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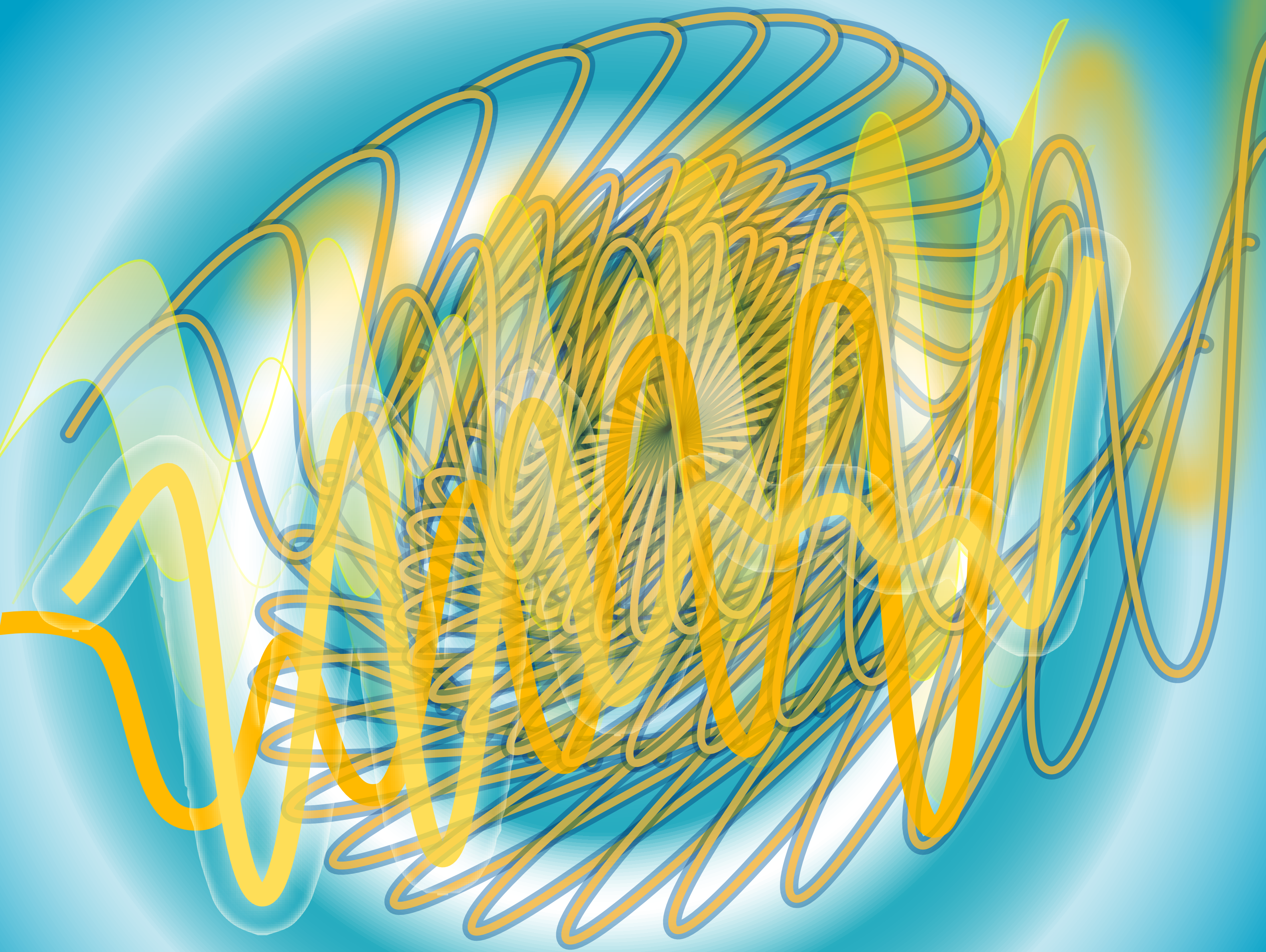

- *Anomalous wave solutions*
- *Designing idiophones*
- *Branched ducts*
- *Opinion evidence*

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Cover illustration: Heidi Hereth.

Message from the President

In my last message I spoke of the need to work smarter not harder. This includes the need to maintain our knowledge area. How many readers have undertaken professional development in the last twelve months? The society strives to provide opportunities in the forms of on-going seminars, technical meetings, workshops and conferences. Unfortunately, many members don't avail themselves of these opportunities.

Recently I was able to attend the 14th International Congress on Sound and Vibration in Cairns, a joint congress between the ICSV and the AAS. This congress provided a blend of international and national presenters in a large number of acoustic knowledge areas. The congress was successful and rewarding for those able to attend. Well done Nicole Kessissoglou and team for a huge effort.

The divisions are providing a number of events either recently or in the near future. For example, recently WA had a successful seminar on train noise and regulations and is planning a one day seminar and AGM, SA is hosting an Environmental Noise Symposium, NSW is planning an expert evidence workshop and AGM in November. Please check the society's web page at www.acoustics.asn.au for more details.

Common reasons for not attending are those of work pressure, looming deadlines, etc. Whilst these are real issues, working smarter not harder recognizes the need for keeping current, identifying new trends and opportunities and continuing education. Networking with others in the profession can have surprising benefits. Recently I was speaking with a colleague about the last seven years in which he had been on the divisional committee. Some of the non-tangible outcomes for this member were an increase in professional exposure both internationally and locally, building of international contacts in many related and non-related areas of acoustics, increasing their professional standing etc.

These outcomes were brought about partly by Society participation, firstly at divisional level and later federal level, participation in conferences both from the participant level and organizational levels. With the Annual General Meetings for the Divisions being organized about this time, members have the opportunity to look to the future and investigate whether they have anything to offer at divisional level. Fresh ideas and enthusiasm are commodities that committees welcome. Think about taking a more active role in the society – the benefits maybe surprising.

From the Editors

What's in Acoustics Australia? and whom do you blame if you don't like it?

The Sydney team has been running Acoustics Australia since the beginning of 2005. If you haven't noticed much change, we'd be happy, because one of our aims was to maintain the same style and standard as that of the Canberra team (Marion Burgess, Neville Fletcher and Joseph Lai). The continuity was aided by the fact that news editor, Marion, has served on both teams.

Over many of the journal's pages, the editors have only limited influence: which papers appear in the journal is determined largely by the authors who submit papers and by the reviewers who review them.

The largest of the inputs of the editors is the choice of topics for special issues. There have been two since 2005, for which guest editors Eric LePage (Mechanisms of Hearing Damage) and Colin Hansen (Active Noise Control) each solicited submissions and oversaw the review process.

For the other issues, papers are submitted, reviewed and published approximately in the order of arrival. The papers published from April 2005 to April 2007, inclusive, may be divided in broad areas as follows:

Active noise control	4
Architectural acoustics	2
Bioacoustics	1
General acoustics and measurement	1
Hearing aids, implants and protectors	4
Hearing mechanism and damage	8
Industrial vibration measurement and analysis	3
Music acoustics	3
Underwater acoustics	1
Vibration and radiated noise	2

Some of the areas in which Australia's acoustical research and technology are strong are well represented here, but others are less well represented. If, however, you find that there is a lacuna in your speciality, you are well placed to remedy it, either by submitting a paper yourself, by encouraging your colleagues to do so or by suggesting a special topic issue.

If you think that there have been too few Technical Notes recently, then your view is shared by the editors, and that scarcity can be solved in a similar way. Over the past two years, the number of Technical Notes submitted has been zero, while the Acoustics Forum pieces have continued at a typical rate. Pieces of both sort have a typical length of half a page (500 words) or so and are generally not formally reviewed. The current issue includes a rather longer Acoustics Forum article which, because of its length, was sent for formal review.

There is one more method whereby the editors can influence the balance of material in the journal: we can remind colleagues about Acoustics Australia and encourage submission of either full papers or Technical Notes. Which is what we are doing here. Information for authors is at www.acoustics.asn.au, and we remind potential authors in tertiary institutes that reviewed papers in Acoustics Australia are recognised by DEST. We hope to hear from you.

Marion Burgess, Emery Schubert, John Smith and Joe Wolfe

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ANOMALOUS SOLUTIONS TO SIMPLE WAVE EQUATIONS

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Australian National University, Canberra 0200

Abstract: Standard fourth and sixth-order differential wave equations for beams and for pairs of fluid-coupled plates are shown to give rise to apparently anomalous solutions describing waves that grow in amplitude in the direction of propagation and thus violate conservation of energy when the propagating medium is semi-infinite, despite the fact that the original equations conform to this principle. The second-order wave equation for a string does not have these problems, nor do they occur in the other cases if the propagating medium is finite in extent and has simple boundary conditions at both ends. This apparent paradox can be resolved by consideration of the group velocity, which is shown to be negative in the case of the anomalous waves, thus preventing them from propagating into the half-space of the medium.

INTRODUCTION

This paper explores briefly the anomalous solutions that arise in the case of waves propagating on semi-infinite beams and plates for which the wave equation is of order higher than two. It is found that, in addition to the "normal" waves generally treated, which are attenuated exponentially as they propagate, there are formal solutions that correspond to waves that grow in amplitude as they propagate and, in the case of a equations of order higher than four, also evanescent waves that are localized very close to the source. While some of these solutions can be eliminated by consideration of the boundary condition at infinity, it appears that in each case at least one such anomalous solution remains. It is the purpose of the present paper to propose a resolution of this paradox. Three simple cases will be considered, corresponding to equations of order two, four, and six respectively.

WAVES ON A STRING

In the case of an ideally flexible string, assumed to have tension T and mass m per unit length, the one-dimensional wave equation has the form

$$m\frac{\partial^2 z}{\partial t^2} + \beta\frac{\partial z}{\partial t} = T\frac{\partial^2 z}{\partial x^2}\,, \qquad (1)$$

where $\beta > 0$ is a damping coefficient. For the case to be considered here, we assume a semi-infinite string with $x \geq 0$ and a motion $z(0,t) = a\cos\omega t$ imposed at the point $x = 0$. Since a semi-infinite string is not physically realistic, this may be replaced by a very long string with a "radiation boundary condition" imposed at the far end. Such a boundary condition ensures that an incident wave continues to propagate past the end without reflection, and it is further appropriate to assume that there is no wave incident upon the string from beyond its far end.

To solve equation (1) it can be assumed that

$$z(x,t) = a\exp[i(kx - \omega t)],$$

where $\omega > 0$, the propagation constant k is a complex quantity, and the amplitude a is real, as required by the boundary condition at $x = 0$. The "physical" solution to the problem is then the real part of $z(x,t)$. Substituting (2) in (1) then gives the well-known formal result

$$k^2 = \frac{m\omega^2}{T} + i\frac{\beta\omega}{T} = \gamma\omega^2 + i\alpha\,, \qquad (3)$$

where, in the version to the right, we have written $\gamma = m/T$ and $\alpha = \beta\omega/T$ for simplicity. The wave speed in the absence of damping is $c = (T/m)^{1/2}$. In the presence of damping that is other than simply viscous, α may have a different dependence upon frequency, but this is irrelevant to the present discussion.

Since $\alpha > 0$, the position of k^2 on a complex plot is as shown qualitatively by the point O in Fig. 1(a). For clarity, a large value has been assumed for the damping constant α.

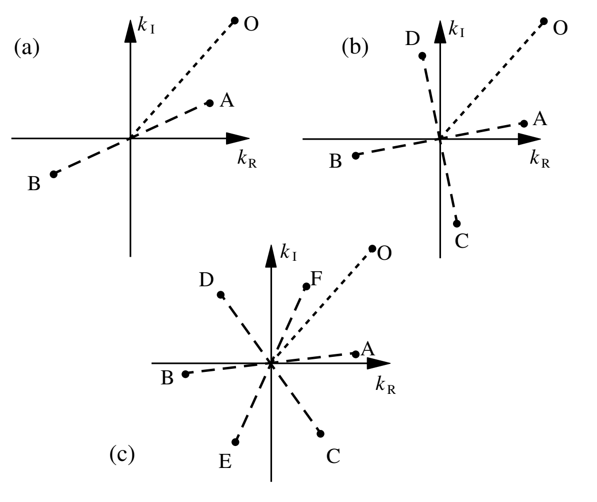

Figure 1: Solution diagram for (a) a taut string, (b) an ideally thin beam, and (c) a symmetric Lloyd-Redwood wave.

Taking the square root of this quantity to find the propagation vector k then leads to the two possibilities indicated qualitatively by the points A and B. These might be represented by the expression $a\exp(ik_Rx - k_Ix - i\omega t)$ where k_R and k_I are respectively the real and imaginary parts of k. Point A has k_R positive, so that the wave is propagating in the $+x$ direction and, since k_I is also positive, the wave is attenuated as it propagates. Similarly, the solution at point B represents a wave propagating in the $-x$ direction and again being attenuated as it propagates. In the domain $x \geq 0$ this second wave can be eliminated, since it must be an external influence that has entered the string through the radiation termination at its far end-point, and it has been assumed that there is no such influence.

