Further details of each system with block diagrams is given by Pollard (1968).

In the mechanical system the keys are connected by a series of levers and roller-boards (which allow for change of direction) to the pallet which admits air into the pipe channel. In this system the player has initial control over the rate of opening of the pallet. The main time delays that affect the player in operating a mechanical system are (a) the opening time of the pallet, and (b) the speech rates of the pipes. The time to reach steady speech depends on the length of the pipe. Measurements shown (Pollard 1968) that, in normal pipe speech, between 10 and 20 cycles are required in order for the pipe resonance to build up to a steady state. The initial time delay (the time interval between touching the key and the first onset of sound) for a mechanical organ is usually in the range 30 - 50 milliseconds. Times in excess of 50 ms can cause problems for the player.

In the electropneumatic system of control, often used for large instruments, the main time delays are (a) the energising time of the electromagnets which control various pneumatic devices, (b) the operating time of any pneumatic motors and valves, (c) the opening time of the pallet (now no longer under the control of the player), and (d) the speech rates of the pipes. Measurements show that the initial delays for an electropneumatic system are commonly in the range 70 - 80 ms.

TYPES OF PIPES

There are two main types of pipes: flue and reed. The essential features of each type are shown in Fig. 3. Flue pipes are further classified into principal, flute or string tone depending on the character of the sound produced. Principal pipes are the basis of organ tone and consist of sets of cylindrical metal pipes at different pitches usually sounding at octave or fifth intervals. Depending on the ratio of diameter to length, the tone ranges from dull to keen. The diameter of a given length of pipe determines its high frequency spectral cut-off, so that a wide pipe will have less harmonic development than a narrow pipe of the same length. Flute pipes may be made of wood or metal and have a larger diameter to length ratio than the principals. They may be open or closed or partly open and may have a tapered body. String pipes are narrower and have a correspondingly high harmonic development. Ranks of flue pipes may be found at all harmonic pitches ranging from Pedal pipes of length 32' (frequency 16.4 Hz for an open pipe) up to the smallest practical size of 3/8" (16,744 Hz).

The source of sound in reed pipes is a vibrating metal tongue which is coupled to a resonant air column. The source of sound in a flue pipe is an edge-tone mechanism which is also coupled to an air column. Air emerges from the narrow rectangular flue and impinges on a sharp edge forming the upper lip of the pipe. When a resonator is added, a non-linear feedback mechanism comes into play. Under steady operating conditions this takes the form of an alternating pressure disturbance at the point of emergence of the jet which has the effect of modulating the jet. With the right phase and loop-gain conditions, self-sustained oscillations will occur. In the flue organ pipe the situation is made very complicated since the feedback from the pipe has a complex waveform and the jet system itself has several modes of operation.

It is of interest to note that when an open tube of air is excited externally, for example by a loudspeaker, it does not produce a harmonic series of partial tones. It is found that the simple classical theory does not apply to a radiating column. However, when tightly coupled to a jet source with the right non-linear feedback mechanism, the partial tones radiated by the system are harmonic within 1 part in 1000.

Attempts to specify the tone quality of musical sounds have not been markedly successful in the past. The old system for specifying steady sounds relied on three parameters: (a) pitche, (b) loudness, and (c) timbre or tone quality. Tone quality has always been assumed to be related to the spectrum of the sounds. According to Schouten (1968), the use of an overall term such as tone quality includes too many identifiable parameters. He suggests the following sub-division for tone quality:

(1) the location of the sound in a range between tonal and noiselike character
(2) specification of the spectral envelope
(3) specification of the time envelope including rise time, duration and decay time
(4) some measures of change, such as
  (a) formant glide (change in spectral envelope)
  (b) micro-intonation (small changes in fundamental frequency)
(5) specification of any acoustic prefix - which may consist of a burst of noise or of more easily excited higher partials of the eventual steady sound.

At present it is not possible to measure all these parameters in a reliable, objective manner. With short-duration transient sounds a major problem is to know the function performed by the ear and brain in assessing the sound. With the type of transients which occur in organ pipes there does not appear to be sufficient time for the ear to indulge in any form of Fourier analysis. In identifying transients it is probable that some more subtle system of comparison is involved.

