



Institute of Acoustics

Special Issue

Musical Acoustics

Technical Contributions

The Guitar: Its Past, Present and Future

Bernard E Richardson MIOA

The Sackbut, the Cornett and the Serpent

Murray Campbell MIOA

A Lyre for Peasants and Traipsing Women

Peter F Dobbins MIOA

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Zachary Taylor

Noise Nuisance – A Solicitor's Review of the Current Law

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Letter from Alan Baker MIOA

acoustics
BULLETIN

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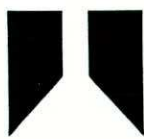
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CEL Sound Level Analysers are specified as follows:

CEL-593 – Sound Level Analyser with Event and enhanced Environmental Mode

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Price List

CEL-593.C1 – Sound Level Analyser with Real-Time, Octave and Third Octave Filters and Environmental mode	£5,995	CEL-573.C1 – Precision Sound Level Analyser with Real-Time, Octave and Third Octave Band Filters	£4,695
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A PARTNERSHIP IN LEARNING

CPD - The Way Forward - a refreshing approach

As more of the Professional Institutions adopt CPD, we will see the emergence of a common vision across the Engineering Profession.

Many of the smaller Institutions already have obligatory schemes in place, but for the larger Institutions the task is not so straightforward. My own Institution, the IEE, has just adopted a voluntary scheme which will run as a pilot for the next three years (see centre pages). The administration required for the number of members involved will be very challenging, and even more so if and when the scheme becomes obligatory. Much needs to be considered concerning the range of activities which may constitute CPD, ranging from regular updating from books, journals and papers, to formal courses. Different requirements will pertain at the various stages of the Engineer's career.

My own belief is that CPD should consist of a mixture of formal and informal refreshment. This does pose something of a problem of accreditation, but - just as we expect Professional Engineers to follow professional codes of conduct without being monitored - so we should expect self-accreditation of the informal parts of CPD.

In addition to technical refreshment through CPD, I believe that there are other areas where today's legislative environment requires Engineers to be updated regularly. These include:

- ◆ Health & Safety (including Risk Management)
- ◆ Environmental Awareness and Management
- ◆ Quality Management

Health & Safety legislation is putting a greater onus on the

Professional Engineer to be able to demonstrate responsible behaviour, and the Risk Issues were touched upon in the leader article by Sir William Francis in the December 1993 issue of 'CPD Link'.

Environmental Management is already being addressed by the profession, and the contribution that can be made by Engineers to improving the environment is something of which we should all be aware; BS7750 should be compulsory reading.

All of these issues are part of the professional way in which we tackle our jobs, and must be seen in the context of a Total Quality approach to our work. BS5750 gives a framework for such an approach, which can be tailored to the complexity or simplicity of a task.

I believe these issues will become a part of every Engineer's CPD portfolio.

Professor William Fairney, FEng
Director of Project Development & Construction,
National Power plc. Vice President, IEE. (Tel: 0793 892200)



A POWERFUL APPROACH TO CPD

A powerful commitment by the senior management to developing staff at all levels has led to major benefits at National Power's Ironbridge Power Station.

The challenges provided by privatisation two years ago initiated a review of the skills across the business. Senior management decided to adopt a major programme of training aimed at developing multiskilled employees, with the objective of empowering people throughout the organisation. Not only has the skills base been raised significantly, but responsibility is now delegated to the lowest practicable level.

The benefits have included an overall increase in profitability of 61%, with productivity per employee up by 111%. Better efficiency in converting fuel to energy has resulted in savings of



Bill Yorke and team

£550,000 a year and the plant has 95.18% availability, compared to 89.97% before the training. Furthermore, Ironbridge has set a new National Power safety record by clocking up 1000 days without a lost-time accident on the site.

The philosophy behind all this has been to raise quality levels by expanding knowledge across the site. Where specialist expertise is identified in particular employees, they are given off-line training in trainer skills. Their challenge then is to cascade that knowhow across the site to all those who will benefit.

Bill Yorke, Ash and Dust Foreman, for example, is being fully empowered to enable him to run a self-sufficient team which can operate in its own right. This involves him in taking over a number of new areas of responsibility. "It is beneficial to both the Station and ourselves as life becomes far easier when all responsibilities are under one roof", says Bill, who joined Ironbridge as a Mechanical Fitter 25 years ago.

Not surprisingly, Ironbridge Power Station won one of the 59 National Training Awards won by employers in 1993. In addition, they won the commendation from the Management Charter Initiative. They are now working towards Investors in People accreditation.

For more information contact John Herbert,
Human Resources Manager (Tel: 0952 433451)

JAPAN'S WINNING MARGINS - MANAGEMENT, TRAINING & EDUCATION

This month sees the publication of three years of effort - a book I have co-authored with Professor Takashi Kenjo in Japan - and which has been a key part of my own CPD. The message is perfectly simple - anything the Japanese do we can almost always do better if we apply simple principles of CPD; after all, as we show, much of Japan's expertise in technology was originally learnt from the UK.

Japan has not only much more broadly experienced managers, engineers and employees in general, but also a willingness for managers to lead from the front, much in the style of the British Armed Forces Officer. As Sir Peter Parker says in his Foreword, "The home-truths are likely to jolt a few open-minded Western managements.....". We need to challenge the role of managers and give them two key things; the skill to coach and develop their staff, and a broadening of their career experience.

The supreme irony is that it was a British engineer, Henry Dyer from the University of Glasgow, who set up the first School of Engineering in Japan. That was in 1873, and it became part of the University of Tokyo and is now the premier Faculty of Engineering in Japan. One of the seven other young British engineers brought out at that time was William Ayrton, now recognised by the Japanese as the 'Father of Japanese Electrical Engineering'; on his return to the UK, Ayrton became President of the IEE in 1892.

Our industrial difficulties in recent years are because we have forgotten the key lessons we ourselves taught the Japanese a century ago - the need for managers to concentrate on developing their staff, for individuals to structure their learning and for employees to develop their talents in the round and to become multi-skilled. To that the Japanese have added the concept of 'Kaizen' - the concept of continuous improvement.

FOOD FOR THOUGHT AT COURTAULDS ENGINEERING

Courtaulds Engineering in Coventry have obtained considerable benefit from organising regular lunchtime seminars for their technical staff - typically for 20 to 80 people at each session. Lasting for 1½ to 2 hours, these have proved to be an economical and successful way of training and updating engineers and technicians in specific engineering topics.

Many of the seminars have been presented by technical representatives from outside the company - including suppliers, contractors and consultants. The topics have included noise, safety, equipment technology (such as boilers) and pressure systems regulations for the mechanical engineers. Electrical engineers have had seminars on subjects including variable speed drive systems, circuit breakers and aspects of the IEE Regulations, while the instrumentation engineers have had sessions in areas as diverse as ultrasonic level measurement and batch software.



**Secondary pharmaceutical production -
the subject of a recent seminar.**

Our approach to CPD in the UK has attracted attention from around the world. Is it not time that we now showed the commitment and application which once made Britain the world's technological leader, a leadership we have continuously lost over the last century? The major purpose of 'CPD Link', which I edit, is to share examples of good practice, particularly those in the UK. In this issue I especially suggest you try to emulate the examples in National Power at Ironbridge on the front page and at Courtaulds in Coventry below; these both well illustrate that precisely those CPD practices which have led to Japan's successes are perfectly possible elsewhere.

We should recognise that there are many different ways to learn. After all, the Japanese have a serial system whereby they provide a very sound base of education first, on which they then build the practical skills required by employers, mainly on-the-job - but in a highly structured way. We prefer a parallel approach with education and practical experience sandwiched, but often fail to structure the learning as well as we should. Perhaps both systems have much to learn from each other.

So what, then, stops us beating the Japanese in future more often?

John Lorriman, CEng, Managing Director,
Ichiban Consultants (Tel: 0203 395299)

("Japan's Winning Margins - Management, Training, and Education"
is published by Oxford University Press, ISBN 0-19-856374-4)



The process engineers also have their own regular programme of lunchtime seminars and the civil engineers and architects will be doing the same. Some lectures are also provided by Courtaulds' own experts. The company is also improving its design expertise through the use of the Institution of Chemical Engineers' video training courses.

Tim Harrison, CEng, Principal Engineer, says: "We are using state of the art technology, so what better way is there of keeping staff updated than inviting our suppliers to provide these seminars? There are also benefits to the suppliers in improving their understanding of what our needs are as customers." Roger Burley, CEng, Senior Manager Engineering, adds: "Engineering is not only about knowing the technology; it is also very important to know where to go for an answer and what to *ask*. These regular sessions help to extend our engineers' networks." "In addition", says Frank Passey, CEng, Chief Engineer, Electrical, "by participating in these lunchtime seminars presented by external experts, they also experience a variety of techniques, helping them to make better quality presentations themselves. This is particularly beneficial to our graduate trainees. We also often require our engineers to make a presentation to their colleagues on returning from any formal training course."

Other approaches used by Courtaulds to develop their technical staff include a Training Centre, providing open learning facilities including PC software and languages.

For further details contact Peter Robinson,
Head of Human Resources (Tel: 0203 862216)

POWERING CPD - A MODULAR SOLUTION

The electrical supply industry operates the largest and most complex of all manmade systems. It is a major user of modern technologies including digital electronics, on-line plant controllers, expert systems, optical fibre communications and data acquisition and control systems. It supports the investigation and exploitation of novel and environmentally friendly sources of generation, flexible and improved forms of transmission, economic modes of distribution and efficient methods of utilisation.

Unfortunately many universities have abandoned electrical power engineering in favour of electronics and associated courses. There has been an impression that information technology is the future and power is the past. As a result there is now a shortage of well qualified and experienced electrical power graduates in the UK.

The Manchester Centre for Electrical Energy (MCEE) at the University of Manchester Institute of Science and Technology is now providing a solution - a uniquely structured postgraduate programme. With a history stretching back as far as 1957 in providing such courses for industry, and an MSc in Power Engineering since 1962, MCEE has now launched a new

Corona discharge
at 600kV AC



modular version. The one and two week modules are each self-contained and involve intensive teaching, tutorial and laboratory work. Modules can be studied individually as part of an engineer's mid-career training or can be accumulated towards an MSc, either full or part-time.

The modules are mainly taught by the 16 members of the MCEE, but specialist lectures are given by senior engineers from the electricity supply industry, manufacturing industry, consultants and from other universities.

Application is being made for formal professional institution approval of this scheme within the new CPD frameworks such as the IEE's, featured on the next page.