All of this is perfectly straightforward and leads to no difficulties at all. It is only when more complex physical situations are considered that problems arise.

WAVES ON A BEAM

Consider next an ideally thin elastic beam under no tension, often referred to as an Euler-Bernoulli beam. The governing differential equation is then[1]

$$m\frac{\partial^2 z}{\partial t^2} + \beta\frac{\partial z}{\partial t} = -K\frac{\partial^4 z}{\partial x^4}\,, \qquad (4)$$

where K now measures the elastic stiffness of the beam. A very simple form has been assumed for the damping term, corresponding to damping by an external viscous fluid of negligible mass; internal damping in the beam would lead to a more complicated function. Assuming a solution of the form (2) then leads to the result

$$k^4 = \frac{m\omega^2}{K} + i\frac{\beta\omega}{K} = \gamma\omega^2 + i\alpha\,, \qquad (5)$$

where now $\gamma = m/K$ and $\alpha = \beta/K$. The resemblance between this equation and (3) should be noted. If damping is neglected by setting $\beta = 0$, then from (5) the wave speed is

$$c = \frac{\omega}{k} = \left(\frac{K}{m}\right)^{1/4}\omega^{1/2}\,, \qquad (6)$$

as is well known. The behavior of such beams has been discussed many times before, most recently by Pavić[2], but the anomalies to be discussed here have not been commented upon.

For the simple case of a finite beam with end conditions specifying both $z(0,t)$ and $\partial z(0,t)/\partial x$, (4) leads to an expression for $z(x,t)$ in terms of trigonometric and hyperbolic functions, and thence to specification of the vibrational mode frequencies. The problem arises only when a semi-infinite beam with $x \geq 0$, or a long beam with a radiation boundary condition at the remote end, is considered. The point O in Fig. 1(b) is the value of k^4 given by (5) plotted in the complex plane, and with again a large value of the damping parameter α for clarity. The points A, B, C, and D then represent the four values of k given by (5). Point A represents a wave propagating in the $+x$ direction and being progressively damped as it propagates, just as before, and point B represents a similar wave propagating in the $-x$ direction that can be eliminated by the boundary condition at the far end of the beam. The problem arises with the solutions at points C and D.

Consider point C, for which $k_R > 0$ and $k_I < 0$. This represents a wave propagating in the $+x$ direction but being amplified as it propagates. Similarly point D represents a wave propagating in the $-x$ direction and being amplified as it propagates. This second case, D, can be ruled out for the domain $x \geq 0$ by the boundary conditions at infinity, since it requires a non-zero amplitude of input wave in the $-x$ direction at the far end of the beam. But what about the wave at point C? It can be matched to the boundary conditions at $x = 0$, and does not violate the radiation condition at the distant end of the beam. It does, however, appear to violate the physical principle of conservation of energy, since a small wave input at $x = 0$ leads to an arbitrarily large input of energy to the radiation resistance at the remote termination of the beam.

SYMMETRIC LLOYD-REDWOOD WAVES

An even more complex situation arises in the propagation of mirror-symmetric waves on two thin plates separated by a layer of dense fluid.[3] These waves have generally been studied in an ultrasonics context, but have also recently received attention in relation to a possible "second-filter" mechanism in human hearing [4, 5]. The propagation speed of these waves can be extremely small if the plates are thin, because a small displacement of the plates towards each other results in a large "squirting" motion of the liquid enclosed between the plates. As has been shown elsewhere [3, 4], the propagation of these waves obeys a sixth-order differential equation so that, if simple damping is assumed, the propagation vector k is given in analogy with the previous results by an expression of the form

$$k^6 = \gamma\omega^2 + i\alpha\,, \qquad (7)$$

with $\alpha > 0$ and γ a positive constant depending upon the system parameters. Once again the resemblance of this equation to the string equation (3) and the beam equation (5) should be noted. In the absence of damping ($\alpha = 0$), the wave speed c is proportional to $\omega^{2/3}$. Equation (7) indicates that there are now six roots for the propagation vector k, and these are illustrated in Fig. 1(c).

The solutions at points A and B represent normal damped waves propagating in the $+x$ and $-x$ directions, as before. Points C and D similarly represent the anomalous waves associated with points with the same identifiers in Fig. 1(b). Points E and F represent a new phenomenon. Point F is a wave propagating in the $+x$ direction but with an extremely high damping, and similarly point E is a wave propagating in the $-x$ direction, again with very high damping. Solution E can once more be ruled out because it would require an input wave at the remote termination $x = \infty$, while solution F can be regarded as an "evanescent wave" which is confined to the immediate vicinity of the wave source at $x = 0$ and so presents no problems.

PARADOX RESOLUTION

While second-order wave equations display no anomalous features, wave equations of higher order give rise to at least two solutions C and D for waves that appear to grow in amplitude as they propagate. These are in addition to evanescent waves such as E and F that are localized near the wave source. In the case of a semi-infinite domain with $x \geq 0$, some of these waves can be ruled out since they require a finite incident wave from outside the system at $x = \infty$, but at least one such as C always remains, and this appears to violate the principle of conservation of energy despite the fact that the original differential equation is in each case based upon simple Newtonian principles.

The solution to this apparent paradox can be found by examining the group velocity $v = \partial\omega/\partial k$ in each case. Suppose that the solution to the general wave equation has the form

$$k^n = \gamma\omega^2 + i\alpha \quad (8)$$

where n is an even integer and α is a positive function of ω. Differentiating with respect to k gives the result

$$\frac{\partial\omega}{\partial k} = \frac{1}{2\gamma\omega}\left(nk^{n-1} - i\frac{\partial\alpha}{\partial k}\right). \quad (9)$$

Suppose that $k = k_R + ik_I$, then

$$k^{n-1} = k_R^{n-1} + i(n-1)k_R^{n-2}k_I - \frac{(n-1)(n-2)}{2}k_R^{n-3}k_I^2 + \ldots. \quad (10)$$

In the case of the anomalous solution for an elastic beam, $n = 4$ so that there are only three terms in the expansion. As shown in Fig. 1(b) for the anomalous solution point C, $|k_I| \gg |k_R|$ so that the third term in (10) is much larger than the first term and the real part of k^{n-1} is therefore negative. When the expression (10) is substituted in (9) the result is therefore that the group velocity for this wave is negative so that it effectively vanishes into the source at $x = 0$.

This result means that the envelope of the anomalous wave propagates in the $-x$ direction, so that a disturbance originating at $x = 0$ is unable to propagate into the domain $x \geq 0$ despite the fact that its phase velocity is positive. If there is a pre-existing wave of this type at time $t = 0$, then it will collapse towards the origin and deposit its energy there. This resolves the apparent anomaly and there is no violation of energy conservation.

The case of symmetric Lloyd-Redwood waves is mathematically more complicated, since now $n = 6$ so that there are three real terms to be considered in (10) and two anomalous waves in the total solution for $x \geq 0$. Resolution of the paradox in this case requires more detailed mathematical analysis, but it is almost certain that the answer is similar: point F corresponds to an evanescent wave localised near the wave source at $x = 0$ while point C describes a wave of which the envelope collapses into the source.

ACKNOWLEDGMENT

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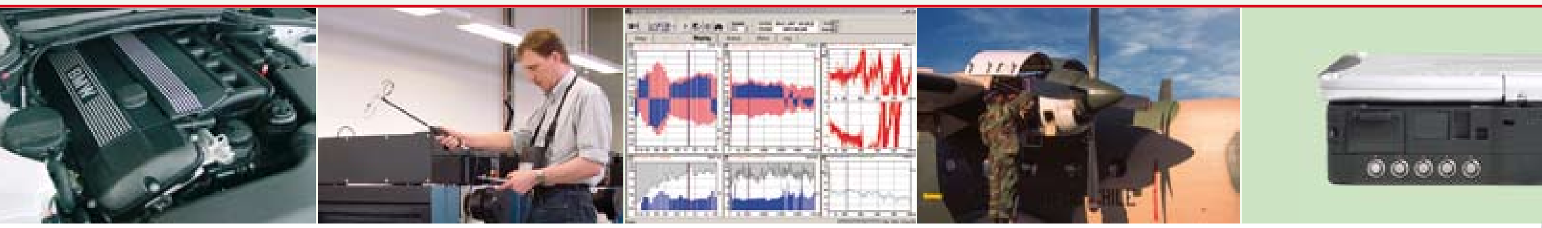

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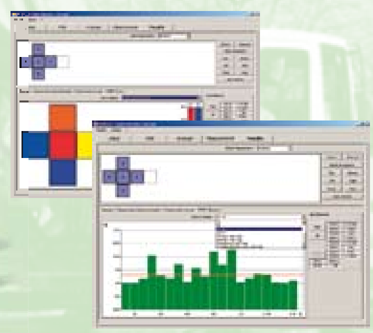

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DESIGNING IDIOPHONES WITH TUNED OVERTONES

K.A. Legge and J. Petrolito

La Trobe University, Australia

The design of a musical instrument is normally the preserve of the specialist instrument maker using empirical techniques developed over centuries. The analysis of instruments and the sounds they produce is undertaken by mathematicians and scientists. Recent advances in computational power and numerical techniques have provided the opportunity for analysis of physically complex vibrating structures.

Moreover, these same numerical techniques can also be used to design vibrating physical structures. In this paper, we consider the application of constrained optimisation to the design of tuned beams, plates and bells.

1 INTRODUCTION

Tuned idiophones (struck instruments) such as marimbas, chimes and bells have undergone centuries of development, resulting in complex profiles, bumps and grooves, the purpose of which is usually to optimise the sound of the strike. The maker seeks to produce an instrument that responds with sounds that are pleasing to the ear, and for the most part this means that normal modes of vibration are appropriately tuned.

Structural engineers also optimise physical structures, such as a building or a bridge, to improve the efficiency of the design. In this case, the optimal design is generally one that minimises cost or the amount of construction material used, and the technique employed is numerical optimisation. To the engineer, a musical instrument is a physical structure, and as such its design can be undertaken using numerical optimisation techniques. This paper illustrates the use of a particular numerical technique, constrained optimisation, for the design of tuned bars, plates and bells. In this paper, we limit ourselves to outlining the approach and discussing the results. A more detailed discussion of the technique has been given elsewhere [1, 2].

2 CONSTRAINED OPTIMISATION

Numerical techniques such as finite element analysis have been used quite extensively to determine the mode shapes arising in musical structures. Less common, however, is the use of numerical techniques in the design of a musical instrument or part thereof. Where numerical optimisation strategies have been adopted, the temptation has been to emulate the maker in the choice of optimising function, namely to optimise the frequencies of the modes [3-5]. Such an approach can leave the designer with the dilemma of determining how close to the desired frequency each mode should be and which mode is more important to get right. In this paper, we outline a different approach.

The design goal is to produce a structure that responds with specified frequencies for specified modes of vibration. Hence, the required frequencies are critical for this design problem and we require a solution strategy where the frequencies are constraints. A general technique that allows maximum freedom in defining the shape, whilst constraining the frequencies, is constrained optimisation. The constrained optimisation problem is uniquely specified by three things, namely, the geometry parameters, the optimisation function and the constraint functions, and different solutions may be obtained by varying any of these. This approach also allows us significant freedom in the choice of optimising function.

2.1 MATHEMATICAL MODELS

The analysis of the motion of any vibrating structure begins with the governing equations. These equations depend on the model adopted, and the first decision is therefore the choice of model to be used to describe the structure.

For example, the dominant response of a struck xylophone bar is transverse to its longitudinal axis, and the motion is therefore beam-like in nature. Hence, a suitable model is a one-dimensional model that can account for shear deformation [1]. However, when the profile of the bar entails sudden jumps in height, the one-dimensional model fails to accurately account for the complex stress system set up around the sharp corners. In this case, a two-dimensional model is more accurate [6]. Similar considerations apply to any musical structure. A plate can generally be satisfactorily modelled as a two-dimensional structure, so long as its thickness is small in comparison to a typical plan dimension [7]. A bell is a three-dimensional structure. However, provided that the thickness is not too large in comparison with the radius, it may be modelled as a two-dimensional surface with appropriate stiffness and mass characteristics [8].

Analytical solutions of the governing equations are generally not available, except in the case of very simple structures. The structures we shall be designing are not simple, particularly given that they involve varying cross-sectional properties. Numerical techniques are therefore required, and finite element analysis is chosen as the most appropriate technique. Finite element analysis converts the governing differential equations into a set of eigenvalue equations that can be solved to give the natural frequencies and mode shapes of the structure.

2.2 STRUCTURAL GEOMETRY

The goal is to design a structure that responds with specified frequencies, that is we seek to determine the geometry of the structure that will respond in a pre-determined manner. Hence, we must describe the geometry by a number of parameters, *hi*. These parameters are the primary unknowns for the problem and will be varied to produce the required outcome.