REGISTRATION

The term registration as used by organists involves the choice of stops, and hence the relative pitch and tone colour, required to match the style and mood of the music. A basic rank of open pipes that sounds at normal (piano) pitch will consist of 61 pipes ranging from a length of 8' at note C_2 to a length of 3" at C_7. (Middle C is designated C_4). It is customary in an organ to provide ranks of pipes sounding above and below normal pitch. For instance, a rank of open pipes labelled 4' will have a range of lengths from 4' to 1.5" and will sound one octave higher than normal pitch.

The pitches available in the various ranks of pipes normally follow a harmonic series. For instance, on the manuals, the following ranks of pipes stops, 78 ranks and 3947 pipes. In the abbreviated specification below, the main numbers indicate the basic pipe length for each rank (numbers in bracket indicate more than one rank of that length), and the Roman symbols, such as IV, indicate a mixture stop containing more than one rank of high-pitched pipes.

GREAT

Principals:	16, 8, 4, 2, IV, IV
Flutes:	8, 4, 2 2/3
Reeds:	16, 8, 4

POSITIVE

Principals:	8, 4, 2, IV-VI
Flutes:	8(2), 4, 2 2/3, 1 3/5, 1 1/3, 1

SWELL

Principals:	4, V-VIII
Flutes:	16, 8(3), 4, 2 2/3, 2 1 3/5, 1 1/7
Reeds:	16, 8(2), 4

PEDAL

Principals:	16, 8, V
Flutes:	16, 8, 4, 2, III
Reeds:	16(2), 8, 4

Accessories include manual and pedal couplers, swell pedal, tremolo on positive and swell, 14 adjustable pistons, 1 setter piston and 1 general cancel piston. The playing action is mechanical and the stop controls are electrically operated.

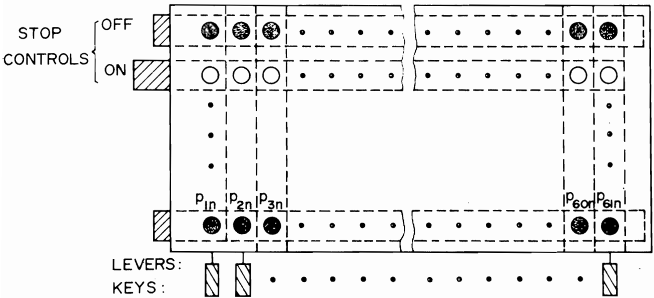

FIGURE 1

SCHEMATIC PLAN OF A SLIDER WINDCHEST. THE PIPES ARE ARRANGED IN THE FORM OF A MATRIX WITH 61 COLUMNS AND N ROWS (N IS THE NUMBER OF STOPS).

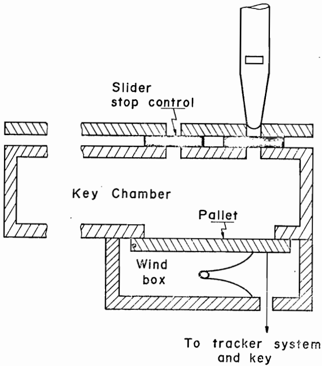

FIGURE 2

SCHEMATIC CROSS-SECTION OF A SLIDER CHEST. THE KEY CHAMBERS, ONE FOR EACH KEY, ARE DIVIDED BY PARTITIONS.

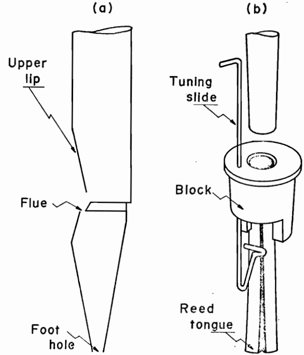

FIGURE 3

ESSENTIAL FEATURES OF (A) A FLUE PIPE, AND (B) A REED PIPE.