For further details contact Dr Peter Crossley
(Tel: 061 200 4697)

IGDS SCHEMES HIT QUARTER CENTURY - AND ARRIVE IN OXFORD

The Engineering and Technology Programme within the newly formed Engineering and Physical Sciences Research Council (EPSRC), one of the successor bodies to the Science and Engineering Research Council (SERC), offers a number of schemes that lead the way in industrially relevant postgraduate training.

The Integrated Graduate Development Scheme (IGDS), funded by EPSRC, has been operating since 1979 and there are currently 25 programmes in fields as diverse as manufacturing systems, packaging technology, aerospace design, environmental engineering and materials technology.

One of the latest has been initiated by the University of Oxford's Department for Continuing Education with some 20 students starting in 1993 from IBM's Development Laboratory at Hursley Park. This particular scheme builds on many years of collaboration between IBM and Oxford University's Computing Laboratory, whose staff provide the tutors for the scheme under the leadership of Dr Jim Woodcock. It leads to a Postgraduate Diploma in Software Engineering with an optional follow-on MSc. It has attracted three types of students:

- ◆ Those early on in their careers, with at least two years post-graduate experience looking for a more specialist qualification.
- ◆ Some who are much more experienced, but want updating.
- ◆ A number who were programmers some two decades ago, have since moved into other careers and now wish to move back into modern software development.

The course is based on rigorous use of mathematical principles to produce high quality software efficiently, and requires a certain level of mathematical competence on entry.

To help prospective students who are perhaps not so confident of their maths ability, the Scheme also includes a pre-course 'Bridge' programme of individually tailored study units aimed at developing these underpinning maths skills. This has

proved very popular and effective.

Five of the six one week modules are run at the IBM Education Centre, with a sixth residential module at Oxford. Some ten hours of self study is required before each module, with an assignment taking about 25 hours in the two weeks following. A portfolio of short reports must also be prepared by each student identifying at least three areas where what was learnt has been, or could be, applied from the modules. All this is reinforced by a project based on work undertaken in the company, mainly during the last five months of the course, and presented as a substantial dissertation leading to the award of a Diploma which can be gained over either one or two years.

There are now two further developments. First, with funding

```
'MODULE SOFTENG (PUBLIC)
PROCEDURE CPD;
BEGIN
  READ (CPDLINK, NOW)
  IF (INT>0) THEN Z:
  **!! *..?*!...splat'
```



I HAD GREAT HOPES
FOR MY CPD AS A SOFTWARE
BUG UNTIL THIS OXFORD IGDS
SCHEME CAME ALONG !!!

from the EPSRC, the scheme is being extended to other companies engaged in software development as from June 1994; these modules will all be taught at Oxford, but otherwise the scheme is the same. Second, those students who have completed the Diploma will have the opportunity to study a further four modules leading to the award of an MSc.

There is one final satisfying aspect of the scheme; Dr John Axford, who helped to initiate the Scheme when heading up education at IBM Hursley, has developed his own career by moving to Oxford University's Department for Continuing Education and continues his involvement with the IGDS programme.

For further details contact Dr John Axford, Oxford
(Tel: 0865 280344)
or Ann Durniat, EPSRC (Tel: 0793 414096)

IEE LAUNCHES ITS CPD SCHEME

As the largest of the professional institutions, with 130,000 membership worldwide, the launch of the Institution of Electrical Engineers' CPD Scheme is an important event for the engineering profession.

The launch took place at the IEE on the 14th February in the presence of some 40 guests from other institutions and professional bodies. As John Williams, the IEE's Secretary noted in welcoming them, many of those present had provided help and information about their own CPD schemes; the IEE's Council took these into account in unanimously approving its own CPD scheme to commence in January 1995.

Three important aspects of the IEE approach are:

- ◆ It is open to all members.
- ◆ Participation in the scheme is voluntary.
- ◆ The Institution will keep information on its database showing the amount of CPD each member has undertaken each year.

Mike Smythe, Director of Professional Services, said: "Our members are professionals, who are proud of their membership qualification. But it only shows an achievement at a particular point in time, namely when it was awarded. Showing proven CPD achievements thereafter will enhance our members' marketability".

A Points Based System

Each participating member who attains a minimum of 60 points of assessed CPD in any period of three consecutive years, on a rolling basis, will qualify for the award of a CPD Certificate (or a CPD Certificate of Merit for 120 points, with their names published in IEE News).

In order to keep the scheme relatively simple to operate and control, only activities requiring attendance are included in the scheme in its present form.

These fall into two types, which are:

- ◆ **TECHNICAL EVENTS** - These may be aimed either at developing a member's specialised technical knowledge or at broadening this beyond their specialisation.
- ◆ **NON-TECHNICAL EVENTS** - In this category come management techniques, inter-personal skills, employment law, health and safety law, finance, languages, etc.

At least 25% of a member's CPD activities must be in each of these two categories to qualify for a Certificate.

The points allocation for all such events will be:

- ◆ 1 point per hour of examined CPD.
- ◆ 0.75 point per hour of interactive CPD.
- ◆ 0.5 point per hour of attendance only CPD.
- ◆ 5 points for presenting a one hour lecture or a refereed paper or article.

Various types of approved providers will be:

- ◆ The IEE itself, including its Centres, Divisions, Professional Groups, Distance Learning Committee, Conferences, Vacation Schools and Short Courses.
- ◆ Other professional institutions.
- ◆ Higher Educational Institutes offering IEE accredited degrees.
- ◆ Employers operating IEE accredited training schemes.

- ◆ Others who seek and obtain approval from the IEE for their CPD provision. These could include training organisations, Colleges of Further and Higher Education, and employers not having IEE accredited training schemes.

Approved providers will be required to operate within specified criteria and to appoint a senior person, known as the Nominated Individual and acceptable to the IEE, to act as the named link between the IEE and the provider.

Members will be able to recognise IEE assessed CPD events by logos shown on the publicity material, or by a plain language statement such as 'This event qualifies for 0.5 Technical IEE CPD point'.

A record of all assessed CPD provision will be maintained in the IEE's Courses Information Unit in the Library at Savoy Place.

Ken Smith, the IEE's CPD Manager, says: "This scheme will cost the Institution around £2 per member per year, plus our start costs. And we think it is worth every penny!"



Mike Smythe, Professor Philip Secker, John Williams and Ken Smith at the launch event.

Some Future Challenges

Professor Philip Secker, Deputy Secretary of the IEE, asks the question "Where do we go from here? Our scheme will operate initially for a period of three years and then will be reviewed. In the meantime, however, there is still a lot to do to develop the scheme further, both within and outside the IEE".

Within the Institution he sees possibilities of extending the range of qualifying activities to include other forms of CPD, such as private study and on-the-job learning. Outside there is the work of The Engineering Council in developing proposals for a Code of Practice in CPD.

He would like to see the larger institutions helping and supporting the smaller ones to develop and introduce their own CPD schemes. To this end, the IEE is prepared to offer its scheme for free to any other institution wishing to adopt or adapt it; and even prepared, for a modest fee, to manage such a scheme on their behalf if so asked.

"Let me make three challenges", says Professor Secker. "First, we should find a way of achieving mutual recognition of CPD across the engineering profession. Second, let us start talking now about the creation of a mutually acceptable procedure for the assessment, measurement and recognition of each other's CPD. But my third challenge is broader still. After all engineers will perhaps need CPD in law, in finance and in medicine, and will attend courses provided by these professions. So my final challenge is this: let us set up an inter-profession group to discuss ways in which we can recognise CPD activities from each other's professions".

For further details contact Ken Smith (Tel: 0438 767257)

OPENING UP LEARNING IN BT

BT have opened up a new Distance Learning Centre (DLC) as part of their Management Training Centre at Martlesham.

The DLC has 16 interactive video workstations of which four supply language training, four are video booths and two are audio. There is also a room set aside for group learning and discussion.

The wide selection of videos contains over 1000 different titles, which can be viewed in the Centre or taken away for use in the office or home.

The facilities include over 40 Interactive Video subjects, divided into over 70 separate modules; these cover a range of interpersonal skills and languages. In addition, there are over 100 audio cassettes to choose from, computer based training materials and a large selection of books.

"One particularly helpful feature of the Centre's resources is that they come in different media, suitable for people like myself and many members of our team who travel frequently" says Chris Webbley, Departmental Quality Manager at



Martlesham. "So I have borrowed audio cassettes to make better use of time while driving on the A12, taken video cassettes to view at home, and used the more powerful features of interactive video at the Centre itself. This has helped me in fulfilling my Personal Development Plan, for example".

Looking to future developments in learning technology, there are also ten workstations equipped with CD-ROM, enabling employees to use the greatly enhanced power of Compact Discs. For further details contact:

Carol Durrant, Head of Management Training
(Tel: 0473 647658)

SHOCK, HORROR..... WE'RE NOT THERE YET !

As Vice-President accountable for overseeing and influencing the professional standards of some 50,000 members in the Institute of Personnel Management, I was dismayed recently to overhear a member speaking critically about CPD in terms of it being, in effect, a 'bureaucratic stick' with which to beat members when they wish to upgrade or maintain their membership. Upon enquiry, my subject turned out to be someone who had, to his credit, studied for and gained Graduateship of the IPM to help broaden his career; not necessarily to become a 'personnel professional'. He had fallen, however, into the trap of thinking about CPD only in terms of what the Institute requires, rather than in terms of what CPD might do for him. I suspect that, in so doing, he is not alone - either within our institute or others.

Times are changing. Professional and management careers are increasingly taking diverse and flexible paths. But that does not mean that there is any room for lack of professionalism within a career which might span one or more professions, specialisms or management functions. Indeed, a change in career direction is often, itself, an expression of personal development. Whether it is seen as professional development is open to debate, but in many cases it will be just that. It would be a tragedy if the benefits from CPD got lost in the transfer.

The IPM sees four overwhelming reasons for requiring CPD of its members:

- ◆ Ensuring that professionals remain up-to-date in a changing world.
- ◆ Ensuring that the reputation of those qualified in the profession is enhanced.
- ◆ Encouraging professionals to aspire to improved performance.
- ◆ Facilitating committed learning as an integrated part of work and to manage learning methods that are appropriate to the needs of the members' circumstances.

The emphasis of CPD should not be about *justification*, but

about *learning*. Our institute's requirements aim to reflect this. Less stress is put on 'What did you do?', than 'What did you learn?' and 'How might you, in the future, use what you did and learned?'. The latter two, we feel, are much more important. Our methods of recording both *formal* and *informal* CPD are non-prescriptive, though we provide guide notes and local help for those that need it.

CPD activity is obligatory for all our qualified members. We look for the equivalent of 5 days activity per annum. We recognise that in many and varied circumstances there are learning events that are applicable to professional capability. If people recognise the opportunities, they will hopefully be further stimulated to do more about 'feeding' those opportunities and making new ones - through education and other developmental processes.