2.3 OPTIMISATION FUNCTION

Optimisation implies one is seeking the best solution. Our goal is to design a structure that responds with specified frequencies. It is therefore tempting to optimise the frequency of each critical mode. However, we prefer to obtain a solution where the frequencies are accurate, and we choose some other function to optimise. This approach leaves us with a wide range of possible optimising functions, including the possibility of having no optimizing function.

2.4 CONSTRAINTS

The constraint functions describe what must be obtained for an acceptable solution. Obvious constraints are those that retain the integrity of the structure. Idiophones for instance should not be so thin that they permanently distort or break when struck. In our approach, the required frequencies are critical to the design, and we therefore include them as constraints.

2.5 CONSTRAINED OPTIMISATION

Constrained optimisation involves solving the governing equations for the problem and minimising the optimisation function f(hi) whilst satisfying the constraint functions gj(hi). The approach can be written as

Minimise $f(hi)$ subject to $gj(hi) = 0$; $i = 1, 2 \ldots N$; $j = 1, 2 \ldots Nc$

where N is the number of variables and Nc is the number of constraints.

In our case, an optimisation procedure is used to determine the values of the parameters describing the geometry of the structure, such that the structure has the desired frequency characteristics and satisfies other specified criteria.

3 EXAMPLES

3.1 MARIMBAS AND XYLOPHONES

Marimbas are simple instruments consisting of an array of transverse beams or bars. Each bar sits on two supports placed at the nodes of its fundamental transverse mode. The bar is struck at its centre when played. Simple linear analysis shows that when a uniform beam is struck between its two supports the transverse modes generated are not harmonic. Hence, there is not a simple integer relationship between their frequencies. From a musical point of view, this non-harmonic response is not desirable. To tune the beam so that at least the three lowest modes are harmonically related, the instrument maker carves a parabolic arch cut on the underside.

Reduction in thickness at the centre of the bar's length results in a significant reduction in the stiffness of the bar and hence the fundamental frequency, and a lesser effect on the higher modes. Thus, the profile of the bar determines the relationship between the modes.

The exact dimensions of the undercut are an empirical design. There has been significant interest in determining the effect of the profile on the frequencies of the natural modes [9-12]. However, we turn the problem around and ask, what must the shape of the undercut be to produce a particular frequency regime?

3.1.1 Numerical solution

We begin by formulating the equations that governs the motion. A one-dimensional model that can account for shear deformation, such as Timoshenko's beam theory, is usually sufficient [1]. The problem is formulated in terms of the amplitudes of the displacement and rotation of the beam as it vibrates, and results in a fourth-order system of coupled ordinary differential equations.

In the case of a xylophone or marimba bar, it is the undercut that is used to tune the appropriate vibrational modes, so the primary unknowns are the heights of the bar at various locations. Hence, we define the height of the bar as a function of the position x along the length of the bar, *h(x)*, restrict the cut section to be between the two supports and choose a geometry with which to work. There are a wide range of geometries that can be adopted, and we previously considered three examples, namely piecewise-continuous heights, piecewise-linear heights and sinusoidal functions [2].

We begin with a solid bar with defined physical and geometrical parameters and request an undercut that will produce a particular fundamental and overtones in the ratio 1:4:10. Figure 1 illustrates three different solutions. The solution for case (a) was obtained by minimising the amount volume of material removed to produced the profile. However, this profile has sudden jumps in height, and the one-dimensional model is less accurate in this case [1]. The solutions for cases (b) and (c) were obtained by requesting smoother profiles. Case (b) was obtained by minimising the height differences between adjacent sections while case (c) used a smoother profile geometry, namely sine curves.

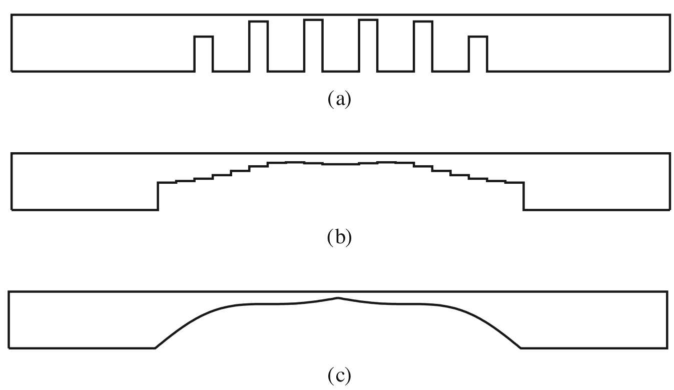

Figure 1: Profiles of xylophones (vertical scale distorted for clarity).

3.2 PLATES

Musical plates are somewhat rarer than the xylophone or marimba. Nevertheless, they are occasionally used as substitutes for bells [13, 14]. Simple linear theory again shows that the transverse modes generated on a flat rectangular or round plate are not generally harmonic [13]. However, a similar approach to that applied to the marimba bar can be used to design the plate.

If the plate is made to vary in thickness along its profile, then there should be some designs whereby the modes are harmonically related. Hence, we set ourselves the goal of designing a plate with a specified geometry, such as rectangular or circular, so that it responds with specified frequencies when struck in the transverse direction.

3.2.1 Numerical solution

While a plate is a three-dimensional structure, it may be accurately modelled as a two-dimensional structure if its thickness is small compared to a typical plan dimension. Several plate theories are available depending on the assumptions made [15]. We have adopted Mindlin's theory [16] as the underlying theoretical model. This theory is applicable to both thin and moderately thick plates. As an example, we consider an initially flat circular plate with a central hole. The plate is divided into eight concentric rings and the task is to vary the thickness of each ring until the first three distinct natural modes are in the ratio 2:3:4. Figure 2 illustrates two possible profiles. The solution for case (a) was obtained by having no optimising function whereas the solution for case (b) was obtained by requesting a smooth profile.

Figure 2: Profiles of circular plates with central hole (vertical scale distorted for clarity).

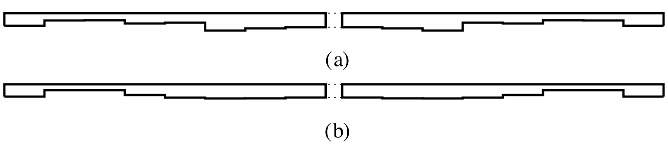

Figure 2: Profiles of circular plates with central hole (vertical scale distorted for clarity).

3.3 BELLS

The sound produced by a large church or carillon bell is the result of the vibrational modes of a particular profile, the decay rates of the natural modes and the sound perceived by the listener [5]. In this paper, we will look only at the design of the bell profile such that important modes are in tune.

Since the 1600s, western church bells have been manufactured to exhibit a clear, recognisable pitch through the design of a bell profile. The five important modes for a tuned bell are generally considered to be the first five extensional modes. These modes are labelled Hum, Prime, Tierce, Quint and Nominal, and are generally tuned so that their frequencies are in the ratio 1:2:2.4:3:4 [13]. Thus, we set ourselves the problem of determining a suitable profile for a bell such that the five lowest modes are tuned according to the ratios above. As with the bar and the plate, the constraints are simply the desired frequencies of these five lowest modes of vibration, together with the usual structural integrity issues. However, in this case an added constraint can arise from the construction technique for a large bell, namely that the bell should be readily removable from its mould after casting.

3.3.1 Numerical Solution

There are various options for describing the profile of the bell. The simplest option is to describe the profile using piecewise-linear variations for the radii, coupled with piecewise-constant variations of thickness. Smoother profiles can be obtained by using higher-order polynomial functions for the variables. For the purpose of this paper, we have limited ourselves to the first option.

We began with a truncated cone with geometry crudely following a standard bell described by Lehr [17]. The structure is then divided into sixteen concentric truncated conical rings and capped with a nearly horizontal piece. The task is then to vary the radius and thickness of each ring until the desired frequencies regime is obtained. Figure 3 depicts two possible profiles. The first was obtained with a zero optimising function and the second included the construction constraint of no reversed radii, thus allowing easy removal from its mould after casting. In both cases, the thickness of each ring also varies, although this is not shown in the Figure.

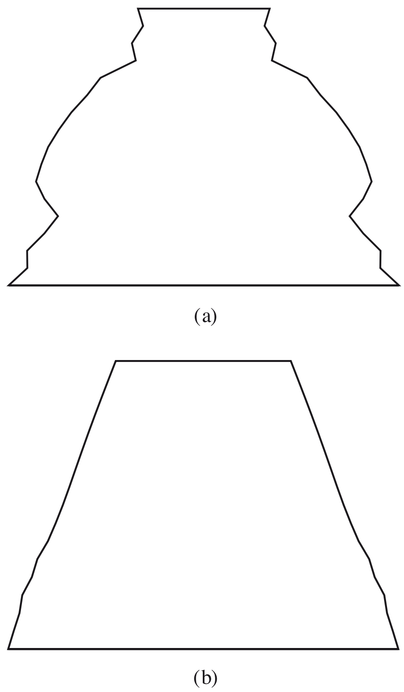

Figure 3: Profiles of bells.

4 CONCLUSIONS

The optimisation of any musical instrument is usually the task of the maker. The design generally follows empirical techniques that attempt to optimise the tuning of the natural modes of the instrument. In this paper, we have outlined a mathematical approach to design that constrains the design to the required frequency regime and allows other parameters to be optimised. The technique is limited only by the adequacy of the model used to describe the structure and the ability to describe the constraint and optimising functions mathematically.

5 ACKNOWLEDGEMENT

The authors are indebted to Harvey Bagot of Bagot's Bellfoundry for his time and patience in describing the intricacies involved in bell design, manufacturing and tuning.

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BRANCHED DUCTS AND THE DIDJERIDUO

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ABSTRACT. Branched ducts can produce a range of resonances and antiresonances, which may be varied by changing the termination condition. One example of the use of such branching is the forked didjeridu or didjeriduo, an unusual instrument occasionally made when a forked section of a tree is suitably eaten by termites. A single player may select the mouthpiece, then produce changes in pitch and timbre, either by adjusting lip tension to select different bore resonances, or by using the heel of his hand to close the other mouthpiece. It is even possible for two players to play the same instrument simultaneously. Here we present detailed measurements of the acoustic input impedance of a forked didjeridu and employ numerical modelling to explain the major features. The modelling gives insights into the behaviour of branched ducts in general.

1. INTRODUCTION

The didjeridu (or didgeridoo) is a musical instrument originally developed by the indigenous peoples of Northern Australia, where its tribal names include the yidaki, yiragi and mago. It is basically a wooden tube with a central bore that is largely produced by termites eating out the interior of small eucalypt trees [1]. The instrument usually plays only a single note at a frequency close to the lowest resonance, although overblowing at the second (and occasionally third) resonance is used for a musical accent [2-4]. The musical interest comes from striking variations in timbre, including the rhythmic contrasts between the sounds produced during inhalation (during which air from the cheeks is expelled into the instrument) and exhalation: a technique called 'circular breathing' that allows continuous sound.

Unlike other wind instruments, the didjeridu bore lacks a significant restriction at the mouthpiece and consequently an unusually strong coupling can exist between the waves in the bore and the player's vocal tract. This allows a skilled player to modify the spectral envelope of the output sound by varying the resonances of his vocal tract [5-7]. The central bore is highly irregular and somewhat flared, both of which features are important to the performance quality of the instrument [8].

Occasionally, a forked section of a tree is suitably eaten by termites. This allows the manufacture of a 'forked didjeridu' or 'didjeriduo' with a branched bore and two available mouthpieces as shown in Fig. 1. This can be played normally by a single player with the other mouthpiece left open, or closed with the heel of his hand to produce changes in pitch and timbre.

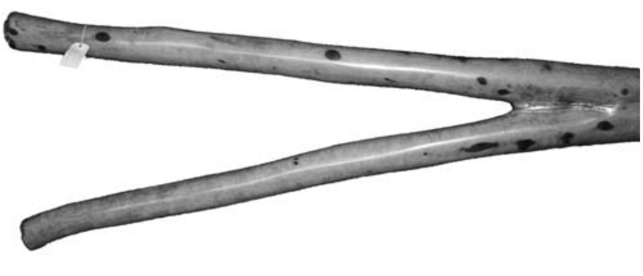

Figure 1. The forked didjeridu measured in this study. Tube A is at the top and has an identifying label attached.

The second branch, whether open or closed, adds new resonances which have musical implications: adding one or more extra resonance(s) in the lowest range may give the instrument two or three pedal notes, instead of one. Extra resonances or antiresonances in the higher range, especially in the range 1-2 kHz, can influence the musical performance in a subtle but more important way. It is in this range that the variable, strong formants or enhanced frequency bands are produced by the variations in the player's vocal tract. We have recently shown that properties of the instrument's resonances in this frequency range are among the most important determinants of the perceived quality of an instrument [8].