AIRCRAFT NOISE AND WHAT IS BEING DONE ABOUT IT

Dunn and Lam

Department of Transport
Melbourne

(Based on the Address given following the Annual General Meeting of the Australian Acoustical Society at Monash University, Melbourne, on 14 September 1973).

SUMMARY

The history of the development of aircraft noise as a problem is briefly reviewed and the action that has been and is being taken, both internationally and within Australia, is summarised.

Brief details of the basis of the ICAO noise certification standards for new subsonic turbo-jet aeroplanes are given and the work being done in ICAO towards control of the noise of other aircraft such as existing subsonic jet aeroplanes, supersonic transports, light propeller driven aeroplanes and STOL/VTOL aircraft is noted.

The Australian scene is reviewed with specific comment on the approach to land use planning, the special noise monitoring programme, and the operational approach to reduce noise.

It is concluded that, although much has been done and is being done to reduce aircraft noise and its effects, much still has to be done before the problem is completely under control.

INTRODUCTION

Aircraft have always made noise but it was not until the early 1950's with the advent of turbo-prop powered aeroplanes such as the Vickers Viscount and later the Lockheed Electra and Fokker Friendship that aircraft noise first became a problem. Prior to this, the number of aircraft was relatively small, they tended to operate out of small aerodromes in lightly populated areas (hence affecting few people) and the noise levels produced were relatively low and of a predominantly low frequency character - essentially of low annoyance.

The turbo-prop aeroplanes brought with them the annoying high frequencies associated with the siren type operation of the rotating engine compressor and turbine as did the first pure jet aeroplanes such as the Boeing 707 which, because of the characteristic high jet exhaust velocity of their engines, also produced a very high exhaust roar.

Experience in Australia showed that from 1958 onwards (the time the first pure jet aeroplanes entered airline service) there was an increasing number of complaints regarding noise generated from aircraft - a trend also apparent in the U.S.A., the U.K. and Europe - and it was becoming clear that something had to be done.

THE ATTACK ON THE PROBLEM

Fortunately at the time, the situation in Australia was good by comparison with that in the U.S.A., U.K. and Europe (and, in fact, still is), and it was appropriate for Australia to work towards a solution internationally - particularly since we were (and are still) a non aircraft engine manufacturing country. Consequently we attended the first international conference on aircraft noise in London in 1966. At this conference, which was sponsored by U.K. and attended by representatives of a large number of aviation States throughout the world, what amounted to an informal exchange of views on noise occurred.

The ways of treating the problem were discussed under three major headings clearly shown in Figure 1

- How can noise be reduced at the source?
- How can the transmission path of the noise be varied to reduce the noise?

and - How can the situation of the receiver be adjusted to reduce the effect of noise?

It became clear at the aforementioned conference that if anything worthwhile were to be achieved internationally it was essential that the International Civil Aviation Organisation (ICAO) should take over control of the problem. The Australian delegation proposed such action and it was generally accepted.

Australia then followed up this proposal by sponsoring a resolution at the ICAO Assembly meeting in Buenos Aires in 1968 instructing the ICAO Council to call an international conference within the machinery of ICAO as soon as practicable, to establish international specifications and associated guidance material on aircraft noise. The resolution was adopted and a special meeting to which all ICAO States were invited was held at ICAO headquarters in Montreal in October 1969.

This meeting considered basically the same items discussed at the 1966 London conference but the results were far better - perhaps more so than even the most hopeful had dared to believe was possible. A new Annex (entitled Aircraft Noise) to the Convention on International Civil Aviation (the Chicago Convention) was developed. Contained in Annex 16, as it is now known, were the first international noise standards which would have to be met by any aircraft manufacturer in the future if he wished to sell his aircraft internationally.

Another major outcome of the 1969 meeting was the establishment by the ICAO Council of a Committee on Aircraft Noise (CAN) charged with the tasks of considering action necessary to control the noise of existing subsonic jet aeroplanes, supersonic transport aeroplanes, light propeller driven aeroplanes, STOL/VTOL aircraft, aircraft airborne auxiliary power units, and so on. This Committee, of which Australia is a member, has met three times in the past three years and has achieved much towards encouraging reduction of aircraft noise at the source.