IPM's policy translates into updating our professional knowledge and skills throughout our working lives, *including* career assignments and career breaks. Self-direction, self-management and responsiveness to development opportunities offered by our experiences in work and life are required. We believe that a commitment to CPD is essential to effective performance in all walks of life and, in our case, it adds value to professional personnel activity.

I am grateful to my younger colleague, referred to earlier, for bringing me some key issues to the forefront of my mind.....truly a CPD experience for me ! We, like other institutes, probably have much more work to do in engaging the hearts and minds of all our members in relation to CPD. In aiming at this, the need for Education by us is more prominent in my mind than the need for Regulation. Across the professions we have, in educating our members, much to learn from each other. The forthcoming merger of the Institute of Personnel Management and the Institute of Training and Development into the largest body of its kind in Europe offers an opportunity and a challenge to provide renewed leadership.

Mike Oram, FIPM, Vice-President, Membership & Education of the Institute of Personnel Management and Vice-President and Chairman Designate of the Membership & Education Committee of the new Institute of Personnel and Development (Tel: 081 946 9100)

CPD- INDIVIDUAL EXPERIENCES

Sally Martin, Instrument Engineer, Shell Refinery, Stanlow

"When I joined Shell as a graduate in 1987 I often felt frustrated by the constraints imposed by the IEE's structured training requirements. At the time I wanted to remain longer in each department to see the projects through, but my Mentor insisted that I stuck to the programme. It has only been in the last two years that I have seen the real merits of this. First, the job rotation provided me with broad technical experience, secondly gave me the time to get an overview of the company and, thirdly, I developed a very significant network; this was enhanced by a 16 week technical course in Holland which



forced me to spend time with a range of different people.

"Learning is not only about knowing the answers, but about **where** to get them. It is very useful, for example, to have the phone numbers of people to contact when you have problems.

"Shell have given me many superb opportunities for learning, including spending six months

commissioning a new catalytic cracker, as part of a commissioning team, early on in my career here. It was a high profile, fast moving, high responsibility job and gave me the chance to learn more in a short period of time than I will probably ever be able to again! Other opportunities have included helping with graduate recruitment interviews, working in the Personnel department for one day a week on two major projects, giving talks in schools and editing a company newsletter.

"The company have worked very hard with me to identify my ultimate career goals. As a result I feel I am managing my

career and am in control of it. It is a very structured approach, just like my initial IEE training.

"My ambitions are in management, rather than technical. One by-product of moving around is that you learn to deal with people. Too many technical people in this country are not trained to be managers, but nevertheless end up as managers and have not learned to deal with people. One of the key things I have learnt is that being an engineer is much more than being a technical expert."

Mark Meffan, CEng, Project Manager, Sir Alexander Gibbs & Partners

"I originally joined the Property Services Agency as a Civil Engineering graduate and followed the Institution of Civil Engineers' training scheme. This provided a very proactive approach to my training needs. There was a nice balance between meeting the company's needs and my own, since I was fully consulted on where I wanted to take my career through appraisals.

"Since my interest was more on the management side, I took on more demanding management positions, as well as attending a series of management courses. In 1991 I spent six months in the Falklands in charge of building a new road from the airport at Mount Pleasant through to Goose Green. This gave me the opportunity to be self-sufficient and the chance to learn by experimentation. We were living well out in the sticks, ten miles from the nearest habitation; I had to keep my team fed, warmed and even entertained in the evening.

"Before I took redundancy from the PSA in April 1993, I had become a part-time tutor on the SERC's Graduate School Programme, tutoring groups of ten for three weeks. I continued this while I was looking for a new job - a task I approached by producing a structured programme of how I would approach organisations applying for jobs.

"I joined Sir Alexander Gibbs in September 1993 and went on a number of very useful orientation courses. I have now achieved a balance in my experience between the theoretical and the practical and am able to realise my career ambitions as a project manager."

Mark Jewell, Mechanical Systems Engineer, British Aerospace Defence

"Having completed a Diploma in Engineering Management (the DipEM, which was featured on page 7 of the April 1993 issue of 'CPD Link'), I presented my experiences in undertaking this course, and the value of CPD, at a recent DipEM Employers Forum. I believe that the demands for CPD and the need to enhance one's marketability - both internally and externally - are growing all the time. These demand that we develop not only our technical strengths, but also our relationship and management skills. The DipEM provides just such an opportunity for self-development, as well as being of direct value to the company.

"For me the greatest form of support I have been given throughout this course by my employer has been the

time of senior managers and executives. I found senior people only too eager to share their views and experiences, which was a great source of encouragement to me.

"In making things happen, I have further developed my interpersonal and political skills, gaining a focus and deeper understanding of the challenges facing many organisations. In particular, my project work for the Diploma has also developed the creative and deeply human processes which I feel are required of leadership.

"I think it is clear that 'organisations' have to move away from the traditional hierarchical career path, to one of horizontal development of its people, moving across projects with the flattening of organisational structures. Without CPD one will simply be left behind or sidetracked; hence my motto is not 'when will I be promoted to a higher grade?', but rather 'what-can-I learn-next?!'"



CPD IN THE INSTITUTIONS

Getting CPD on the Right Rails

The Institution of Railway Signal Engineers launched their new Licensing Scheme on the 25th January 1994, with Sir Anthony Hidden as the Guest Speaker. Sir Anthony chaired the Investigation into the Clapham Junction Railway Accident in December 1988. The Licensing Scheme introduces a system for the licensing of competencies for safety-critical and safety-related tasks in the railway industry.

In his speech at the Launch, Sir Anthony said: 'Today is a day to look forward. Anything which has the effect of improving the standard of expertise in, and management of, railway signalling must be applauded as a good thing, and thus I warmly welcome the inauguration of this licensing system.'



Participants in the scheme are required to maintain a Continuing Professional Development Folder and Licensing Scheme Logbook as proof of their continuing employment on licensable work. This record of the competent use of skills will be reviewed when licences are due for renewal, and will also assist railway industry employers to satisfy the work authorisation requirements contained in the Railway (Safety Critical Work) Regulations, which came into force on the 1st April 1994.

Already 30 activities in design, installation, testing and maintenance have been identified for Licensing in signalling and telecoms. Employers of licensable staff are now able to register with the scheme. They will receive copies of Competence Assessment Checklists to use in the workplace assessment of their employees, prior to formal assessment at an IRSE approved Assessing Agent.

The CPD Folder then has an important role to play in both ensuring that these Licensed Competencies are maintained and in planning the licensee's career development. In addition, the document provides employers with a verified record of a prospective employee's capabilities and achievements.

For further details contact Mark Watson-Walker, Licensing Registrar (Tel: 071 836 3357 ext 208)

IPM and ITD to Merge

The memberships of the Institute of Personnel Management (IPM) and the Institute of Training and Development (ITD) have voted overwhelmingly to merge their two organisations. The new combined Institute of Personnel and Development will formally take over the affairs of the IPM and the ITD as from the 1st July 1994. With around 70,000 members, it will become Europe's largest body of personnel and development professionals.

IPM President Mike Bett said the results showed the strong commitment of personnel and development specialists alike "to emphasising the strategic importance of people". ITD spokesperson Judith Manifold said the vote "clearly indicates the will of training and development professionals to adopt a strategic approach".

£150,000 Engineering Professional Development Awards Launched

The Royal Academy of Engineering is launching a new initiative to help engineering companies develop the skills of their engineers. The £150,000 Engineering Professional Development Awards are being launched with the assistance of a Government grant from the Office of Science and Technology.

Sir William Barlow, FEng, President of The Academy, says: "Training is constantly identified as a key means of improving competitiveness. Through these awards we are asking companies to identify their own training needs and then seek the necessary support from us".

Awards of between £2,000 and £10,000 will be made to companies or consortia of companies submitting training programmes involving up to 15 engineers. Those eligible will be UK companies operating in the engineering and manufacturing sectors with experienced engineering employees already educated to degree or HND level.

Training programmes may involve full or part-time short courses relating to technology or management subjects, language courses and training required for implementing new legislation.

Short-term secondments for familiarisation with new practices and processes, and attendance at conferences and seminars are also eligible for support.

Applications must be received by 14 October 1994. Applications should include details of each participating engineer, justification for the training and post-training performance objectives. Details of any courses or secondments and their providers must also be given. Total cost breakdowns should include the amount that the company itself intends to contribute to the training programme.

For details contact Ian Bowbrick, Manager Postgraduate and Professional Development (071 222 2688)

MOVING TOWARDS A LEARNING ORGANISATION IN HONG KONG

In Hong Kong the 1990s have been characterised as turbulent years with companies facing a rapidly changing social, economic and political environment. This level of change is likely to escalate as Hong Kong heads into an increasingly uncertain future and a company's ability to deal with this dynamism is likely to be the chief arbiter of its success. In order to maintain and improve its high level of service to the Hong Kong community, The Mass Transit Railway Corporation (MTRC) believes that the key to long-term success is the creation of a learning culture.

Continuous Improvement

MTRC adopted a competency-based approach to man management in 1990 to facilitate a culture of 'Continuous Improvement'. They developed a structured way of describing behaviour in the organisation, looking at the added value of managers and providing a common language to integrate both strategic and operational level personnel and business plans. The competencies critical for success at three different levels in management were agreed and, early this year, extended to supervisory levels.

A Competency Based Development Approach

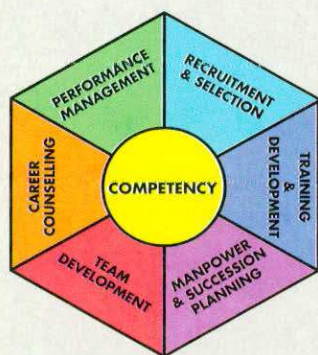
A combination of objective and empirical methods were used to identify the key competencies critical for the success of the organisation. These methods included using structured computerised questionnaires, the repertory grid method and the 'critical incident technique' (where managers are asked to identify the significant competencies they have used in a number of different situations). Recognising the dynamic nature of Hong Kong, these key competencies are regularly reviewed.

An Integrated Human Resource Management Systems Approach

Use of these key management competencies starts at the recruitment stage to ensure that individuals are a 'best fit' for

their jobs. They are also integrated into the appraisal and performance management system, and in designing training and development programmes. This has allowed MTRC to reward those whose competencies best meet its business needs and to maximise its investment in its employees.

This also provides a framework to identify the quality of the staff resources currently available, as well as to plan manpower needs over the next five years.



INTEGRATED HUMAN RESOURCE MANAGEMENT SYSTEMS APPROACH

Contributions Welcome

Following my request in the last Issue, a number of useful comments have been received on the value of these newsletters. Further views are invited and will be summarised in the next Issue; contributions for articles are always welcome.