Some forked dijeridus may be played simultaneously by two players – for novelty value rather than intrinsic musical interest. Generally this requires that the two bores are joined in the output half of the instrument. If the bores are joined too close to the mouthpieces, it can be difficult for each player to maintain stable lip vibration whilst the bore immediately outside his lips is pressurised by the other player.

In this paper, we present detailed measurements of the acoustic input impedance of a forked didjeridu and demonstrate that numerical modelling can explain the major features.

2. MATERIALS AND METHODS

The instrument used was made available from the collection of the Didjshop (www.didjshop.com). The input impedance Z_{IN}, i.e. the impedance at each mouthpiece, was measured as a function of frequency f for each instrument as described in detail elsewhere [8,9]. The overall quality of this instrument was assessed by 6 players giving an average score of 6.1/10 (see [8] for more details, including the relation between subjective quality and physical properties of an instrument). This assessment might have been influenced by the higher sound level at the player's ear when the second tube was open.

3. NUMERICAL MODELLING

A simple one–dimensional model composed of three cylindrical elements was used (see Fig. 2). The bore of an instrument made by termites in the traditional manner is, of course, very much more complicated. The various impedances were calculated in the standard manner (e.g. see [10]). Radiation impedances were included when appropriate. The values used to approximate the dimensions for this forked didjeridu were; $L_A = 0.93$ m, $L_B = 0.88$ m, $L_C = 0.17$ m, $d_A = d_B = 0.025$ m, $d_C = 0.05$ m.

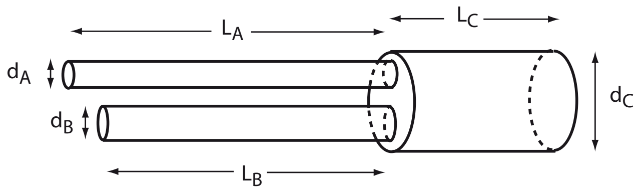

Figure 2. Schematic diagram used for the numerical model of the forked didjeridu measured in this study. Although the diameter d_C is greater than $d_A + d_B$ in this sketch, this is not necessarily true in the model.

4. RESULTS AND DISCUSSION

Acoustic impedance spectra.

The acoustic impedance spectra, $Z_{IN}(f)$ are shown in Fig. 3, measured for the four possible playing configurations (A or B used as mouthpiece, and in each case with the other port closed or open). As might be expected, the impedance spectra are rather more complicated than those of simple didjeridus [8]. We consider the low frequency behaviour first.

All four configurations display the strong fundamental resonance of frequency f_1 required to set up a stable, low frequency oscillation in conjunction with the lips (see Fig. 4 with an expanded scale at low frequencies). However, an interesting feature is a splitting of each of the low frequency maxima into a doublet when the other mouthpiece is closed. Figure 4 indicates it is possible to play notes corresponding to each of these adjacent maxima, but we found the lower frequency note to be stronger and easier to play. In each of the four possible configurations, it was possible to play the higher resonance at frequency f_2, where the ratio $2.83 < f_2/f_1 < 2.93$.

We now turn to the critical range 1-2 kHz. In this range, the resonances of a skilled player's vocal tract can attenuate the radiated power over certain frequency ranges. The remaining frequency bands or formants give the instrument characteristic timbres, and it is the variation of these formants over time that is one of the most important elements of idiomatic performance.

The resonances of the tract give rise to peaks in acoustical impedance that are typically one to several MPa s m^{-3} [5,6]. In another study [8], we showed that the most important single determinant of the subjective judgment of instrument quality was the value of Z_{IN} in the frequency range 1 to 2 kHz, with low maximum values associated with high quality instruments. This is readily understood: if the instrument's resonances in this frequency range are too strong, the player is less able to manipulate the spectral envelope with his own resonances.

This instrument could be blown at either tube A or tube B, but tube A was chosen by the Didjshop as the normal mouthpiece. Figure 3 shows that tube A has the lowest values of Z_{IN} in the frequency range 1 to 2 kHz, particularly when the other tube is open (tube A blown and tube B open). When tube B is closed (tube A blown and tube B closed), there is an increase in the maxima in the 1 to 2 kHz frequency range. This would be expected to alter the timbre of the sound, and to reduce the influence of the player's vocal tract. A similar increase of Z_{IN} is apparent when tube B is blown and tube A is changed from open to closed.

Inspection of these curves suggests that the low value of Z_{IN} in Fig. 3 for tubes A and B open is due to cancellation of standing waves. Could the open second branch thereby be turning a mediocre instrument into one of higher quality? To consider this possibility, we conducted some numerical modelling.

Numerical modelling

The model used in Fig. 2 very substantially underestimates the complex bore of a traditional instrument. However, it explains qualitatively the $Z_{IN}(f)$ of this didjeridu, and some features of branched ducts in general.

We start by defining $Z_D(f)$ as the input impedance for tube A if the extra tube (in this case tube B) were absent or blocked off at the junction. This configuration would correspond approximately to a conventional didjeridu.

When tube B is present, it introduces an additional impedance Z_B in parallel with Z_C, the impedance of tube C from the junction to the external radiation field. We define Z_P as the parallel combination of Z_B in parallel with Z_C. The impedance Z_C is less than Z_B at low frequencies and, because ducts in parallel add admittances rather than impedances, the only features of tube B that will appear in Z_P correspond to the minima in Z_B (see Fig. 5). The effect of these minima is to produce additional, small maxima in Z_{IN}.

If the end of tube B is open, Z_B will be roughly similar to Z_D, providing that L_B is not too different from $L_A + L_C$, and consequently their minima will occur at similar frequencies. These minima in Z_B will produce minima in Z_P that in turn produce maxima in Z_{IN} around the frequencies where minima would occur in the absence of tube B.

Figure 5 shows that, if the end of tube B is closed, Z_B is almost the inverse of Z_B when open (it is not exactly the inverse because there is also a radiation impedance present when the tube is open). In this case, minima in Z_B occur at frequencies that correspond approximately to the maxima in Z_D. They will thus produce minima in Z_P that in turn produce maxima in Z_{IN} around the frequencies where maxima would occur in the absence of tube B. This will effectively produce notches in the maxima of Z_D producing the pairs of adjacent maxima.

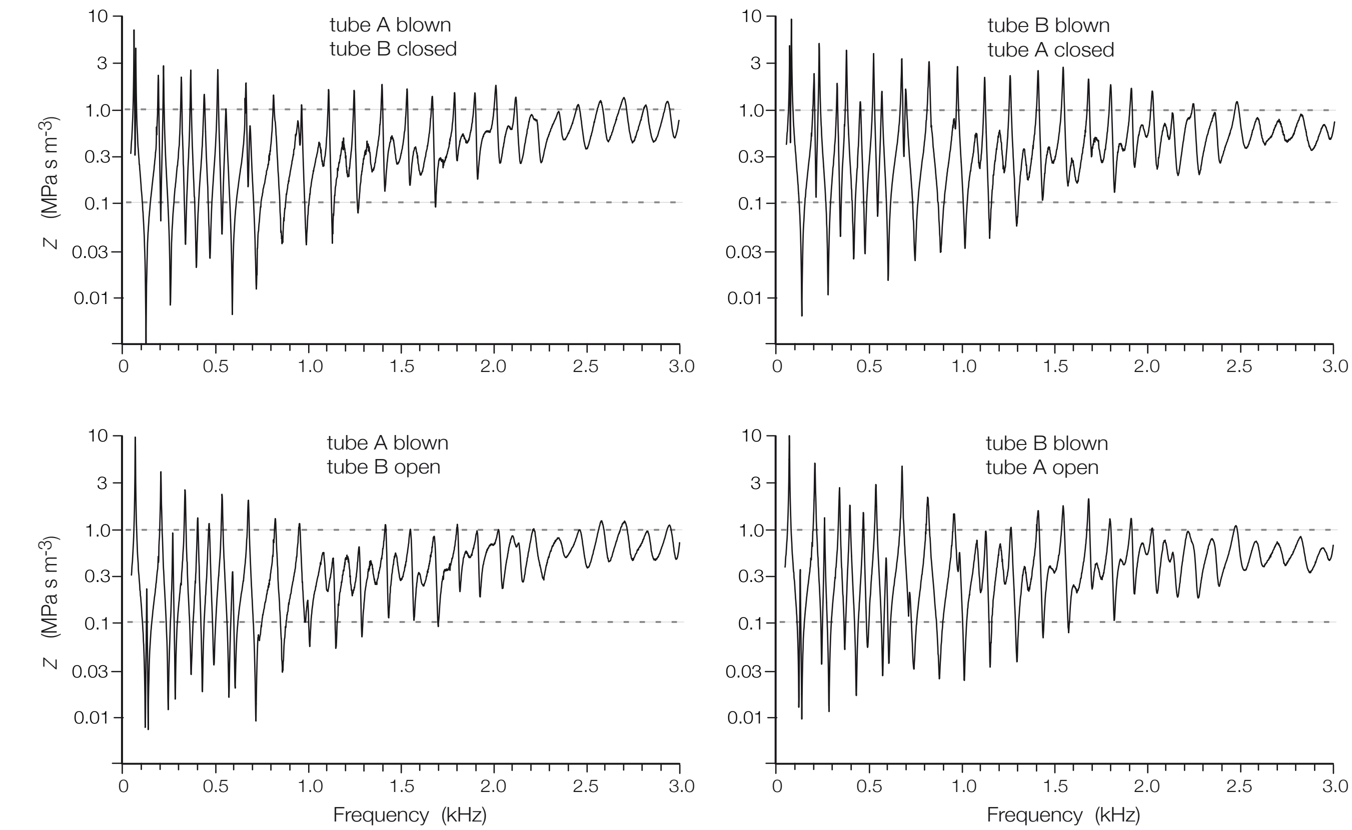

Figure 3. The measured acoustic input impedance Z_{IN} as a function of frequency plotted on a semi-logarithmic scale for the 4 possible input configurations of the forked didjeridu shown in Fig. 1.

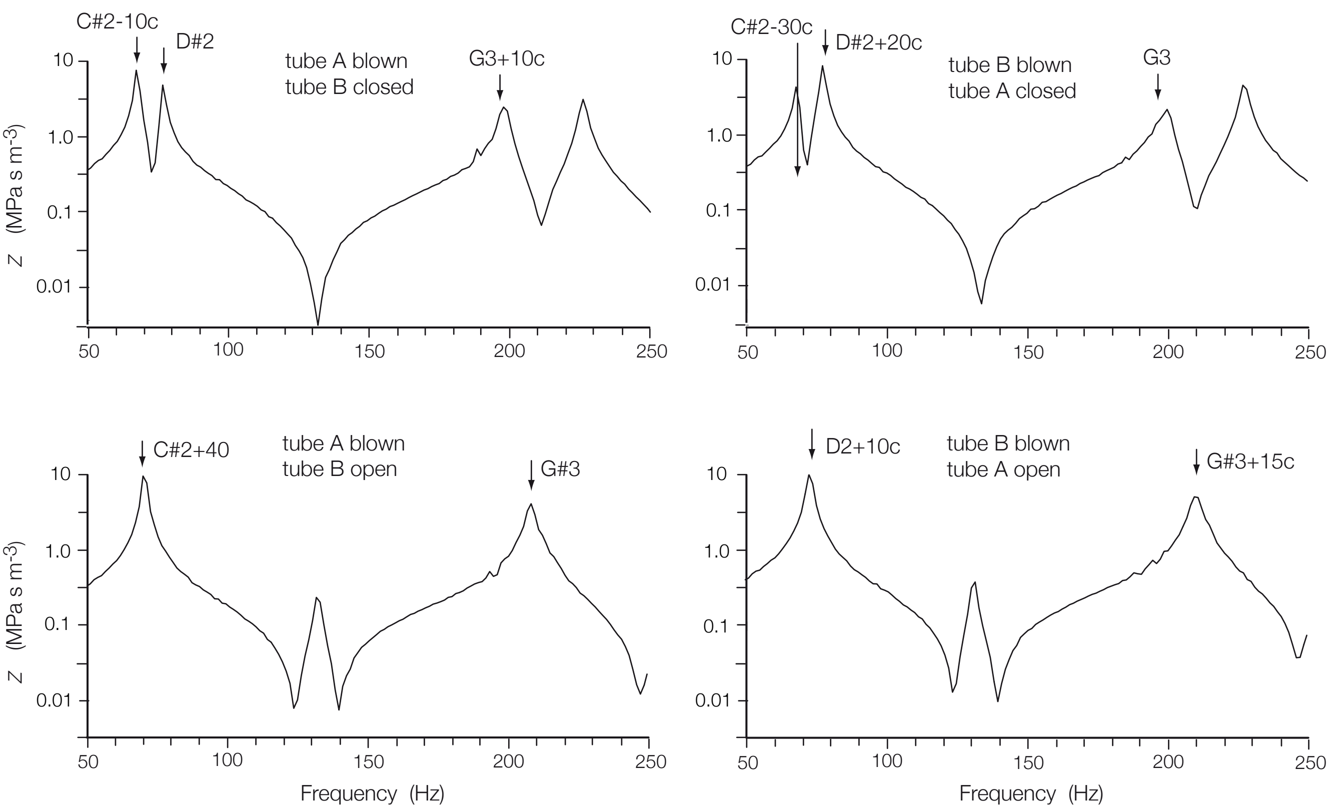

Figure 4. The measured acoustic impedance spectral data of Fig. 3 shown on an expanded scale for low frequencies. The vertical arrows indicate the frequencies of the musical notes played on the instrument by one of the investigators.