Some brief details of Annex 16 and the work that has been and is being done by CAN are given below.

Annex 16 - The Noise Certification Standards for Subsonic Turbo-jet Aeroplanes.

The basic unit chosen for noise certification of subsonic turbo-jet aeroplanes is the effective perceived noise level, or EPNdB. This unit is probably the most sophisticated unit that one can find in acoustic measurements. It arose as a result of considerable research into people's response to noise and is probably the best objective measure available at present to evaluate an individual's response to aircraft flyover noise. It takes into account the physical characteristics of the noise that are responsive to annoyance factors, namely, the spectrum level, tonal and time characteristics. Its make-up is shown in Figure 2.

The basic noise measurement points for aircraft certification as detailed in Annex 16 are shown in Figure 3. It is clear that the certification concept is based on measuring the noise at three points; landing or approach, being 2000 metres from the threshold; lateral or side-line, being 650 metres from the runway centre line where the noise is the greatest; and flyover or take-off, being 6500 metres from the start of the take-off roll.

The maximum noise levels for noise certification are shown in Figure 4. It will be seen that this is based on a sliding weight scale. It may not seem quite logical, but it was developed knowing what was reasonably achievable with current technology and knowing that the heavier aircraft usually require more engine power and this tends to result in increased noise. This standard is now essentiall fully applicable to all new subsonic jets.

Although the standard has only been applicable since January 1972 it already had a significant impact. One only needs to compare the noise levels of the Douglas DC-8-50, the Boeing 747 - 200B and the Lockheed 1011 as shown in Table 1.

TABLE 1

Aeroplane Type	Noise Levels at Annex 16 Noise Measurement Points EPNdB		
	Flyover	Lateral	Approach
DC-8-50	114	106	118
B747-200B	109	97	109
L - 1011	98	91	103

The Douglas DC-8 was designed and built prior to any noise certification requirements; the Boeing 747 in the middle of the preparation of the requirements while the Lockheed 1011 was obliged to meet the requirements fully. The reduction in noise has been dramatic.

Other Aspects of Annex 16

Apart from aircraft noise certification standards, Annex 16 also contains agreed recommendations regarding the basic unit to be used for noise measurement for monitoring purposes; (dB (D) or dB (A)), and for landuse planning purposes, the equivalent continuous perceived noise level. Guidance material relating primarily to safety considerations in the establishment of aircraft noise abatement operating procedures is also contained in the Annex.

THE WORK OF CAN

The Retrofit Problem

The retrofit problem - namely the question whether existing subsonic jet aeroplanes can be modified to reduce noise - is without doubt the most difficult question considered by the Committee on Aircraft Noise to date. A working group established by the Committee investigated the technical and economic aspects for nearly three years without really resolving the matter. Following the last CAN meeting in March 1973 a recommendation was put to the Council of ICAO that all States should seriously consider the matter and the Council has since partially endorsed the recommendation. It was not thought reasonable to establish an international requirement for retrofit.

Technically it has been shown that retrofitting existing jet aeroplanes to reduce noise, at least down to the limits of Annex 16, and in some cases below, is possible in most cases. Whether the cost is truly worth it, however, is the big question. It has been estimated that to retrofit the existing world fleet of commercial jet aeroplanes to reduce noise levels at least to Annex 16 limits, would be over (perhaps well over) 1000 million dollars. Is it worth it? Who pays? Is it better to retire the aeroplanes instead and, if so, where do these "noisy" aeroplanes go? These questions, among others, make a decision for or against retrofit a difficult one. So far, no country has made the decision.

Supersonic Transport Aeroplanes

No noise certification standards have yet been established for supersonic transports such as the Concorde and the TU-144. It is apparent from submissions presented at the last CAN meeting that both the U.S.S.R. and the U.K./France consortium are doing everything possible to lower the noise levels of their respective aeroplanes. Since the designs were effectively established well before any noise certification rules were established, the situation was accepted. The noise levels of both aeroplanes will, incidentally, be in excess of existing Annex 16 limits for subsonic aeroplanes but comparable with the noise levels of existing subsonic jet aeroplanes such as the Douglas DC-8 and Boeing 707. For future S.S.T.'s guidelines have been established that the noise levels should not be in excess of the requirements valid for subsonic aeroplanes.