Please contact Chris Senior, CEng, at The Engineering Council. (Tel: 071 240 7891, Fax: 071 379 5586)

Assessment Centres for the Development of Individual Potential

Assessment Centres are used to assess groups of managers for possible promotion using well qualified observers in an off-the-job setting. The assessment tools used include tests, questionnaires and behavioural simulations.

MTRC believes that organisational performance can only be improved by the commitment of individual managers to their own self development. Therefore all managers are encouraged, but not forced, to participate in the two-day assessment events. By the end of 1993, 19 executive managers (63%), 59 senior managers (92%) and 76 junior managers (33%) had already attended these centres.

The Role of the Development Adviser

The assessment feedback report is discussed by the participant's manager, the observer, the participant and a development adviser, whose role is to advise on the appropriate next steps. The adviser continues to review progress with the participant until a development plan has been implemented, offering individually tailored advice and support at every stage.

However, responsibility for implementing the development plan rests firmly with the individual, supported by the line manager, who carries out a final review approximately a year after the date of the assessment.

Future Direction

MTRC believes firmly that CPD is the key to its future success. In 1994 the concept of competency will be cascaded down to supervisory levels and a detailed analysis of the technical competency needs will also be made.

A database has been set up to monitor all the data from the evaluations made at the recruitment stage, the annual appraisal and the assessment of potential at the Development Centres. All this is used for manpower and succession planning to support the organisation's future business plans.

For further details contact Daniel K K Cheung, Manager Manpower Development (Fax: 010 852 751 3400)

Congratulations to CRAC

on their 30th Anniversary. For the fourth year running they are organising a CPD Conference - this year on 24th June. Entitled 'Integrating Continuing Professional Development into Business', it is arranged in association with The Engineering Council, the Institute of Management, the Institute of Personnel Management and The Law Society.

The three main speakers will be Mike Bett - Deputy Chairman of BT and President of the Institute of Personnel Management, Mary Chapman - Chief Executive, Investors in People UK, and Dr Alan Mumford - Specialist in Director and Management Development. There will also be 11 different Workshops discussing key issues in a practical way.

For details contact Gini Jackson (Tel: 0223 460277)

CPD Team Expands

Bob Sellix, CEng, seconded from PowerGen, has become CPD Manager for Kent and Sussex. Bob will promote CPD and support action by individuals and employers, linking professional and academic institutions. He joins other members of The Engineering Council team providing a focus for CPD in the regions.



For further details, please contact Miss Sonia Thomas (Tel: 071 240 7891)

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The Institute of Acoustics was formed in 1974 through the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society and is the premier organisation in the United Kingdom concerned with acoustics. The present membership is in excess of two thousand and since 1977 it has been a fully professional Institute. The Institute has representation in many major research, educational, planning and industrial establishments covering all aspects of acoustics including aerodynamic noise, environmental, industrial and architectural acoustics, audiology, building acoustics, hearing, electroacoustics, infrasonics, ultrasonics, noise, physical acoustics, speech, transportation noise, underwater acoustics and vibration. The Institute is a Registered Charity no. 267026.

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Dear Fellow Member

The Spring Conference in Salford was the occasion for my inauguration as President and, as I tried to say at the time, I am very conscious of the honour the Institute has done me in asking me to preside for the next two years. I will have to work hard to maintain the high standards set by all those big names of acoustics. For those of you who may not know me, I recently retired as partner in Sandy Brown Associates and am now a part time consultant with them. Prior to this, until 1973, I was with the BBC Research Department at Kingswood Warren.

During my two years of preparation as President Elect I have only had to deputise twice for Peter Wheeler – that wasn't much of a preparation, was it? However, it has been invaluable to watch and note the necessary activities during Council meetings, Committee meetings, AGMs, Conferences etc. Everything proceeds at a leisurely pace with the actual responsibilities safely ahead until, suddenly, your time is upon you. As various chairmen of committees and activists on other matters approached me during the recent conference I began to realise that the post wasn't the sinecure that I had expected. My admiration for previous presidents who have simultaneously held down posts as Departmental heads, Senior Local Authority Officers etc grows apace.

It is traditional for the incoming President to lay out his stall in his first letter with the measures he intends to promote during the next two years. We are still a long way short of the sponsor level of support which Chris Rice put forward as an aim for financial stability in 1990. The membership growth has already exceeded his expectations but our subscriptions, painful though they may be, do not of themselves cover our operational outgoings. I hope to renew contact with many old friends and make new contacts and friends in the coming years, and the possibility of encouraging new sponsors will be in the forefront of my thoughts. We should also attempt to raise our profile generally and ensure that the Institute is seen as the prime source of acoustical information and comment.

The Spring Conference was a success at many levels. The number of papers expanded to fill two parallel sessions; of these several were refereed and our thanks are due to the referees who dealt with papers quickly in order to maintain the printing deadlines. The number of delegates (and a small number of accompanying delegates) swelled to 169. Fourteen firms exhibited an ever growing range of sophisticated measurement and analysis equipment together with some acoustic materials and related exhibits. My apologies to those stands which I didn't manage to visit this time round - come back next time and give me another chance. The social programme took us on visits to places many of us never otherwise have seen but which proved interesting, and our thanks are due to those who organised this side of the Conference.

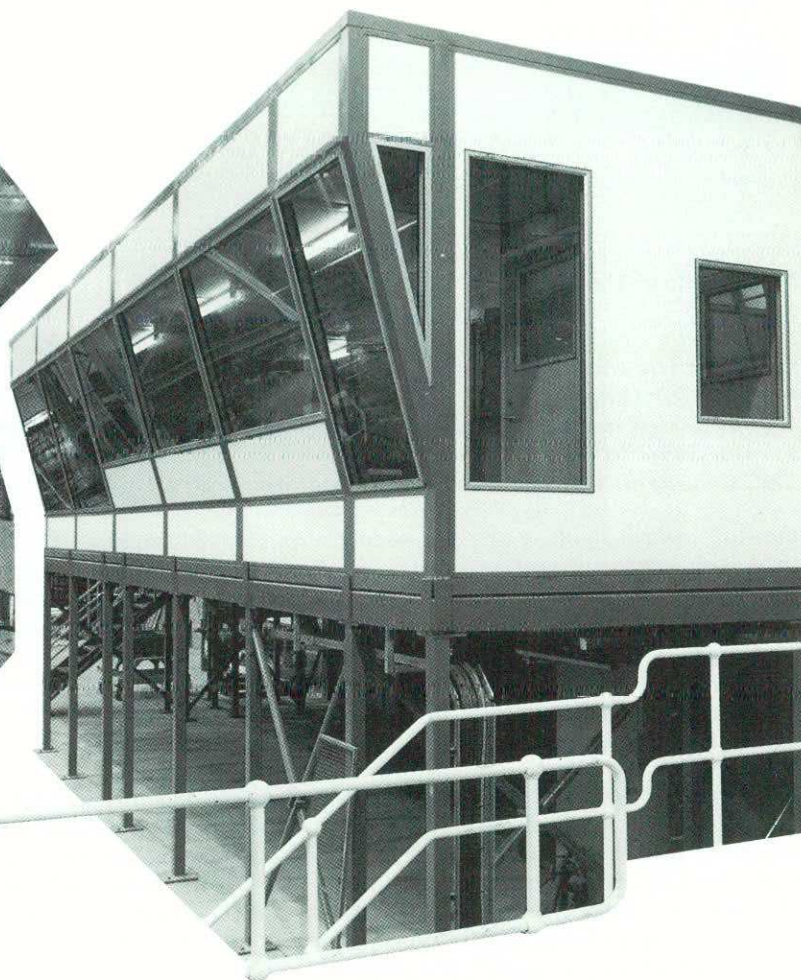
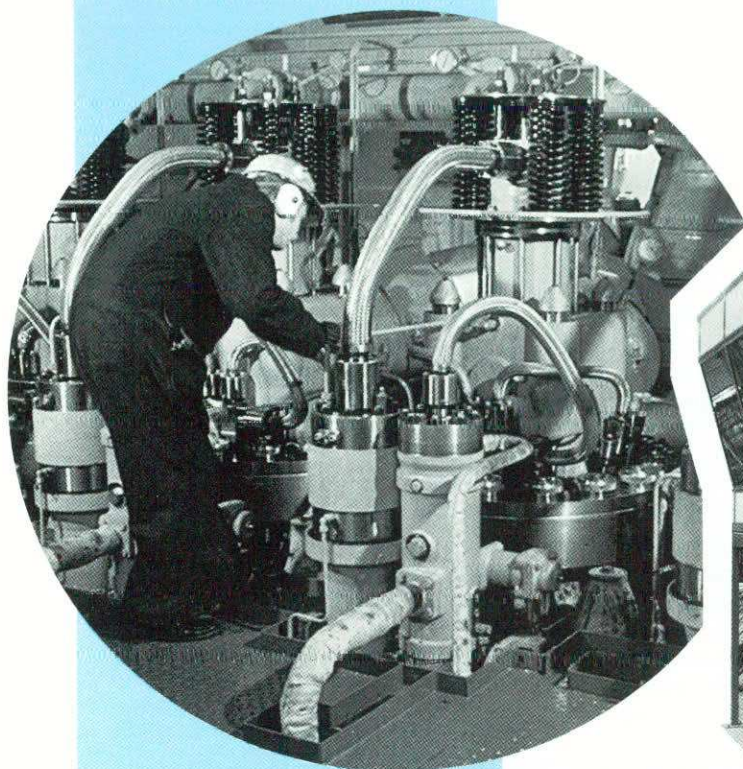
I look forward to the challenges of the next two years with your support.

Sincerely yours,

Alex Burd

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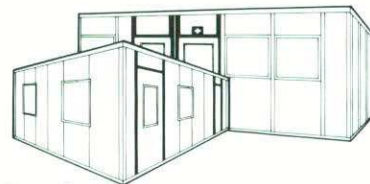
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THE GUITAR: ITS PAST, PRESENT AND FUTURE

Bernard E Richardson MIOA

Historical Origin

The earliest examples of stringed musical instruments consisted of one or more strings stretched over a stick attached to a hollow resonator such as a gourd. The strings, possibly made from plaited horsehair, might be plucked with the finger or a plectrum or bowed as in a violin. Although such primitive instruments still exist in various parts of the world, we are concerned here with the more sophisticated wooden instruments which appeared in Europe during the Dark and Middle Ages with the spread of the Islamic culture. Following the death of the prophet Mohammed in 632, Arab Moslems became a major political force, overtaking lands to the west along the Mediterranean coast of Africa and north into Spain. To the east they conquered Persia, northern India and parts of China. But these were not barbaric invaders like those who had brought about the demise of the Roman empire; these people were highly civilised with interests in the arts and sciences, legacies from their own culture and those of the ancient Greeks. During this expansion, they took with them a group of instruments known as *al' ud*, literally meaning 'of wood', a word which was later transformed into 'lute'. *Al' ud* was the successor to much earlier pear-shaped Egyptian and Persian instruments, which were carved from solid wood and incorporated a soundboard made from stretched animal skin. By contrast, *al' ud* was made entirely from wood.