The frequency dependence of Z_{IN} is a complicated function of the exact geometry of the forked didjeridu, particularly at high frequencies. This is because the frequency dependent load produced by tube B will have a greater effect, at a given frequency, when there is a pressure maximum at the junction, and this will depend upon the location of the junction. It is thus possible that, under some circumstances, the addition of a parallel duct could reduce the magnitude of several sequential impedance peaks.

The sound produced by two players.

To a first approximation, a duct closed by a player's lips behaves acoustically like a closed end. So Fig. 4 shows that the impedance peaks available for playing regimes are somewhat similar for the two players.

A notable feature of the sound produced the didjeridu is the very wide range of heterodyne components produced when a single player vocalises during playing. Thus if the didjeridu plays a note at frequency f while the player vocalises at a frequency g, the non linearities present can produce frequency components at frequencies given by $nf \pm mg$, where m and n are integers, e.g. see Fig 11 of Tarnopolsky *et al*., 2006 [6]. Even without vocalisation, two players using pairs of the impedance peaks shown in Fig. 4 can produce similar sets of heterodyne components. Two of the investigators found this possible, but somewhat difficult to control. The possible frequency components if two players play and vocalise simultaneously at four different frequencies are bewildering.

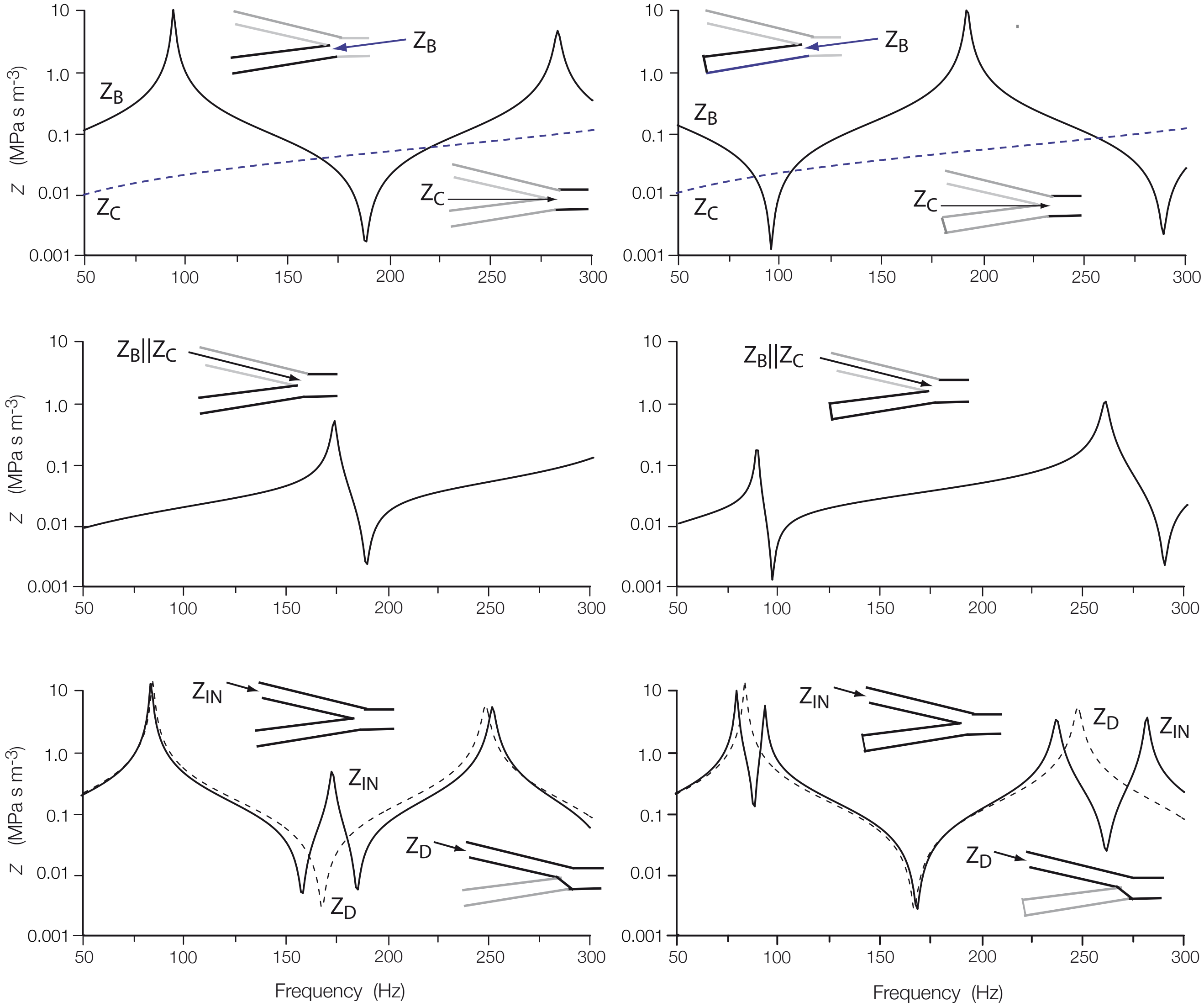

Figure 5. The calculated acoustic impedance of elements of the model shown in Fig. 2. The left and right hand curves were calculated with the end of tube B open or closed respectively. The continuous curves on the upper figures show the impedance Z_B of tube B alone as seen from the junction, whereas the dashed curves show the impedance Z_C of tube C alone as seen from the junction. The middle figures show the impedance Z_P presented at the junction by tube B and tube C in parallel. The lower curves show the input impedance Z_{IN} of the instrument when played at tube A. The dashed line on the lower curves shows the input impedance Z_D if tube B were blocked off at the junction.

5. CONCLUSIONS

The additional mouthpiece on a forked didjeridu can allow a player to produce changes in pitch and timbre by using the heel of his hand to close it. These effects can be explained by the use of a simple numerical model. Under propitious conditions, the extra tube may improve the playing qualities, which suggests the possibility of 'tuning' the length of one side tube to improve the quality of an instrument.

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This is a modified version of a paper that originally appeared in the Proceedings of the 14th International Congress on Sound and Vibration edited by Bob Randall.

Acoustic Opinion

A DISCUSSION ON OPINION EVIDENCE FOR PRACTITIONERS

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This paper discusses expert opinion in dispute resolution and comments on procedures in the Commonwealth and in New South Wales. It briefly reviews science, opinion evidence and admissibility and some differences between science and law.

INTRODUCTION

Litigation can occur where negotiation, mediation or arbitration have failed to resolve a dispute. In the acoustics discipline disputes can arise about compliance with statutes, codes and by-laws in matters including property development, noise levels, noise annoyance, hearing conservation and hearing damage, acoustic measurements, and auditory discrimination. Professionals may include those who practise basic science, applied sciences in medicine, engineering, psychology, and technical disciplines.

The breadth of opinion evidence is covered in detail in the CCH Subscription Service for Expert Evidence [1]. Of particular interest to acousticians in this series is Chapter 114 on noise analysis by Barry Murray. This presentation to assist advocates and litigators includes fundamentals and definitions about sound and noise, measurement and physical characteristics. It describes environmental noise that includes construction, transportation and rural sources, with assessment and calculation procedures, and it includes reference to current Australian standards, as well as some state legislation.

Duly qualified experts are retained by lawyers for the parties to litigation and/or court appointed as required. The opinions presented in direct examination are subject to cross examination by the lawyer for the opposing party. For the Commonwealth and New South Wales, experts must have relevant specialised knowledge based on training, study or experience or a combination of all, and their evidence must be wholly or substantially based on that specialised knowledge (S.79 Uniform Evidence Act, Commonwealth & NSW 1995 [2]).

New rules for expert evidence and expert witnesses, detailed in Uniform Civil Procedure Rules (Amendment No.12), 2006 under the Civil Procedure Act, 2005 (NSW) were introduced 4 December 2006. These rules have broadened regulation controls for expert evidence, and include a new code of conduct for expert witnesses.

SCIENCE, OPINION EVIDENCE AND ADMISSIBILITY

A qualifier of “scientific” in not included in S.79 [2], but is implied under the term “specialised knowledge”. It is significant that Mason [3] indicated that “specialised knowledge” should be identified with precision and must have “scientific rigour” [4]. It is reasonable to conclude that “scientific rigour” implies “scientific method”, described by the American Association for the Advancement of Science in its Amici Curiae Brief to Daubert [5a], viz “ A new theory or explanation must generally survive a period of testing, review, and refinement before achieving scientific acceptance. This process does not reflect the scientific method, it is the scientific method” [5b].

Additionally, “scientific” implies grounding in methods and procedures of science, more than belief or unsupported speculation. Indeed measurement is the basic tool in the application of scientific method. The concept of scientific method and admissibility of scientific evidence is embraced thus:

“Just when a scientific principle or discovery crosses the line between experimental and demonstrable stages is difficult to define. Somewhere in the twilight zone the evidential force of the principle must be recognised, and while the courts will go a long way in admitting expert testimony deduced from a well-recognised scientific principle or discovery the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs”. Frye v. United States [6].

This opinion recognises scientific principles, and its genius is to distinguish between the experimental (novel) stage of a theory or technique and the “demonstrative stage” where it will receive judicial recognition. It has been referred to with approval in Australian superior court cases, for example [7]. But the ‘general acceptance’ or field of expertise test is replaced by wide discretion of the courts to accept or reject evidence, whence the test under S.79 appears more liberal then the Frye test.

The Frye opinion dominated the admissibility of scientific evidence in the United States from 1923 until 1993 with the US Supreme Court judgement in the case Daubert, based on the US Federal Rule of Evidence 702 [8]. Daubert introduced a check list, meant to be helpful, not definitive, to provide a procedure to evaluate scientific evidence, viz: One, has the theory or technique been tested?; two, has it been subjected to peer review?; three, has the technique a potential rate of error?; and four, whether the theory or technique enjoy "general acceptance' within the relevant scientific community?

Even though Daubert is American case law, the opinion was significantly endorsed in two Canadian and two New Zealand cases, not cited. Indeed the Daubert opinion was an innovative step to equal the genius of Frye, in that it provides a pragmatic framework to establish validity and reliability in science, applied science and other specialised knowledge as judges exercise their gate-keeping responsibility. In contrast, for acoustics and engineering, Daubert type tests may be adequate for falsifiability, problems may be encountered in the 'soft' or social and behavioural sciences, where say Freudian theory is applied to disputes in psychology or psychiatry, and reliability is difficult to establish [9].

SCIENCE AND LAW

Briefly, in basic science, discrete variables and data are objectively quantified, analysed and directed to repeated demonstrability and predictions, not always successfully. Thus clear cut answers may sometimes not be possible from an evolving and collective process that results from the work of many scientists. Nevertheless aspects of applied science can be supported with degrees of certainty using demonstrability, probability or other evidence that establishes validity and reliability. However, courts seek to resolve disputes using the rules of evidence, which are designed for that purpose, and not to seek cosmic understanding [5a, p.597]. Indeed the gaps between science and law are a balance achieved within the discretion of the court system. Additionally, it is well recognised that bad science and junk science may be presented by expert witnesses, but shaky evidence is expected to be successfully rejected by vigorous cross-examination.

In conclusion, the great jurist, Oliver Wendell Holmes is reported as saying "Certitude is not the test of certainty. We have been cocksure of many things that were not so", [10]. "The best test of certainty we have is good science, the science of publication, replication and verification, the science of consensus and peer review." [11].

Acknowledgment:

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1. CCH Subscription Service for Expert Evidence (Freckelton & Selby)
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5a. Daubert v. Dow Pharmaceuticals Inc., 509 U.S. 579 (1993)

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6. Frye v. United States. 293 F2d 1013 at 1014 (1923)
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8. United States Federal Rules of Evidence, Rule 702: Testimony by Experts: "If scientific, technical, or other specialised knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case".
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10. Schlesinger. (1989) "The Opening of the American Mind" New York Times, July 23.
11. Huber, Peter W. (1993) "Galileo's Revenge: Junk Science in the Courtroom". BasicBooks, p.228.