The sonic boom is a special noise problem associated with supersonic aeroplanes. This boom is carried by the pressure disturbance associated with the shock waves generated at the leading and trailing surfaces of the aeroplane during supersonic flight. The conical shock waves spread from the aircraft and intersect the ground in an arc which moves across the ground sweeping out a boom carpet along the flight path of the aircraft. Depending on conditions (e.g. aeroplane speed and altitude) the boom carpet can be as wide as 50 miles. The boom is causing concern both because of its loudness and its startle effect. No technical way has been found yet which can eliminate this noise problem. The only solutions available at the present are operational (that is in the transmission path) such as restricting supersonic flight to over sea or over-non-populous areas. These matters are being considered by the ICAO Sonic Boom Committee.

Light Propeller Driven Aeroplanes

Tentative noise standards have been established for new light propeller driven aeroplanes as shown in Figure 5 and work is proceeding towards establishing these as firm standards. Note that the noise unit proposed is dB(A) which was considered to be more appropriate since the noise produced by propeller driven light aeroplanes generally does not have features (such as pure tones) which warrant the use of a more sophisticated unit such as the Effective Perceived Noise Level. It is hoped that these standards will lead to a reduction in light propeller driven aeroplane noise much the same as the standards in Annex 16 have led to a reduction in subsonic jet aeroplane noise.

Other Considerations

There is still a great deal more work to be done by ICAO and CAN. A working group is currently developing recommendations for noise requirements for STOL/VTOL aircraft and at the next CAN meeting, planned for late 1974, the action necessary to reduce the noise produced by airborne auxiliary power units and during reverse thrust operations (among other things) will be discussed. A working group of CAN, on which Australia is represented, is also currently working towards making Annex 16 more severe.

It is clear from the above that the major effort in the international scene has been towards reducing the noise at the source. ICAO do have proposals in hand to consider in depth what can be done in relation to reducing the effect of noise by operational procedures (the transmission path) but, as mentioned earlier, have so far only come up with some general guidance material related to safety considerations. Similarly little has been done in ICAO on land use planning guidelines except to recommend the unit for international usage and to publish guidance material provided by ICAO contracting States on land use planning.

THE AUSTRALIAN SCENE

Whilst all the activity was being undertaken in the international sphere, the Australian parliament decided to set up a Select Committee on Aircraft Noise. This was in November 1968. The report of that Committee was completed in October 1970 and included twenty-nine recommendations to be implemented in Australia to alleviate the effects of aircraft noise. The DCA in conjunction with the Commonwealth Acoustic Laboratories and other government departments is vigorously engaged in implementation of the various recommendations at this time.

The Select Committee recommended, among other things, that we press for reduction in aircraft noise through ICAO and this is being done. Australia will uphold the requirements of Annex 16 and continue to participate strongly in CAN.

It was also recommended that Australia adopt the U.S. developed Noise Exposure Forecast (NEF) for land use planning purposes and this has been done. The components which make up the NEF are shown in Figure 2. The procedures for calculating noise exposure are based on the predictions of the cumulative effect of aircraft operations averaged over an extended period of time. There is no direct relationship between noise level and noise exposure. The noise exposure is related to community response on the average for land use compatability purposes and as such is only a planning tool (albeit a very useful one). It can be used for comparative studies when siting new airports or when considering introducing new flight paths, flight procedures and/or aircraft types, but it cannot be used as a noise measurement standard or criterion to solve any local or day to day problems.

The Department of Civil Aviation is producing NEF contour charts for all major airports in Australia and these are or will be available from the relevant Regional Offices. Estimates of the situation in 1980 and 1985 have been made in most cases. It must be emphasised that, although

DCA has the responsibility for producing the NEF's it does not hold any constitutional power to become a land use planning authority - nor does any Australian Government Department for that matter. This right is vested in the States. DCA can give the best estimate of noise exposure but zoning is a State responsibility.