Originally it had four strings and four frets to enable it to play a modest 20 notes on the diatonic scale. *Al' ud* had all the characteristics which were later to

become highly stylised in the renaissance lute: it had a back constructed from several facets, a steeply-angled head stock, and a soundboard incorporating a carved rose and a fixed bridge. Further details of the origin and subsequent development of the lute family is given by Jahnel [1].

The Vihuela and Early Guitars

The Moorish settlers of southern Spain retained power

Special Issue on Musical Acoustics

Music has been with us since the beginning of recorded history, and in many parts of the world archeologists have found instruments made of materials such as stone, metal and bone that are many thousands of years old. By the time of the rise of the early cultures in the Near East, the plucked string of the hunter's bow had probably evolved into early forms of harps and lyres, to be used with pipes and drums of various kinds.

By the sixth century BC, Pythagoras knew about the musical consonances of the octave, fifth and fourth, and these intervals provided the harmonic basis for almost all Western music until the end of the Middle Ages.

This is no coincidence; these intervals are derived from the first overtones of the harmonic series generated by most natural sound sources, especially strings and pipes. Nor, of course, is our use of the word harmonic in relation to both music and spectral overtones a coincidence.

None of this would have been known by the early Luthiers (nor would it be known by many today), but the point is made that music and the instruments to play it have evolved together over time, and that this evolution has been based largely on natural laws. It is only with the relatively recent arrival of musical acousticians that we have begun to understand these natural laws.

However, in order to fully understand the subtleties and complexities of modern musical instruments, especially when it comes to subjective judgements about what is good and bad in music, this evolutionary process must be taken into account. The physics of musical instruments can only be studied sensibly in conjunction with a knowledge of the music played on them, the demands of both musicians and listeners, the materials available for their manufacture, and the tools and technology their makers could have used. In short, musical acoustics forms just part of an overall musical culture.

This small collection of articles introduces some of these concepts with a discussion of some instruments that were widely used throughout Europe in the first half of the millenium, and whose descendants are still with us today. It is entirely a matter of luck (or Editor's skill at cajoling volunteer authors) that three of them deal with strings and one with brass, while reeds and percussion have been left out. Nevertheless, it will be seen that all four papers contain many ideas that are complementary, and enhance the evolutionary concepts discussed above.

Finally, these piece have been written by three musical acousticians – some of them 'amateur' and some of them 'professional' – and an instrument maker, and all of them have a degree of competence as musicians.

This mixture leads to a variety of viewpoints, and if some of the luthier's ideas seem unusual in the acoustical sense remember that he makes beautiful musical instruments and makes them work!

Peter Dobbins

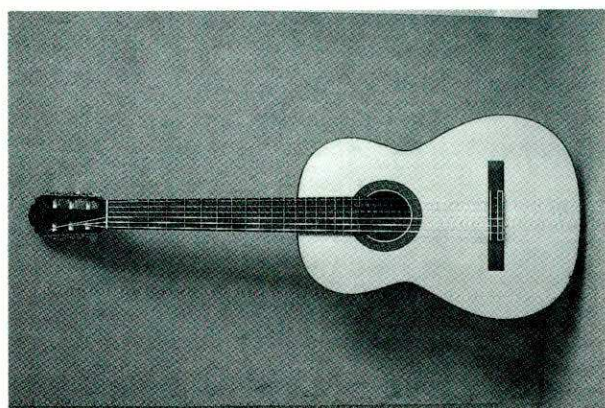
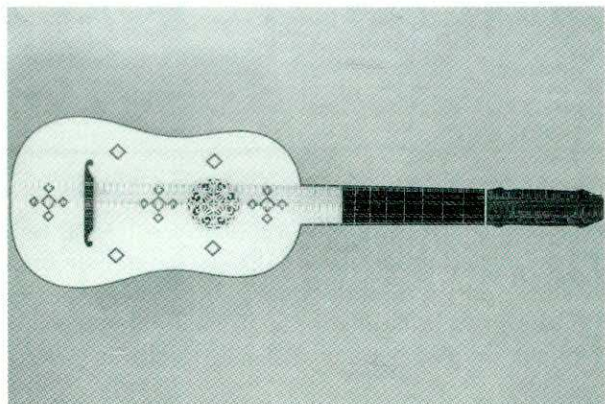


Fig. 1. (a) Instrument in the style of a vihuela made by Martin Fleeson in 1978 (courtesy of Rhisiart Arwel). (b) Modern concert guitar.

from their centre of government in Cordoba for nearly 600 years. The Islamic influence can still be seen in buildings such as the Great Mosque at Cordoba or the Alhambra at Granada. By the time Christian rule came back to Andalusia, a group of new instruments had come into existence. These were known collectively as *guitarra*. They differed from *al' ud* in that they were of box construction, with their soundboards and back plates separated by pairs of ribs (sides). By the fifteenth century, two forms of *guitarra* were in common use: the six-course *vihuela de péñola*, and a smaller, less-refined four-course 'guitar'. Courses refer to pairs of strings tuned either in unison or octaves and were a common feature of instruments of this period. Both the vihuela and the guitar displayed the characteristic features of the modern guitar, including the incurving waist, flat back and a shallow-angled head stock with pegs inserted from the rear (see Figure 1). As suggested by its name, the *vihuela de péñola* was played using a plectrum, but contemporary references are also made to *vihuela de arco* and *vihuela de mano*. Because of Spanish rule in the State of Naples, similar instruments were also to be found in Italy under the name *viola*.

The golden age of the vihuela was during the sixteenth century. By this time only the *vihuela de mano*, plucked with the fingers and thumb of the right hand, was prominent in Spain. Its use by professional musicians playing in the Spanish royal courts and noble houses

prompted foreign commentators to call the vihuela the 'Spanish lute'. Indeed, the two instruments shared the same tuning. Figure 1a shows the general form of the vihuela. There was no standardisation in size, though many used a string length comparable to the modern guitar. The most noticeable differences between the vihuela and the modern guitar are the smaller body and shallower ribs, the low bridge position, the moveable gut frets and the carved rose. Table 1 compares important dimensions. Some wonderful music, much of it technically demanding, survives in tablature form from composer/players such as Luis Milán and Alonso Mudarra. Guitar transcriptions of their entertaining music can still be heard in concert halls today.

During this period, the four-course guitar was also popular but it enjoyed a lower status, possibly because it was less demanding to play. However, it is interesting to note that Mudarra includes transcriptions for it in his vihuela anthologies. It is somewhat ironic, therefore, that by the end of the sixteenth century the vihuela had fallen from favour and its place taken by the guitar, now invested with a fifth course of strings. The courses were tuned A-D-G-B-E like the upper five strings of the modern instrument. Five-course guitars became popular throughout Europe. Instruments from this period are often highly elaborate, with intricate decoration skilfully executed in exotic materials. Photographic examples are given by Turnbull [2].

The story comes full circle when at the end of the eighteenth century a sixth string, tuned to low E, was added and the practice of double stringing ceased. This followed a period in which the most popular use for the guitar had been strummed accompaniment for songs. The addition of the extra string revitalised interest in the guitar, which now repossessed the more formidable musical possibilities of the noble vihuela.

Nineteenth Century Developments

There can be few pupils of the guitar today who have not benefited from the music and studies of Fernando Sor or Mauro Giuliani. These two virtuosic exponents of the new six-string guitar gave concerts throughout Spain, France and Italy and inspired new approaches to guitar making. A longer, raised fingerboard with the twelfth fret at the body joint facilitated playing in the upper range. As a

Item	Dimensions/mm	
	Vihuela	Modern Guitar
String Length	600	650
Body Length	440	480
Upper Bout	235	275
Waist	215	230
Lower Bout	275	360
Depth of Ribs	72	110
Soundhole Diameter	80	86

Table 1. Physical dimensions of the vihuela and guitar shown in Figure 1.

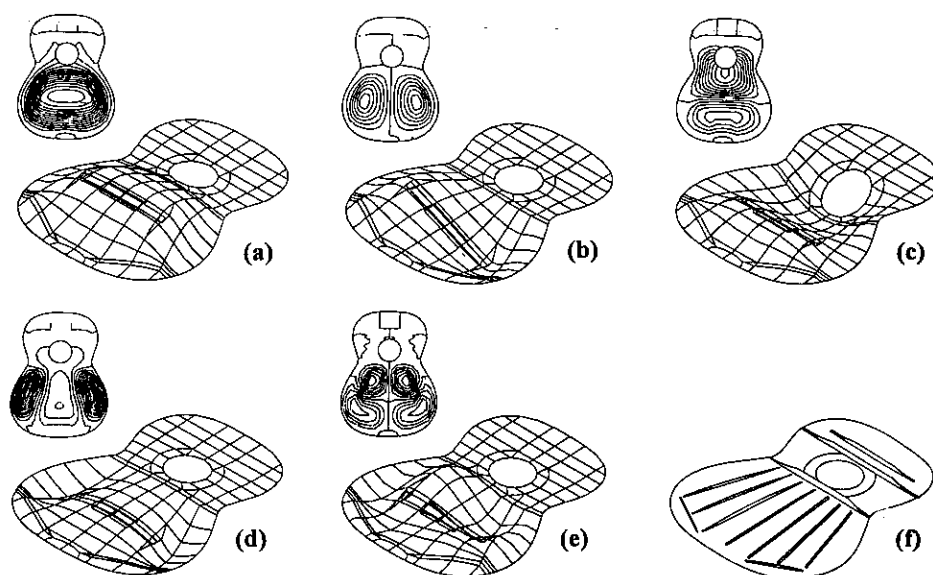


Fig. 2. Modes of vibration of a guitar soundboard computed by the finite element method. Figure 2f shows the internal strutting of the soundboard.

consequence, the bridge was raised to a more central position and the use of a bridge saddle created a cleaner sound. The carved rose and most of the excessive ornamentation was abandoned to produce guitars of beautiful simplicity. But there were more subtle changes occurring inside the instrument. Influential makers such as Josef Pages of Cadiz and Louis Panormo of London were beginning to develop a rudimentary system of fan-struts to support the bridge in its new, more vulnerable position. These replaced the simple lateral bars used in the lute, vihuela and early guitars (Usher [3], Ford [4]). Given the history of the guitar, it is perhaps fitting that the guitar finally came of age in the workshops of a native of Andalusia. Antonio de Torres Jurado (1817–1892) enlarged the size of the body and further developed the fan-strutting (see Figure 2f) to provide the basic model for the guitar in use today. A fascinating insight into Torres' life and methods is given by Romanillos [5]. Torres' success was not, however, simply the result of his technological achievements but due in part to his symbiosis with Tárrega, the most influential player, composer and teacher at the end of the century. Performances by Tárrega and his pupils spread these new sounds to the rest of the world and helped to make the guitar one of the most popular musical instruments of the twentieth century.