Sustaining Members

The following are Sustaining Members of the Australian Acoustical Society. Full contact details are available from http://www.acoustics.asn.au/sql/sustaining.php

3M AUSTRALIA

ACOUSTIC RESEARCH LABORATORIES

ACRAN

ACU-VIB ELECTRONICS

ADAMSSON ENGINEERING

ASS'N OF AUSTRALIAN ACOUSTICAL CONSULTANTS

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NSW DEPT OF ENVIRONMENT & CONSERVATION

PEACE ENGINEERING

PYROTEK SOUNDGUARD

SINCLAIR KNIGHT MERZ

SOUND CONTROL

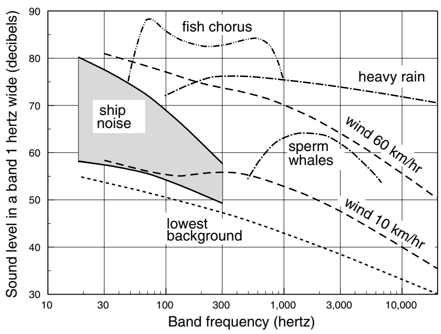
SOUND SCIENCE

VIPAC ENGINEERS AND SCIENTISTS

News

Sounding out the Secrets of the Sea

Among its other roles, the Australian Academy of Science has a strong interest in presenting science to the community, and particularly to young people. One of its most successful projects has been the web site "NOVA: Science in the News", which is one of Google's top addresses with 2.8 million "hits" in the past 12 months. The site currently has 98 different topics displayed, almost all of them sponsored by an organisation with special interest in that particular subject. Just launched has been a new topic "Sounding out the Secrets of the Sea" sponsored by the Australian Acoustical Society, this topic being seen as increasingly important because of questions about the potential impact of undersea sonar and other noise sources on marine life. The topic was developed with assistance from Neville Fletcher and Doug Cato and is well worth a look, which you can do by going to the website www.science.org.au/nova . Reproduced below is a figure from the topic giving a summary of typical noise levels in oceans around Australia. The site also contains links to related sites around the world, a glossary of relevant acoustic terms, suggested activities, and many other things. There are two other acoustics topics on the NOVA site, one on cochlear implants and one on noise pollution, and it is worthwhile scanning through the topic list to find interesting information on a host of other subjects.



This diagram was reproduced with the permission of the Australian Academy of Science.

Deep Purple in space

Pop supergroup Deep Purple were responsible for perhaps the second most notorious guitar riff in popular music in Smoke on the Water. (The most notorious riff undoubtedly appeared in Led Zeppelin's Stairway to Heaven).

Recently Andi Petculescu (University of Louisiana –Lafayette) and Richard Lueptow of (Northwestern University – Evanston) have developed a physical model that predicts the acoustic properties of gas mixtures that depend on the composition of the gas as well as its pressure, density and temperature. This was then been used to model the acoustic propagation at any altitude for Titan, Mars, Venus and the Earth. The plots of attenuation vs. frequency show how the four planetary environments will act as acoustic filters with different characteristics. To illustrate how this affects sound waves, Petculescu and Lueptow played the opening bars of Deep Purple's classic track through filters with the appropriate frequency responses. Their results were presented at the Acoustical Society of America's June 2007 meeting in Salt Lake City, Utah.

Readers with an interest in acoustics, astronomy and heavy metal should direct their browser to www.acoustics.org/press/153rd/petculescu.html for full details.

Their audio sample shows the effect of the 'Earth filter', the'Titan filter'and the 'Venus filter'. The very thin atmosphere on Mars produced a filter with very strong attenuation and thus not included.

Physician heal thyself

Pyrotek's Soundguard division report using their own product to remove the excessive reverberation that occurred inside their own laboratory as a consequence of all walls having hard surfaces. Their solution involved simply making and mounting three large and three small sound absorptive panels on the walls made from 25 mm thick Sorbertex 3D Ultrasorb that covered only 10 per cent of the total interior surface area. Measurements with white noise indicated a reduction in the A weighted sound level by 5 dB when the panels were mounted.

A different successful project involved soundproofing a meeting room adjacent to a massive array of servers at the Andrews Corporation R&D facility in Wollongong. The installation of appropriate materials reduced the A weighted server noise from 65 dB to 53 dB.

For more details see

http://www.infolink.com.au/articles/B5/0C045BB5.aspx

FASTS

Science lags national investment in R&D

On 18 June FASTS released a paper on the changing profile of expenditure on R&D in Australia between 1996/7 and 2004/5 called Is this what you had in mind? Science and the changing profile of Australian R&D expenditure.

It shows that university expenditure on R&D was increased by 82% in cultural studies and 72% in tourism between 2000 and 2004, but the increases in physics and mathematics were only 17%. Indeed mechanical and industrial engineering suffered a decrease of 16%.

The key findings include;

- The natural sciences were the only field of research to decline as a share of GDP in this period;
- In real terms, science increased by 13.5% but lagged medical research (81%) and the humanities, arts and social sciences (50%).
- Mathematics, physics and chemistry, the key enabling sciences, only increased by 8%, well behind the overall average of 42% and
- Public sector funding of R&D in science, IT, computing, engineering and technology all declined as a share of GDP

The President of FASTS, Professor Tom Spurling said the decline in science was surprising given the policy focus on science and innovation over the past decade.

"Increased expenditure in health and medical research is well justified and popular". The critical point is that structural change in Australian research has created a raft of intended and unintended consequences that need close analysis. Irrespective of how the shift from science is interpreted, it is a good idea that there is informed debate over what social, environmental and economic outcomes we want from R&D as a way of guiding appropriate distribution of expenditure. Some of the trends highlighted in the report will surprise researchers and policy makers and we hope it will contribute to constructive discussion about the structure and direction of Australian R&D", concluded Professor Spurling.

Preparedness

The Productivity Commission report on science and innovation recognised the critical role of 'preparedness' as a public policy goal to minimise risk, to develop options for future action and to build capacity to meet future contingencies. But the next step is to ensure 'preparedness' is not simply a rhetorical construct but is evaluated and operationalised. FASTS have released a brief discussion paper as a preliminary contribution on evaluating preparedness.

There are a number of compelling reasons for the public sector to devote resources to science and innovation and there will always be a debate about whether it is enough. Research and development generates large spillovers or benefits to the rest of society. Those spillovers are traditionally an important rationale for the public support for research and development. But science and innovation are an essential part of society in other fundamental respects.

FASTS believes that support for research and development needs to include the concept of "preparedness" as a distinct class of outcome. The Productivity Commission (PC) has accepted "preparedness" as an important rationale for the public support of science and innovation. Indeed, the PC expanded the definition of "innovation" to include preparedness, which it defined as "an enhanced capacity for dealing with future uncertainties". The use of the concept of "preparedness" as a public policy goal is illustrated in the issue of support for the environmental sciences. Here the PC said:

> *There are ... strong arguments on the grounds of increasing preparedness to continue to make substantial investments across a wide diversity of environmental concerns, especially given Australia's unique ecosystems; the particular concerns about water scarcity and climate change risks; and one of the largest marine assets per capita in the world.*

FASTS wants to develop the concept of "preparedness" as something more than rhetorical flourish. Preparedness is a useful goal of science and innovation policy and the concept needs to be operationalised. Preparedness as a public policy goal is associated with the value of risk minimisation, developing options for future action and, critically, building the capacity to meet future contingencies. Most people value R&D expenditures that minimise risks in climate change, energy futures, water management and public health. These aim to produce precisely the sort of outcomes that are expected from research funded by taxpayers.

More details at http://www.fasts.org/images//preparedness%20brochure.pdf

Government support for industry R&D

The Industry Statement on Global Integration announced on 10 July includes some important initiatives including changing the tax concession rules so that the 'beneficial ownership test' will be changed to allow multinationals to claim the 175% tax concession. This is expected to increase Business investment in R&D by $1b and will affect 300 companies. FASTS have advocated this change so we are pleased that it has happened. At the other end of the scale there is new funding for public sector start-ups and small businesses to access matching funds support up to $250,000 for R&D, proof of concept and early stage commercialisation. The Government has also allocated $351.8 million for Australian industry productivity centres.

Funding of $36.2 million over four years was also announced to further develop research into critical challenges facing Australia's manufacturing sector. This will allow the establishment of a new CSIRO Research Flagship for Manufacturing - aimed at addressing opportunities in niche manufacturing, primarily focussed on nanotechnology and material sciences.

More details available via http://www.industry.gov.au.

New Produts

Rattlebuster. Locating automotive buzzes and rattles

It can be very difficult to locate various buzzes and rattles in a car when the car is stationary. It can also be difficult to demonstrate them to car dealers and repairers. Rattlebuster have now released a CD that contains five digital 'Power-Tones' designed to mimic different types of road vibration. It can be played in a stationary vehicle with the engine off, allowing the driver to move freely around and to pin-point the location of any annoying rattle or vibration. The bass, volume and balance controls can be varied to help induce the problem. Any problem can then be reliably demonstrated to a dealer or repairer.

http://www.rattlebuster.com/

BSWA Measuring Tubes for Material Sound Absorption and Impedance

Kingdom Pty Ltd have released a new series of BSWA sound Impedance Tubes that can accurately measure sound absorption coefficients and impedance according to standards described in ISO10534-2 (1998) using the Transfer Function Method.

They are specially designed not only to work with cut samples, but also for direct measurements in the field. Their small size and durable aluminum construction make it easy to transport them in the supplied robust transport case. The tubes have a very wide range of applications. Examples include estimating the absorption and impedance properties of walls, ceilings, installed building materials, materials used in the manufacturer of goods and products, for road surface and different ground surface measurement and the characteristics of vehicle interiors. The tubes are supplied with an integrated 20W loud speaker in the impedance tube to supply the excitation energy.

The BSWA SW230/260 Impedance Tubes are intended to be used over the measurement frequency range from 125 Hz to 6300 Hz using two locations for optional 1/4" microphones which measure sound pressures. SW433/463 Impedance Tubes are designed to measure both sound absorption coefficients and transmissions loss over 125 Hz to 3250 and 6300 Hz and use four optional 1/4" microphones for measuring sound pressures along the tubes. The BSWA Impedance Tube systems include the tubes, optional microphones, acquisition hardware and VA-Lab measurement software. The optional VA-Lab analysis software provides all measurement functions for sound absorption and transmission loss testing.

Please contact Kingdom Pty Ltd for more information. 02 9975 3272 or visit www.kingdom.com.au

Kingdom Re-Introduces Data Physics Product Line

Kingdom Pty Ltd has re-released various Data Physics products that were withdrawn from international sales by Data Physics 12 months ago to enable negotiations to proceed with the US Department of Commerce regarding which countries were acceptable to the Department as secure and safe export destinations. Dick Lovegrove, the Managing Director of Kingdom Pty Ltd has announced that all Data Physics products are again available in Australia, New Zealand and Indonesia.

SignalCalc ACE on QUATTRO is a 2 to 4 channel dynamic signal analyser which provides 0 to 2 wave form output channels and a tachy/trigger port but which weighs less than 480 grams and provides a dynamic range of 130 to 140 dB from hi-performance 24 bit ADCs.

SignalCalc Mobilyzer on ABACUS is a 4 to 32 channel per chassis dynamic signal analyser which provides 0 to 8 wave form output channels per chassis and 8 tachy/trigger ports per chassis. Configured as SAVANT, separate chassis can be linked together to provide a total of from 40 to 1024 input channels with from 0 to 256 wave form output channels and all configurations provide a dynamic range of 130 to 150 dB from hi-performance 24 bit ADCs.

SignalStar VECTOR on ABACUS the world's first DSPcentric engine and is a single shaker vibration controller which provides such features as record to disk, 4 to 32 channels per chassis, a comprehensive system satisfying all modes of vibration testing: Random, Sine, Resonance Search and Dwell, Classical Shock, SRS, Transient, Sine on Random, Random on Random, Time Replication and FFT Analysis.

SignalStar MATRIX on ABACUS is a multi shaker, multi axis vibration controller with all the capability of VECTOR plus advanced features including conversion of time domain to Power Spectral Density (PSD), multiple profiles, conversion of time record to PSD and much more.

SignalForce includes two lines of shakers, the first from the DP UK factory provides Electro Dynamic Shakers to 50 KN including Inertial and Modal shakers, the second from DP San Diago factory provides water cooled shakers to 230 KN and all with matched amplifiers.

Please contact Kingdom Pty Ltd for more information. 02 9975 3272 or visit www.kingdom.com.au

New Power Amplifiers address EMC requirements

Gearing and Watson (UK) have released a new line of power amplifiers which can operate in switch mode (DSA1& 4) or linear mode (PA series), and which replace the previous family of power amplifiers, the SS series. They can produce up to 6 KVA output with high efficiency (>90%) and are suitable for driving various vibration test systems.