Other action which has been taken within Australia to reduce noise either as a direct result of the Select Committee's recommendations or otherwise includes:-

The establishment of a special noise monitoring programme. A very sophisticated noise monitoring system consisting of eleven fixed noise monitoring terminals and one mobile van fitted with a sound measuring system all backed up by considerable recording, analysing and computer facilities is already in full operation in Sydney. Such noise monitoring systems are used to carry out routine measurement of noise levels and for the purpose of monitoring compliance with and checking the effectiveness of noise abatement procedures.

The Department has developed rules restricting the times, duration and location of engine ground running in order to minimise disturbance to the public.

A National Co-ordinating Noise Abatement Committee has been established to investigate all matters pertaining to aircraft noise from the operational point of view. The Committee, supported as necessary by individual Airport Noise Abatement Committees, considers whether night curfews should be imposed (these already exist for turbojet operations at Brisbane, Sydney and Adelaide between 11 pm and 6 am); whether flight paths can be safely varied to avoid noise sensitive areas; whether take-offs and landings can be made at preferred runways; whether aircraft in-flight holding areas (necessary when an airport is closed down temporarily due to bad weather) can be repositioned to minimise the effect of noise received on the ground; and many other matters.

Noise abatement take-offs and low thrust decelerating approaches are in use at many Australian airports and have proved successful in reducing noise exposure on the ground, and other operational procedures to reduce noise are under investigation. It is emphasised that in all cases any new operational procedures to reduce noise are under investigation. In all cases any new operational procedure proposed must be demonstrated to be safe before it can be incorporated as regular practice.

FINAL COMMENT

It is clear that both internationally and within Australia much has been done and is being done to reduce aircraft noise and its effects. Much still has to be done, of course, before the problem of aircraft noise is completely under control.

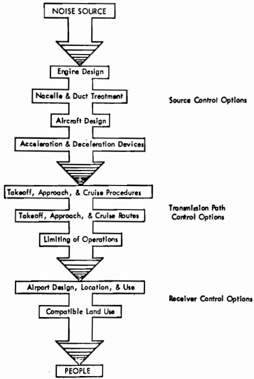

FIGURE 1

FLOW DIAGRAM FOR AIRCRAFT NOISE CONTROL OPTIONS

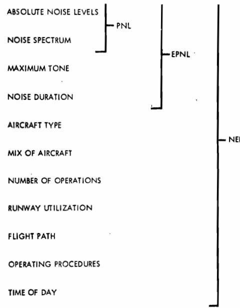

FIGURE 2

FACTORS INCLUDED IN COMPUTATIONS FOR
PERCEIVED NOISE LEVEL (PNL)
EFFECTIVE PERCEIVED NOISE LEVEL (EPNL)
NOISE EXPOSURE FORECAST (NEF)

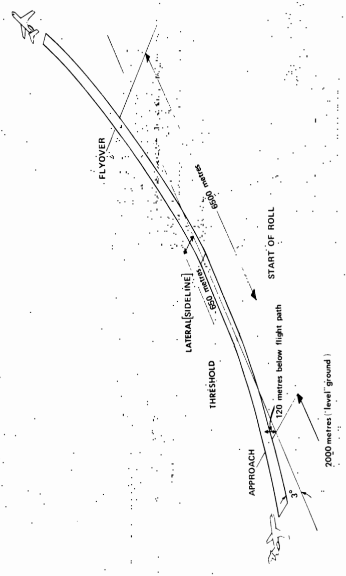

FIGURE 3
ICAO MEASURING POINTS
ANNEX 16 (1971)

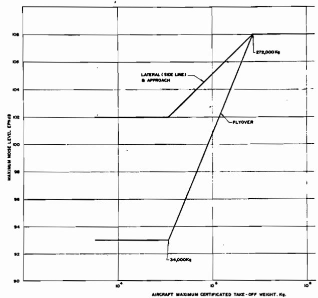

FIGURE 4

ICAO PROPOSED NOISE LIMITS FOR SUBSONIC JET AEROPLANES ABOVE 5700 KG (ANNEX 16 AUG. 1971)