An Acoustical Perspective

There are two complementary requirements of the fan-strutting system in the guitar. Clearly, the strutted

plate must have sufficient static strength to prevent distortion and premature failure under the action of the sizeable force applied to the upper edge of the bridge by the strings. The magnitude of this torque has increased over the years because of the use of higher tension strings and because of the increase in height of the bridge saddle. On the other hand, the soundboard must retain sufficient dynamic flexibility to respond to the vibrations of the strings. Hence, the relative merits of various strutting systems is a hotly-debated subject amongst makers. Many makers consider that the 'secret' of a good guitar is hidden in the design of the fan-strutting. Some have even taken out patents to protect their strutting systems. However, when you consider that any maker's 'secret' can be

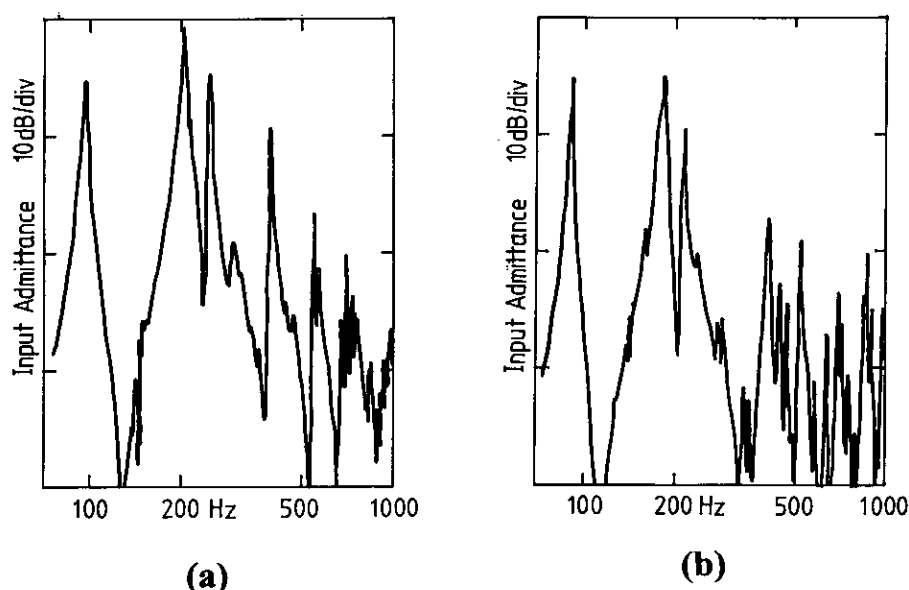


Fig. 3. Input admittance measured at the bridge of (a) a vihuela, and (b) a modern guitar. The same reference level was used in each case.

discovered in a few minutes using a lamp and mirror, it is clear that the construction of a good instrument has further, less-apparent complexities.

The basic function of the guitar body is to act as an impedance converter to enhance the transfer of the vibrational energy of the string into sound energy in the surrounding air. As the vibrating string swings to and fro, it alters the down-bearing force it exerts at the bridge, and this varying force causes the whole body of the instrument to vibrate in sympathy. The sound we hear comes from these vibrations of the body. The most efficient radiation comes from motion which creates a cyclic volume change of the instrument.

The body itself vibrates in a complex manner, but it is convenient to break down this motion into the component normal modes of vibration of the body. Computer simulations of the first five modes of a guitar soundboard are shown in Figure 2. Vibration studies of guitars in various stages of construction show that these are accurate representations of the real action of the instrument (Richardson [6]). The figure highlights some important aspects of the mechanical action of the soundboard. The dominant struts are those which traverse the plate, the most important being the strut immediately below the soundhole and

thickness. Torres was a clear master at this process. For example, he would sacrifice visual symmetry in order to obtain the greatest advantage from the woods at his disposal (Romanillos [5]).

The guitar body is a lightly-damped structure, so we find that the input admittance (velocity per unit driving force) is highly dependent on frequency and displays a large number of sharp resonance peaks (Figure 3). The majority of resonance peaks in the frequency range up to about 2 kHz can be attributed to individual modes of the soundboard or back plate. In other cases, they are the result of coupling between pairs of modes. The most notable of these is the coupling between the fundamental plate mode (Figure 2a) and the Helmholtz mode of the cavity. This extends the low-frequency range of the instrument and operates on the same principle as the bass-reflex loudspeaker. The motion of the plate at both resonances is similar, involving uni-phase motion over the plate. The coupled resonances involve either in-phase or out-of-phase motion of the plate relative to the air in the soundhole. The back plate may also participate in this coupled system (eg see Fletcher and Rossing [9]). The two lowest peaks in Figures 3a and 3b represent the result of this coupling.

Comparisons between the modes of the vihuela and the modern guitar shown in Figure 1 are interesting, partly because of the different outline shape, and partly because the vihuela was strutted in a traditional style with two light struts only placed either side of the rose. (It was common to include a third strut just below the bridge, which may or may not be present in this instrument.) Table 2 compares the resonance frequencies of the first few modes. Holographic interferometric measurements showed that the mode shapes of the vihuela were very similar in character to those on the guitar, despite the differences in construction. Even though the vihuela is much smaller than the guitar, we see that the resonance frequencies are comparable. This is due mainly to the vihuela's extremely thin soundboard (estimated to be about half that of the modern instrument). The lowest resonance is kept low partly by the thin plate and partly by the reduced opening in the carved rose and the corresponding low Helmholtz resonance of the cavity. Neither set of frequencies should be regarded as being definitive for that class of instrument. There is, in fact, considerable variation in mode frequencies from one instrument to another; this is one of the reasons why each instrument has its own unique sound quality.

There is a common misconception amongst the stringed-instrument fraternity that it is the absolute frequencies of certain modes which determines the sound quality of an instrument. I myself have indulged in these notions, but considerable research has failed to show any clear relationships between the two. What is more important is to understand the coupling between the strings and the body and the coupling between the body and the surrounding air, because this gives a measure of how readily the instrument assists in the radiation of useful energy. For example, a soundboard may in principle be an excellent radiator of sound, but if the string is located near a

Mode ¹	Mode Frequency/Hz ²	
	Vihuela	Modern Guitar
'Air Mode'	101	103
(1,1)	203	213
(2,1)	246	268
(1,2)	399	436
(3,1)	520	553

Note 1. The first two resonances involve motion similar to that shown in Figure 2a (see text). The following modes correspond to Figures 2b, 2c and 2d respectively.

Note 2. Data from Richardson [6]

Table 2. Comparison of resonance frequencies in the vihuela and guitar shown in Figure 1.

the bridge. Both lie across the grain of the soundboard, a direction in which it is naturally much less stiff. Makers do not normally consider that the bridge is part of the strutting system, but its overall dimensions and the relative proportions of the bridge wings have a profound effect on the frequencies and shapes of the modes of the soundboard (Richardson [7]). Much less important are the small fan-braces which run more or less along the grain (along the length of the instrument). These help to stiffen the plate, but it is clear that their exact number or their specific orientation is of little importance. Of course, the thickness of the soundboard and the elastic properties of the material from which it is made are extremely important. Walker [8] has investigated the effect on the modes of systematic variations in soundboard parameters, including dimensions and material properties. One of the skills of the maker is to select wood which is inherently light-weight but stiff and to work this to its 'optimum'

node it will fail to communicate with it effectively. So the precise shape of a mode is of considerable importance. Another common misconception is that high string frequencies radiate through high-frequency modes. However, Brooke [10] has shown the importance of the low-order body modes in sound radiation at all frequencies. In all cases, the important measure here is the effective mass of the mode as seen by the string at the bridge. Even tiny changes in construction can bring about substantial modifications to this quantity and consequently affect the sound quality. This explains the variability of instruments apparently built to the same specifications.

The coupling between the strings and the body must, however, be carefully regulated. Our text-book string begins to depart rapidly from its usual behaviour when it is mounted on a support which is itself an oscillator. As in the case of the soundboard and air cavity, we get coupling, and if this becomes too strong, mode splitting occurs, which produces inharmonicity of the string partials and a rapid decay of the sound. The string ceases to be the dominant partner with disastrous consequences for the sound. The lowest few modes of the guitar are susceptible to this problem. In my opinion, too many contemporary makers fall into the trap of making over-responsive instruments, which although they sound loud often lack the sweetness and clarity of more-controlled instruments. This is one of the dilemmas which has accompanied the gradual increase in size of the guitar.

Figure 3 shows a comparison between the input admittance of the vihuela and a guitar. We see clearly that the light-weight structure of the vihuela is much easier to drive than the modern guitar, ie the effective masses of the modes are much lower. This was necessary to take account of the much lighter-gauge strings which were in use in those days. The gut strings fitted to the vihuela had a tension about one third their synthetic counterparts on the modern instrument; thus, although the driving force of the strings at the bridge is reduced proportionately, the sound output of this instrument was surprisingly loud simply because the structure was easier to drive. It appears that, in response to higher-tension stringing, the natural development of the instrument has been to create larger, more rigidly-braced soundboards. The balance between plate size and stiffness must, however, be carefully regulated if the acoustical advantages are to be maximised. There is no reason to believe that balance has yet been optimised.

Current Trends

From this brief encounter with the history of the guitar, it will be clear that guitar makers have always been an innovative group of people. This is a refreshing change from the dogmatic approach taken to the construction of some other stringed instruments. Few, therefore, are content to build to a 'formula' without some experimentation of their own. One of the most interesting recent developments is the use of criss-cross lattice bracing, a technique which clearly owes much to the traditional concepts of fan-strutting, but one which allows the stiffness-to-mass ratio of the plate to be further increased. The result can

produce a more powerful instrument, but as always one must be aware of the possible degradation of tone quality discussed above. Instruments such as these, however, go some way towards satisfying the demands of players who need to perform in large concert halls.