Please contact Kingdom Pty Ltd for more information. Phone 02 9975 3272 or visit visit www.kingdom.com.au

Meeting Reports

VICTORIA DIVISION

Air Conditioning Noise & Legal Options to address Noise

An AAS/ANCE meeting on this topic attended by 25 was held in the EPA Theatrette on June 28, 2006. The speakers were James Nancarrow [Atmosphere & Noise Unit, EPA] and Yvonne Maglitto [lawyer, with the legal firm of Maddocks].

James Nancarrow spoke firstly about the residential noise criteria for domestic air conditioners. Current noise limiting provisions were more concerned with enforcement rather than setting and approving design limits to be observed by manufacturers, with the current noise limit being 35 dB(A) maximum at the residential property boundary. In some states [NSW and WA], air conditioner installation requires approval. In Victoria, the only grounds for approval are "heritage overlay".

In general, the responsibility for controlling this noise falls on the air conditioner installer, for which there are EPA noise guidelines for fixed domestic plant [as on the EPA web page]. Some Councils use an earlier edition of AS 1055. By contrast, in the AIRAH best practice guide, the legal responsibility for minimizing this noise falls on the property owner not the installer [see www.airah.org.au]. The situation is further complicated by other regulations which give noise criteria in terms of PWL [eg, a maximum PWL of 40 dB(A)] so that additional factors such as distance to neighboring property, local noise limit, and type of dividing fence must be considered, and a nomogram used to estimate the resulting noise at the property boundary.

For commercial and industrial installations, the Victorian State Environment Protection Policy No. N-1 on the *Control of Noise from Industry and Commerce* applies, with day, evening and night noise limits. The NSW criterion is somewhat simpler, with noise not to exceed the background noise by more than 5 dB. The recent conversion of former industrial sites to dwellings in densely built-up areas has caused new noise problems, such as with "music" from hotels. Under present regulations the penalty falls on the noise-maker. To deal with this change more justly, new regulations in which the "Agent of change" bears the compliance cost are now being developed.

Yvonne Maglitto, as second speaker, outlined the various legal options which may be resorted to in addressing noise problems. *The Health Act* may be invoked if the noise nuisance is considered dangerous to health or offensive. Proving nuisance is onerous, requiring detailed description of the noise its location, character, duration, time of occurrence and effect on "reasonable" persons.

The Environment Protection Act [§ 48] refers to unreasonable noise and vibration from residential premises, and through § 114 allows appeals to VCAT. *Local Planning Schemes* specify the conditions under which various types of activity are permitted. The *Liquor Control Reform Act* is used to oversee the conditions of a licence, which a licensee must not contravene. Municipal Councils have powers to make local laws [but which need to be consistent with related state or federal law].

Discussion and questions followed, after which Andrew Rogers [chair] thanked the two speakers for their interesting expositions of how to deal with the many noise problems, which thanks were carried with acclamation.

Sound Design and New Features in Acoustic Simulation.

On July 5, 2006 a combined meeting of the AAS and ANCE held in the SKM Theatrette, Armadale, was addressed by Dr Wolfgang Ahnert, a co-author and contributor to two chapters of G Ballou [ed], *Handbook for Sound Engineers*, Oxford, Elsevier Inc, 2002, 3rd ed. There were 14 members present.

Dr Ahnert's basic argument was that sound systems need to be designed according to the acoustics of the room in which they are to be used. Early work in this field dates back to 1935; computer simulation techniques date from 1965, with numerous programs now available, of which EASE 4.2 is one.

To achieve a detailed design, comprehensive frequency responses, directivity, and acoustic feedback characteristics of microphones and loudspeakers are required, as are the room and its boundary acoustical characteristics.

Frequency responses have been extended to 40 kHz, and are now being extended below 120 Hz. With stereo loudspeakers placed 3m apart, interference patterns occur. With 21 loudspeakers placed at 50 cm intervals, interference can be minimized, the virtual source located, and sound definition and clarity enhanced by controlling the output and time delay of each loudspeaker. After questions and discussion, Norm Broner thanked Dr Ahnert for a most interesting talk.

Tour of Docklands Film and Television Studios

The technical meeting in conjunction with the Victoria Division 2006 AGM, was a site visit to Stage # 3 of the recently constructed Docklands Film and Television Studios. This studio has a floor about 35 x 26.5 m and a room volume of 25 000 m^3. It was designed to achieve NC25 [unoccupied, and with all auxiliary equipment operating] and STL > 60 dB, and a "room radius" of 10 m [ie, the transition point between direct and reverberant sound fields]. Its reverberation time was estimated as of the order of 0.1 s. To achieve these characteristics, there was resilient insulation between the foundation piles and the building interior, and the outside walls were 160 mm thick concrete, with a 400 mm airspace, and interior lining of 100 mm easyboard. On behalf of the 34 present Norm Broner thanked the studio staff for an informative inspection and the group followed for refreshments and AGM.

Outdoor smoking areas and how to approach noise assessment

This topic was discussed at the 2007 Victoria Division technical meeting held on July 31 at the Terminus Hotel, 605 Victoria St, Abbottsford, which 15 attended. Victorian legislation restricting smoking within restaurants, hotel bars, etc after July 1 has led to an increased number of proposed outdoor smoking venues. Appropriate noise assessment and control guidelines and criteria are needed.

Andrew Rogers [meeting chairperson] opened the discussion by listing eight criteria in current use : -

[1] an L_1 which the noise of voices must not exceed, calculated from measured L_{90} [background noise] octave band levels + 15 dB,

[2] $L_{eq.A}$ of background noise + 5 dB,

[3] the EPA Victoria N-2 Policy criteria [including sleep disturbance] for music noise from public premises,

[4] the EPA Victoria N-1 Policy criteria [including sleep disturbance] for noise from trade, industry and commercial premises,

[5] the NSW Road Traffic Authority sleep disturbance criteria,

[6] the 'Greifann' method,

[7] voice noise heard indoors as less than background octave band levels, and

[8] the Melbourne City Council criteria based on a combination of number of patrons, and noise at distances of <30 m, <60 m and >60 m.

In a situation in which there is as yet no defined rule, and hence confusion for planners and consultants, the discussion opened with the questions

[a] Is there an appropriate existing policy ? and

[b] Is there a consistent method of assessment?

Because local and state government decisions in the granting of approvals are subject to appeal, it was noted that the Victorian Civil and Administrative Tribunal [VCAT] grants an approval if it can be shown that local amenity is not worsened by approving a proposal, and that VCAT needs to be provided with consistent criteria. The answer to question [a] was that this appears as yet to be a matter requiring further experience and development. That to question [b] was that, with several methods available, one consistent method needs to be determined, again from further experience.

The ensuing discussion of those taking part centred on their experiences in measuring crowd vocal and similar noise, and in using the various available methods for assessing it.

Several observed that the L_{eq} of crowd noise at closer range varied from 70 to 80 dB[A], with maximum levels around 15 dB above the L_{eq}. The decrease in noise level with increasing distance from the source has not yet been systematically investigated. It had been observed that a group of more than about ten people constituted a crowd, in that the noise became a "babble" and that individual voices were no longer readily distinguishable. Crowd noise from hotel car parks was observed to be from 5 to 10 dB higher in level than that from car parks outside gaming venues. This suggested the need for a "PI" [pickled idiots] Index, and on a more serious note suggested that under some circumstances there was need to consider the loudness of conversation of those who had suffered a hearing threshold shift after an evening of very loud music.

It was noted here that the regulations define an outdoor situation as one in which the equivalent of 25% of wall space is open to the exterior. This has useful implications in reducing crowd noise by means of noise barriers and sound absorbent materials for protecting noise-sensitive residential areas. It was reported, also, that the Liquor Control Board is currently granting licences to premises with an early morning time limit of 0100h.

In the area of noise criteria and measurement, several variants of those described in [1] to [8] above were suggested. These included

[a] comparing measurements of the overall noise made according to N-2 with background levels + 8 dB, background + 15 dB, and with L1 and sleep disturbance criteria, and

[b] using background noise octave levels + 8 dB.

In discussing noise limits, some asked whether levels in dB[A] were sufficient, or whether octave analysis was needed. Sleep disturbance criteria were considered useful for limiting the occasional exceptionally high level noise. In general, N-1 was considered to provide a useful starting point for measuring and assessing crowd conversation noise. N-2 appeared more suited to music noise.

At the end of the discussion, the general consensus was that, as an interim conclusion,

[1] further systematic study of crowd conversation noise was needed to provide a body of typical levels of this noise, and

[2] noise measurements made according to a combination of the methods of N-1, N-2 and sleep disturbance tests would provide adequate data for assessing any crowd noise from outdoor smoking areas.

In conclusion, Andrew Rogers thanked all present for their contributions to the discussion.

Louis Fouvy

Future Meetings

AAS2008

The next AAS Annual Acoustics Conference will be hosted by the Victorian Division and promises to be not only a very futuristic conference but also will provide a very lush surrounding and access to Victoria's prime tourist attractions along the Great Ocean Road and in Geelong, the second largest city in Victoria.

The Conference will be held at the Deakin Management Centre just out of Geelong from 24th - 26th November, 2008. The theme of the Conference will be "acoustics and sustainability" and papers are invited in all aspects of acoustics with particular emphasis in the role of acoustics in achieving sustainability. Prime tourist attractions apart from the fine historic buildings in the area are the Twelve Apostles, the Otway Fly, Port Campbell and Otway National Parks, fine beaches, waterfalls and walks.

Registration will commence Sunday afternoon in conjunction with a casual "happy hour" and there will be a BBQ on Monday evening. The Conference banquet will be held on Tuesday evening. The Deakin Management Centre has world class conference facilities and is only about 10 minutes from the city of Geelong and 20 minutes from Avalon airport. The Conference will finish at Wednesday lunchtime, allowing delegates to either return home or enjoy the local wineries and tourist attractions.

There will be a large exhibition area with some 20 exhibitors committed to being there and sponsorships for the Conference BBQ, Banquet etc Contact Norm Broner at nbroner@skm.com.au to confirm your place or Sponsorship.

We look forward to seeing you there. More information from the conference link on www.acoustics.asn.au or from aas2008@acoustics.asn.au

Norm Broner

Nonlinear acoustics and vibration at ICSV15

Dr W. S. Gan is organizing a structured session on nonlinear acoustics and vibration for the 15th International Congress on Sound and Vibration (ICSV15) to be held in Daejeon,Korea from July 6 - 10, 2008. The relevant dates are

Closing date for 300 words abstract: Dec 1 2007

Notification of Acceptance: Feb 28 2008

Deadline for Full-length Paper Mar 31 2008

Deadline for early registration: Mar 31 2008

Interested readers should email or fax their 300 word abstract to Dr W S Gan by the 1st December, 2007. His email address is: wsgan@acousticaltechnologies.com and his fax number is (65) 67913665.

For further information and online registration please go to www.icsv15.org.

Noise Effects 2008

The International Commission on Biological Effects of Noise (ICBEN) holds its week-long International Congress on Noise as a Public Health Problem every five years. In July, 2008, the Congress will bring its 500–600 participants, representing many nationalities, to the United States for the first time since 1968. The meeting will be held at Foxwoods Resort in eastern Connecticut to discuss advances in

- Noise-induced Hearing Loss
- Noise and Communication
- Non-Auditory Effects of Noise
- Effects of Noise on Performance & Behaviour
- Effects of Noise on Sleep
- Community Response to Noise
- Noise and Animals
- Regulations & Standards

The conference will include keynote speeches, Invited papers, Contributed papers Poster sessions, Workshops and Technical exhibition.

Noise Effects 08 will be held 21 to 25 July 2008 in Mashantucket, Connecticut, USA. For more information ICBEN2008@sbcglobal.net. and note that the closing date for abstracts will be 28 April 2008. More backgound on the conference can be found at www.icben.org

Internoise 2008

The Organizing Committee of the 37th International Congress and Exposition on Noise Control Engineering (INTER-NOISE 2008) extends a warm welcome and invitation to participate fully in what promises to be the premier noise control engineering conference of 2008. The INTER-NOISE 2008 Congress, sponsored by the International Institute of Noise Control Engineering (I-INCE) and co-organized by the Institute of Acoustics, Chinese Academy of Sciences (IACAS) and the Acoustical Society of China (ASC), will be held at the Shanghai International Convention Center, Shanghai, China, from 26–29 October 2008.

In addition to being an interesting and pleasant venue for the congress, Shanghai is truly a historical but modern city. The Congress will feature a broad range of high-level research papers from around the world, as well as an extensive exhibition of noise and vibration control and measurement equipment and systems. Distinguished speakers will provide additional stimulation for our technical sessions and discussions with a focus on our theme of "We are Active but Quiet."

For more information www.internoise2008.org

ICA 2010

This is the seventh in a series of regular items in the lead up to ICA in Sydney in 2010.