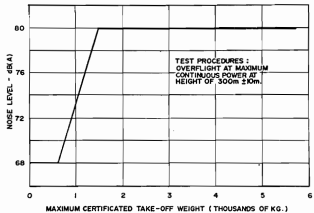

FIGURE 5

ICAO PROPOSED NOISE LIMITS FOR LIGHT PROPELLER-DRIVEN AEROPLANES

THE AUTHORS

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Mr. M.D. Dunn, B.E., A.F.R.A.S., G.I. Mech. E, is the Principal Engineer in the Noise Abatement Branch of the Department of Civil Aviation. He jointed D.C.A. in 1964 as an aircraft systems engineer in the Airworthiness Branch, later concentrated on aircraft power plants and subsequently took charge of the Mechanical Engineering Sub-section dealing with all aircraft systems and power plant problems. Prior to joining D.C.A. he had four years experience, initially as a Graduate Apprentice and later in design and development with English Electric Aviation (later British Aircraft Corporation) in England. He has been one of the Australian representatives on the International Civil Aviation Organisation's Committee on Aircraft Noise and is now actively associated with working groups of that committee.

R.C. LAM

Mr. R.C. Lam, A.R.M.I.T., B.E., M.Sc., M.I.E.Aust., joined the Department of Civil Aviation in 1963 as a project engineer in the Air Traffic Control Engineering Section. In 1965 he moved to the Engineering Research and Development Laboratory and has been actively involved with aircraft noise, particularly in the areas of objective and subjective measurements and evaluations, and community reactions.

He has recently completed fourteen months of post graduate studies at the Institute of Sound and Vibration Research, Southampton, followed by three months observational studies in Europe, Canada and U.S.A.

H.F. POLLARD

Professor Pollard is in charge of the Acoustics Division of the School of Physics, The University of New South Wales.

A graduate of the University of Western Australia, he worked for a number of years at the National Standards Laboratory, Sydney, before joining the University of New South Wales at its inception. His main scientific interests include the analysis of musical transients, the tonal design and characteristics of pipe organs, and the use of ultrasonic pulse and resonance methods to investigate loss mechanisms in solids.

He is Chairman of the Organ Institute of NSW and is an active organ recitalist. He has made a series of organ recordings for The University of New South Wales for use in graduation ceremonies.

TECHNICAL NOTE

SOUND AND LIGHT !

M.A. Burgess

An illuminating experience at the Experimental Building Station may be of interest to those concerned with the finer details of architectural acoustics.

Recent modifications to the external walls of one of the reverberation rooms had resulted in increased reverberation times, particularly at the low frequencies, with the exception of the one-third-octave band with centre frequency of 160 Hz. The measured reverberation times for the low frequency bands are shown as the broken line in Figure 1.

As there seemed no logical explanation for this low value, a "trial and error" approach was used in the subsequent investigations. All the moveable objects were removed sequentially from the room and then changes were made to the fixed objects. These changes all produced variations in the reverberation times but the low values at 160 Hz still persisted. An accelerometer was used on all the surfaces but no unusual vibration resonances were observed.

At this stage the light globes were being replaced so measurements of the reverberation times were made with the light covers removed. To our great amazement the low values increased to acceptable values as shown by the solid line in Figure 1. The proof that the light covers were acting as absorbers was supplied when the low values were reproduced after replacement of the light covers.

These light covers were of a round drum style which clipped onto a section fixed to the ceiling, as shown in Figure 2. Attempts to calculate the resonant frequency produced a variety of answers because of uncertainties in assessment of the area of the opening and the effective dimensions of the other parts of the enclosure. The absorption of each of the light covers in the one-third octave band with centre frequency of 160 Hz was approximately 0.1 m^2 sabins (or 1.2 ft^2 sabins).

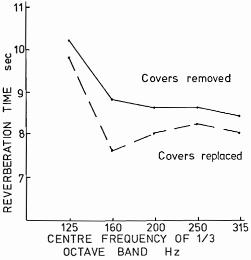

FIGURE 1

FIGURE 2