Makers will continue to innovate, partly because it is a necessary part of the process of learning how to accommodate for variations in materials. As well as traditional methods, new materials and automated methods of manufacture are now available. Only time will tell whether these will help to 'improve' the quality of instruments or at least improve the consistency of their manufacture. The most significant and lasting developments which have occurred in the guitar have come about in response to the musical demands of players and composers. The success of each manifestation of the guitar in its own time is a testament to its suitability for its required purpose. Change should not be driven by technology or economics. One of the greatest difficulties to be faced is in defining what changes would be desirable. There is not, and never will be, any such thing as an 'ideal' guitar sound. Radical changes in materials or construction which offer genuine musical advantage will, no doubt, be universally adopted. Unfortunately, all too many innovations in guitar design are based upon a false premise or false expectation, and these sorts of innovations are doomed to failure or to become the curiosities of future generations. At the end of the day, however, there is no substitute for the sensibilities of the skilled craftsman, whose traditional skills embody centuries of experience, and who has learned through long experience how to extract the required vibrations from carefully chosen and carefully fashioned pieces of wood. It is these makers who hold the key to the future prosperity of the instrument.

References

- [1] F JAHNEL, 'Manual of Guitar Technology', Verlag das Musikinstrument, Frankfurt am Main, (1981)
- [2] H TURNBULL, 'The Guitar from the Renaissance to the Present Day', Batsford Ltd, London, (1974)
- [3] T USHER, 'The spanish guitar in the nineteenth and twentieth centuries', *Galpin Society Journal*, Vol XI, pp 5-36, (1956)
- [4] C FORD (Ed), 'Making Musical Instruments', Faber and Faber, London and Boston, (1979)
- [5] J L ROMANILLOS, 'Antonio de Torres, Guitar Maker - His Life and Work', Element Books Ltd, Longmead, Shaftsbury, Dorset, (1987)
- [6] B E RICHARDSON, 'The acoustical development of the guitar', To be published in *Journal of the Catgut Acoustical Society*, Vol 2, No 5, (1994)
- [7] B E RICHARDSON, 'The influence of strutting on the top-plate modes of a guitar', *Catgut Acoustical Society Newsletter*, No 40, pp 13-17, (1983)
- [8] G P WALKER, 'Towards a physical model of the guitar', PhD Thesis, University of Wales, (1991)
- [9] N H FLETCHER & T D ROSSING, 'The Physics of Musical Instruments', Springer-Verlag: New York Inc, (1991)
- [10] M BROOKE, 'Numerical simulation of guitar radiation fields using the boundary element method', PhD Thesis, University of Wales, (1992)

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The Sackbut, the Cornett and the Serpent

Murray Campbell MIOA

Introduction

In the early nineteenth century, the world of brass instruments was revolutionised by the introduction of piston and rotary valves. The valve allowed an additional section to be added to the tubing of any type of instrument, thus lowering the frequencies of all of the modes of the tube and permitting a range of additional possible notes. By a suitable choice of valve system, every instrument could be made capable of playing a chromatic scale (in consecutive semitone steps), at least over most of its compass.

Before the introduction of the valve, few instruments with cup mouthpieces had this capability. In the seventeenth and eighteenth centuries, there were only three cup mouthpiece instruments which were routinely expected to play chromatically over two octaves or more: the sackbut, the cornett, and the serpent. In this paper, some of the acoustical properties of these three Baroque instruments are briefly considered.

Acoustical studies of early wind instruments are motivated by various considerations. On the whole, the instruments are simpler in design and construction than later wind instruments, and offer a useful testing ground for theoretical studies of the acoustical effects of bore profile and finger hole variations. The manufacture of reproductions of early instruments is now a flourishing industry, and studies of existing instruments can help to guide the modern generation of makers. Frequently, a surviving museum specimen may have been constructed to play at a pitch different from that in current use, and the scaling of the instrument to play at modern pitch would be greatly aided by an understanding of the acoustics of the instrument. Such an understanding would also help a maker to correct faults in intonation or timbre in a particular instrument.

Several techniques have been used to study the acoustical properties of modern cup mouthpiece instruments. A long established approach, which has added greatly to our understanding of all wind instruments, has been the measurement of the input impedance, defined as the ratio of pressure to volume flow rate at the entrance to the instrument (Backus [1], Elliott et al [2]). Pulse reflectometry has more recently been shown to be capable of providing measurements of input impedance and bore profile (Watson and Bowsher [3]). Interference holography has demonstrated the vibrational patterns of trom-

bone bells (Smith [4]), and deductions have also been made from measurements of the sound spectra of played instruments (Lawson and Lawson [5]).

Up to the present time, few measurements have been made on the acoustical properties of historic cup mouthpiece instruments, although a recent study describes impulse reflectometry measurements on serpents (Drinker and Bowsher [6]). The following discussion focuses on results obtained using a conventional input impedance measurement apparatus in the Acoustics Laboratory of the Department of Physics at the University of Edinburgh.

Technique of Input Impedance Measurement

The apparatus used to obtain the measurements discussed below (Figure 1) is based on that described by Backus, but incorporates various improvements suggested by Kergomard and Caussé [7]. The output from a sine

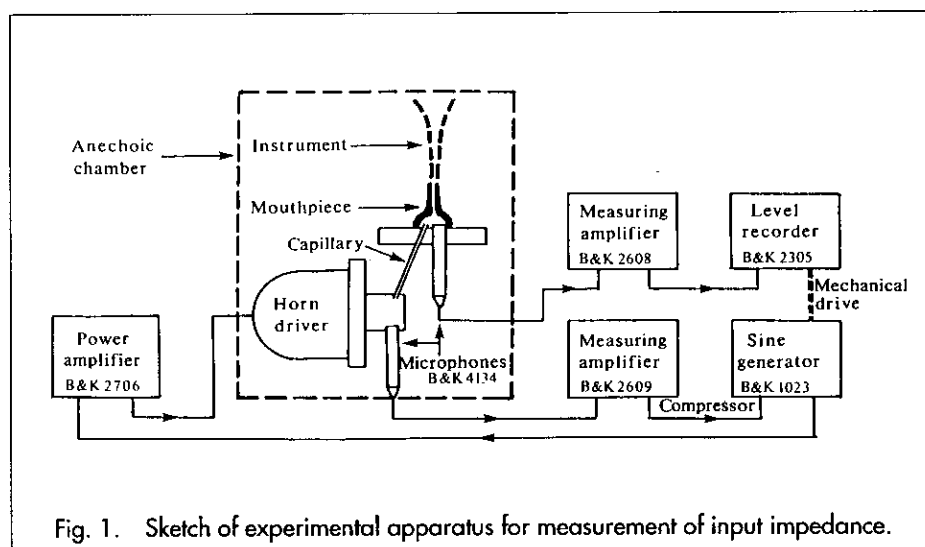


Fig. 1. Sketch of experimental apparatus for measurement of input impedance.

generator feeds a horn loudspeaker driver. A microphone senses the acoustic pressure generated in a cavity by the driver; the output of this microphone is used as a feedback signal, controlling the output of the sine generator so as to maintain a constant cavity pressure amplitude. An annular capillary, in the form of a hexagonal rod forced into a cylindrical tube, connects the cavity to a horizontal flange on which is mounted the mouthpiece of the instrument under test. On the assumption that the impedance of the capillary is independent of frequency, and much larger than the highest impedance to be measured, this system can be considered as a source of constant volume velocity. The pressure in the mouthpiece, measured by a second microphone, is then directly proportional to the input impedance at the entrance plane of the instrument. Measurements on systems of known impedance, such as small closed volumes and cylindrical

tubes, allow the apparatus to be calibrated. Further details are given elsewhere (Campbell [8]).

It should be noted that this type of equipment yields only the magnitude of the complex input impedance. Nevertheless, many interesting deductions about the practical behaviour of wind instruments may be made by observing this quantity. The following sections concentrate on the information which may be obtained about the frequencies of the resonant modes of the air column.

The Sackbut

The trombone, with its characteristic double slide, evolved from the slide trumpet (with a single sliding mouthpipe) in the second half of the fifteenth century. Until the eighteenth century it was known in Britain as the sackbut. The instrument has changed remarkably little in its five centuries of life, although the modern orchestral trombone has a rather wider bore and a much larger bell than its Renaissance ancestor. The volume and profile of a typical present day trombone mouthpiece are also considerably different from those of surviving sackbut mouthpieces. It is interesting, therefore, to compare the acoustical properties of the sackbut and the modern trombone.

The University of Edinburgh is very fortunate in housing one of the largest collections of historic instruments in Britain. This collection includes a sackbut made by Anton Schnitzer in Nuremberg in 1594, shown in Figure 2. Since the present year marks the four hundredth birthday of this instrument, it seems particularly appropriate to



Fig. 2. Sackbut by Anton Schnitzer, dated 1594 (photo courtesy of Edinburgh University Collection of Historical Musical Instruments).

present a measurement of its input impedance (Figure 3), and to compare this with a corresponding measurement on a twentieth century medium bore King tenor trombone (Figure 4). The King trombone was fitted with a Wick 6BS mouthpiece; the Schnitzer trombone no longer has its original mouthpiece, and a reproduction by Buchel of a 1579 mouthpiece was used in the measurements.

It is evident from a comparison of Figures 3 and 4 that the two instruments have the same general pattern of impedance maxima and minima, but that the peaks and dips are in general much sharper in the case of the modern trombone. The relatively low Q of the sackbut resonances may of course be due in part to leaks caused by wear through usage and ageing, but this feature has also been observed in studies of the Baroque trumpet (Smithers et al [9]). Another interesting divergence between the

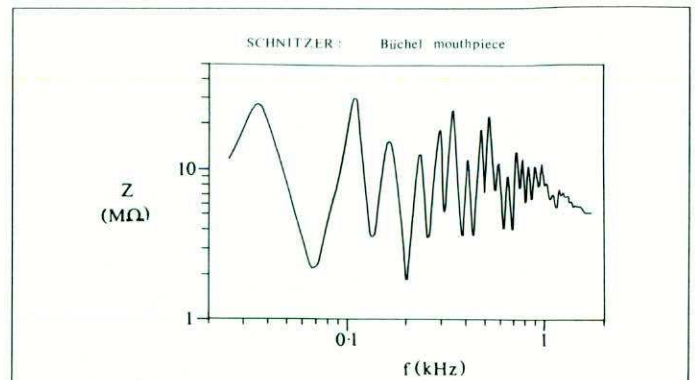


Fig. 3. Input impedance of sackbut by Anton Schnitzer, dated 1594, with reproduction by Buchel of mouthpiece dated 1579.