The International Congress on Acoustics (ICA) 2007 in Madrid is shaping up to be a well attended event. The program runs over the five days with many social events to balance the busy technical program. As the ICA is only held every three years the next one will be the ICA2010 in Sydney. So at the end of the Madrid conference, representatives from the ICA2010 committee will make a short presentation encouraging all those present to plan to come to Australia and New Zealand in August 2010. As well as providing the first circular on the ICA2010 this presentation will launch the ICA2010 logo.

To date, the ICA2010 committee has comprised the executive; Marion Burgess, David Anderson and Chris Schulten. We have been busy ensuring the foundations for the ICA2010 are well established. We appreciate the trust that the AAS has placed in our committee to just get on with the job. Of course we need to report to the Division and to Council but we already appreciate how much more efficient it is for our committee to be able to make important decisions ourselves.

In the coming years the committee will expand as the tasks associated with organizing the conference increase. We look forward to the support of the wide membership of the Australian Acoustical Society in this undertaking. The ICA 2010 provides the opportunity to both showcase the high standard in Australia for the wide range of topics within acoustics as well as to learn from international colleagues.

ICMSA have been appointed to provide the professional services that are required to arrange a successful conference of this scale. ICMSA have arranged for the attendance of one of their representatives at ICA2007 in Madrid at no cost to the ICA2010 budget. This will provide a great opportunity for boosting the delegate attendance.

As well as the main congress, there will be a number of associated meetings. There is long standing tradition for an associated meeting on Musical Acoustics and this will be held in Australia. Another associated meeting will be held in New Zealand on acoustics and sustainability. This topic is likely to become even more important over the coming years when there is an increasing demand to use products which will not cause harm to the environment either in their manufacture, during their life or at the time of demolition. Its likley that during the forthcoming years additional associated meetings will be planned.

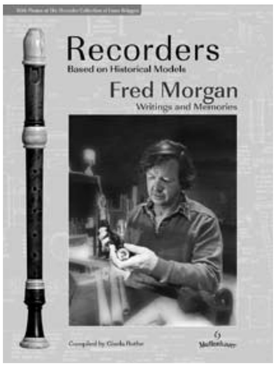
For more information on the ICA2010 go to www.ica2010sydney.org or www.acoustics.asn.au.

Marion Burgess, Chair ICA 2010

Book Reviews

Recorders Based on Historical Models: Fred Morgan, Writings and Memories

Ed. Gisela Rothe



Conrad Mollenhauer GmbH, Fulda, Germany 2007. 208 pp hard cover, large B4 format, ISBN 978-3-00-021215-4. Also published in German. Price approx $63

Fred Morgan was born in Mentone, Victoria, in 1940 and began playing the recorder at age 12. After studying commercial art at Melbourne Technical College, he worked for 10 years at the Pan Recorder factory in Hawthorn, a company making recorders for the growing school market, and during that time became a highly skilled recorder player and gave many concert performances with Baroque music groups in Melbourne. He continued to perform throughout his life, often with his wife Ann who was a leading Australian harpsichordist. It is not for his playing that Fred is most renowned, however, but rather for his study and reconstruction of classical recorders and for the many instruments that he made for the world's finest players in his workshop in country Daylesford in Victoria. Tragically Fred was killed in a motor accident in 1999, and this volume has been compiled as a tribute to his achievements and his memory.

The making of modern versions of classical instruments begins with a careful study of those that remain in museums and private collections, and Fred compiled many excellent drawings and sets of measurements during his several periods in Europe. Fred was generous in sharing his knowledge with other recorder makers and some of the drawings and measurements were published by Zen-On in Tokyo. A modern version of a famous instrument is not just an exact copy, however, since the wood from which it is made will have shrunk and warped, and the desired pitch and tuning may be slightly different from that of the original. Making the new version therefore requires scientific understanding of the instrument, slight design adjustments, meticulous craftsmanship, and finally extended playing, evaluation and adjustment. In all these matters Fred excelled, and he conducted several master workshops during his visits to Europe.

This memorial volume is a wonderful mix of authors and topics. Most important are five essays by Fred himself on various topics related to the making of recorders based upon historical models, these essays being reprinted from several recorder journals. There is also an extended interview with him. Together these constitute an excellent guide to recorder makers and also to recorder players, and they are made much more interesting and informative by the many beautiful and large-scale photographs of the resulting instruments and those from famous collections provided by Markus Berdux of Mollenhauer.

Much of the book, however, consists of short biographical pieces contributed by more than fifty authors from around the world, some of the names being those of renowned performers on the recorder. Each of these is just one to two pages long, but together they give a wonderful overview of the development of interest in recreating the best of the available historical instruments and of Fred's immense contribution to this endeavour. As Walter van Hauwe from the Netherlands writes "He was unique, probably the most significant, outstanding and skilled recorder maker ever."

This large-scale (B4) book is a joy to hold and read and is printed on high-quality glossy paper. As well as the text and the many large-scale colour photographs of recorders, there are many photos of Fred himself and his collaborators, together with extracts from the correspondence he had with famous players and others around the world. The book is published by Mollenhauer, a family business in Fulda near Frankfurt, which has been making recorders, and initially other woodwind instruments, of the highest standard since 1822. One of their most prestigious lines is the reproductions of classical recorders designed by Fred Morgan. Their web site www.mollenhauer.com is worth a visit.

I strongly recommend this book to all those with an interest in the recorder or in the development of musical instruments generally. Its large format, beautiful illustrations, and short individual pieces make it an excellent "coffee-table" book as well as an essential for the library.

Neville Fletcher

Neville Fletcher is a Visiting Fellow in the Research School of Physical Sciences and Engineering at the Australian National University. He has researched and written widely in the field of musical acoustics and actually contributed a short piece to the present volume.

Self on Audio: Second Edition Douglas Self

Newnes (an imprint of Elsevier), 2006, 468 pp (Soft-cover), ISBN-13: 978-0-7506-8166-7, ISBN-10: 0-7506-8166-7. Approx Price A$71

Douglas Self is a respected and well-known designer and writer on audio electronic subjects. This book contains 35 articles written by him for the British electronics journal Wireless World (now Electronics World) between 1979 and 1999. This second edition is a somewhat expanded version of the first edition published in 2000.

A listing of the contents aptly indicates the range of topics dealt with : Advanced preamplifier design; High-performance preamplifier; Precision preamplifier; Design of moving-coil head amplifiers; Precision preamplifier '96; Overload matters; A balanced view; High-quality compressor/limiter; Inside mixers; Electronic analogue switching; Sound mosfet design; FETs versus BJTs: the linearity competition; Distortion in power amplifiers; Power amplifier input currents and their troubles; Diagnosing distortions; Trimodal audio power; Load-invariant audio power; Common-emitter power amplifiers: a different perception; Few compliments for non-complements; Loudspeaker undercurrents; Class distinction; Muting relays; Cool audio power; and Audio power analysis.

Each article (chapter), or series of articles, has a brief introduction setting some of the technical context of the piece following. Each chapter describes the design or factors related to the design of high quality audio pre-amplifiers, power amplifiers and related equipment. The design process is clearly explained and in particular Self illuminates problems and compromises, which are inevitably part of the design process. Each chapter includes many clearly presented circuit diagrams and performance charts . The index, while short, is adequate to allow readers to find the chapter that has the information they are seeking.

The book will appeal to anyone interested in understanding more on the design process for audio circuits rather than simply wanting to reproduce the circuit designs presented in this book (or found elsewhere). In their recent high performance "20W Class-A Amplifier Module" in Silicon Chip (May 2007) Leo Simpson and Peter Smith make reference to the ideas and circuits they gained from the Douglas Self books. Another example is the two part article on analogue switching, which provides useful background to anyone wanting to switch audio signals electronically.

It is convenient to have these clearly presented articles collected into a single volume. This book will be invaluable to anyone involved in the design of high quality analogue audio equipment and to the dedicated audiophile.

Glen Torr

Glen Torr is an electronics technical officer of many years experience who works in the Acoustics and Vibration Unit at UNSW@ ADFA.

Building Services Engineering 5th edition David V Chadderton

Taylor and Francis, 2007, 427pp, soft cover ISBN 0 415 41355 9, also available in hard cover and ebook Approx cost soft cover A$80.:

David Chatterton has been teaching for many decades both in UK and in Australia. His vast experience with explaining the concepts is clearly demonstrated in this book for which each edition has expanded, amended and updated the information from the first edition back in 1991. Each chapter attempts to focus on the basic principles with explanations and diagrams and example calculations. At the end of each chapter are questions, some multiple choice while others require short explanations or calculations. The calculations and multiple choice answers are included in the annex. It is also possible to access, at no cost, the web page associated with the book to access a more extensive set of multiple choice questions with an instant response on the correctness of the answer.

The content is neatly presented in 19 chapters, each taking a particular aspect of building services in a logical order. For example, the early chapters deal with the built environment in general principles of energy economics and heat loss calculations.Chapters 4 and 5 deal with heating and ventilation and air conditioning. The following chapters deal with other aspects of building services such as hot and cold water supplies and soil and waste systems. As the author has spent considerable time teaching in the UK, there is understandably a somewhat greater emphasis on heating than on cooling systems. For example there is much on gas fired and storage hot water,only a small section on solar hot water systems and nothing on use of solar panels for electricity.

Chapter 14 deals with room acoustics. From the introductory section defining decibels, sound absorption etc the main focus of the chapter is on determining the noise levels in the room or transmitted to adjacent rooms from an item of plant. Thus there are example calculations on room constant and sound pressure level from sound power level data. There is also a free web access to downloading a spreadsheet for use in these calculations. There is a little inconsistency in the equations, which could lead to confusion; for example in one the sound reduction index is *B* while in another it is SRI. Perhaps more confusing is that the explanation of directivity and the first few examples use *Q* but then it switches to *DI* with no explanation. Although there is a reference to Australian Standard 1469 for Noise Rating (which incidentally has been withdrawn) there is no reference to AS2107 for internal noise levels and Table 14.6 for Noise Ratings for various spaces does not have any citation indicating its source.

One of the multiple choice questions is *"What does the building services engineer do with noise? With the choice of answers: A) Ignores it; B) Passes any problem to a specialist; C) Not select plant that generates noise; D) Controls it to acceptable standard in occupied spaces; E) Alters the use of the building to avoid any noise problem"* and, to save you puzzling, the correct answer is given as D. But it is somewhat disappointing that there is little guidance on how to control the noise at source. Apart from diagrams with labels for spring or rubber mounts and reference to flexible connectors there is little guidance on planning to minimise the problem or selection of low noise items or even lining ducts.

Seeking to understand a little more about building services I enjoyed dipping into the book and finding explanations of some of the terms that appear on the engineering drawings for buildings. I also found the web linked resources interesting and valuable to reinforce the concepts. Overall I recommend this as a valuable addition to the reference library for the acoustic consultant.

Marion Burgess

Marion Burgess is a research officer at the Acoustics and Vibration Unit of the University of NSW at the Australian Defence Force Academy and involved in acoustics research, consulting and education.

Standards Australia

Sydney Office Move

In June/July Standards Australia moved to the new office location at The Exchange Building, 20 Bridge St, Sydney. The building fit out allows for many improvements as well as the opportunity to further distance Standards Australia from SAI Global which was floated in 2003 and ensure its independence.

Diary

2007

28 - 31 October, New York
IEEE Int Ultrasonics Symposium.
www.ieee-uffc.org/ulmain.asp?page=symposia

1 - 5 December, Melbourne
25th Conf. Aust. Inst. Occupational Hygienists
http://www.aioh.org.au/conference/2007/

2008

31 March - 2 April, Leuven
LSAME.08 - Leuven Symposium on Applied Mechanics in Engineering
http://www.mech.kuleuven.be/lsame08/

12 – 15 May, Sopot, Poland
10th School on Acousto-Optics and Applications
http://univ.gda.pl/~school/

20 - 23rd May, Canberra
Audiological Society Australia Annual Conference
www.audiology.asn.au

30 June - 4 July, Paris
Acoustis'08 Paris
http://www.acoustics08-Paris.org

6 – 10 July, Daejon, Korea
15th International Conference on Sound and Vibration
http://www.icsv15.org/

7 – 10 July, Stockholm
18th International Symposium on Nonlinear Acoustics (ISNA18)
http://www.congrex.com/18th_isna/

21 – 25 July, Mashantucket
Noise Effects 2008.
http://www.icben.org

22 - 26 September, Brisbane
INTERSPEECH 2008 - 10th Intl Conf on Spoken Language Processing (ICSLP).
www.interspeech2008.org

26 - 29 October, Shanghai
Internoise 2008
www.internoise2008.org

24 - 26 November, Geelong
Australian Acoustics Society National Conference
'Acoustics and Sustainability'
http://www.acoustics.asn.au/conference-link.shtml

2009

6 - 10 September, Brighton
Interspeech 2009
www.interspeech2009.org

2010

23 - 27 August, Sydney
ICA2010
http://www.ica2010sydney.org/

Meeting dates can change so please ensure you check the www pages. Meeting Calendars are available on http://www.icacommission.org

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