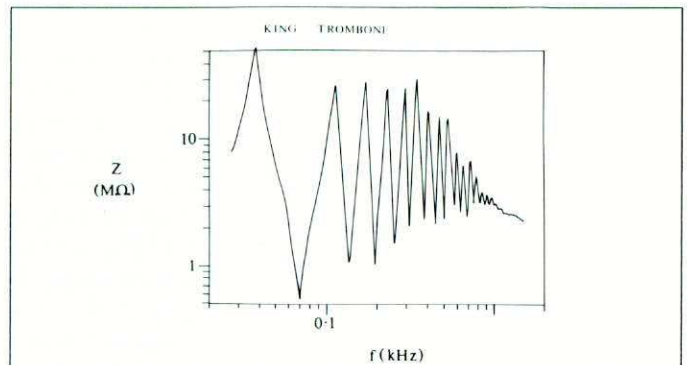


Fig. 4. Input impedance of modern King tenor trombone, with Wick 6BS mouthpiece.

two graphs is that the 14th, 15th and 16th impedance peaks are higher and more sharply differentiated on the Schnitzer than on the modern King. This difference is due to the variation in bell flare and final diameter between the two instruments, giving the Schnitzer a higher cut-off frequency: a wave of frequency 900 Hz travelling towards the bell of the King passes with little reflection, whereas a significant fraction of the energy at this frequency is reflected in the bell of the Schnitzer. The early instrument should thus offer a little extra security in playing notes at the top of its range.

The interaction between the lips of the player and the vibrations of the air column in a brass instrument is most successful in generating a stable note when several modes of the air column are mode-locked in a co-operative regime of oscillation. This requires that the air column modes have an approximately harmonic frequency relationship. The deviation of mode frequencies from such a relationship can be usefully displayed in terms of the 'effective cone length'

$$L(n) = nc/2f(n)$$

where $f(n)$ is the frequency of the n th mode and c is the speed of sound. $L(n)$ is the length of an ideal cone whose n th mode frequency is $f(n)$; for such a cone L is constant, since the mode frequencies are exactly harmonic.

The variation of equivalent cone length with mode number for the two trombones under consideration is displayed in Figure 5. The vertical line at $L = 2943$ mm indi-

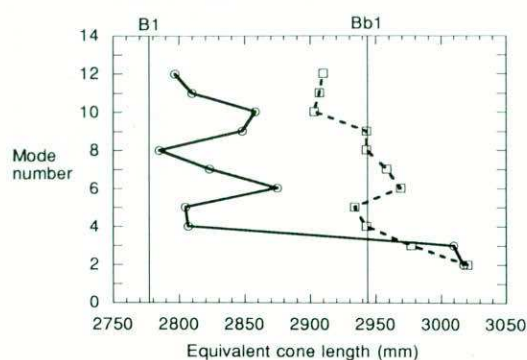


Fig. 5. Equivalent cone lengths for Schnitzer sackbut (circles, solid line) and King trombone (squares, broken line).

cates the behaviour of a cone giving an exact harmonic series based on the fundamental B_{b1} (58.3 Hz), on the assumption that $c = 343$ m/s. For comparison, the line at 2778 represents an exact set of harmonics a semitone sharper, with fundamental B_1 . It can be seen that, on the King, the modes from the third upward vary by only a small fraction of a semitone from the B_{b1} line. The second mode is noticeably flatter, and the equivalent cone length for the first mode (over 4.4 m) is so much greater that it is not shown. This behaviour is typical of a modern trombone; the first mode is not used in playing, and the others are close to a harmonic series.

The Schnitzer curve shows two different regions. The second and third modes are similar to those of the King, although the third is rather flatter in pitch (with greater L). The modes from the fourth upwards, on the other hand, are apparently related to an approximately harmonic series corresponding to a pitch about a quarter of a semitone below B_1 . Playing tests on the instrument have confirmed that in its upper register the instrument does play at a pitch nearly a semitone above modern pitch. The lower notes can also be sounded at this sharp pitch standard, although the regime of oscillation can then only involve the modes from the fourth upwards. The resulting lack of body in the tone of the low notes seems characteristic of many original and reproduction instruments; it would be most interesting to have a number of similar acoustical studies of other historic sackbuts, to see whether this type of equivalent cone length variation is typical.

The Cornett

The sackbut achieves its chromatic capability through the use of the slide to extend the length of the air column; the cornett makes use of the finger hole principle familiar on woodwind instruments like the flute, and an example is shown in Figure 6. The basic tube is approximately conical, with length around 600 mm; seven holes are bored in the side wall, at approximately equal intervals from the wide end of the tube. Six holes (on the upper side as it is held for playing) are covered by the fingers, while the seventh is covered by the left hand thumb. The cup mouthpiece is about half the diameter of a typical mod-



Fig. 6. A modern reproduction cornett by Jeremy West.

ern trumpet mouthpiece, and often has a very thin rim. By opening appropriate combinations of holes, a chromatic scale from G_3 to D_6 can be obtained.

The opening of side holes provides a major acoustical complication, since the mode pattern and radiation properties of the instrument are different for each of the many possible permutations of open and closed holes. To illustrate the general behaviour of the instrument, we consider the fingering appropriate for the note D_4 , in which only the lowest three holes are opened. The measurements were carried out on a reproduction instrument by Jeremy West, used professionally.

The input impedance curve is similar in general appearance to that of the sackbut, although there are only eight peaks of significant height. In Figure 7 the equivalent cone length is displayed. Again two distinct regimes are evident: the first three modes correspond to a series about half a semitone flatter than the required pitch, while those from the fifth upward are closer to a series based on B_{b3} . The fourth mode represents a transition: the mode frequency (1005 Hz) is close to the cutoff frequency for this fingering pattern. Below the cutoff, travelling waves are reflected back to the mouthpiece near the highest open hole, while above this limit they travel to the far end of the instrument. A similar behaviour has been observed with modern woodwinds.

It might seem that only the first three modes could be involved in the oscillation regime for D_4 . On a well designed instrument, however, an upper harmonic of the mouthpiece excitation frequency may find a partner in an air column mode of different number. This is best illustrated by replotting the data of Figure 7 in the form of Figure 8. The intersection of the solid line with each horizontal line gives the frequency of one of the harmonics of D_4 . It can be seen that the first three modes are well placed to provide resonant amplification of these components. The fourth mode is ineffective. The fifth mode, however, is close in frequency to the fourth harmonic of

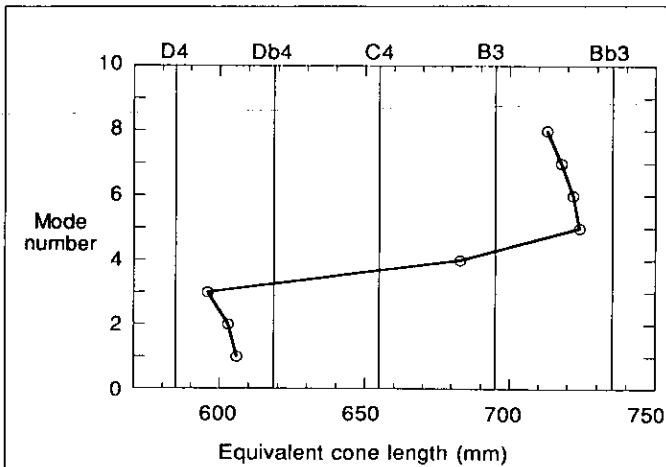


Fig. 7. Equivalent cone length for West cornett with lowest three holes open.

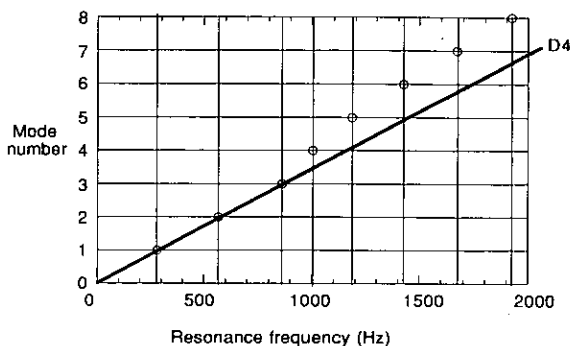


Fig. 8. Resonance plot for West cornett with lowest three holes open.

the excitation, and the sixth mode can be equally helpful to the fifth harmonic. The daunting task facing the scientific cornett designer is to be able to correlate the appearance of such fortunate coincidences with the detailed positioning and spacing of the holes and the subtleties of bore variations. Computational studies of this problem are showing promise, but cannot yet achieve the requisite accuracy (Keefe [10], Matthews [11]).

The Serpent

The acoustics of the cornett is dominated by the transition which occurs at the cutoff frequency. The diameter of a cornett fingerhole is usually a substantial fraction of the local bore diameter, giving a cutoff frequency well above the third mode. To conclude this brief survey, we examine what happens when the cutoff frequency is lowered so far that only the lowest mode is safely below it. This is the case of the serpent. Attempts to construct an instrument using the cornett principle but playing in the bass register led in about 1590 to the invention of the serpent. To make the holes easier for the fingers to reach, the tube is bent in the sinuous form which gives it its name; even so, the spacing of the holes is in two clumps (one for each hand). The lack of uniformity in hole spacing causes various acoustical complications. The most striking feature of

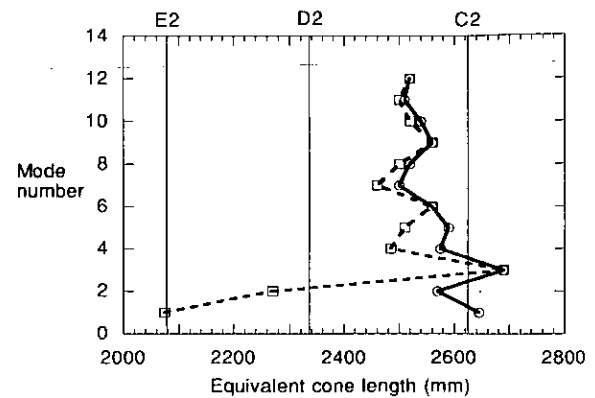


Fig. 9. Equivalent cone lengths for Haye serpent c.1820, with all holes closed (circles, solid line) and lowest hole open (squares, broken line).

the serpent, from the acoustical point of view, is the small size of the ratio of hole diameter to bore diameter: although the open end of the conical tube is typically about 100 mm wide, the holes cannot be much more than 10 mm in diameter, since they must be covered by the fingers. A hole so small is only effective in reflecting very low frequency waves.

Figure 9 gives the equivalent cone length for an instrument manufactured by Haye in the early nineteenth century, shown in Figure 10. It is evident that, with all the holes closed, the serpent behaves reasonably, with a set of modes close to those of its nominal pitch C₂. Opening one finger hole should raise the pitch to D₂. In fact, the first mode rises by two tones instead of one; the second mode, already demonstrating behaviour characteristic of the cutoff frequency region, is a tone flatter, and clearly provides what support there is for the nominal pitch of D₂; but the third and higher modes are scarcely affected by the opening of the hole.

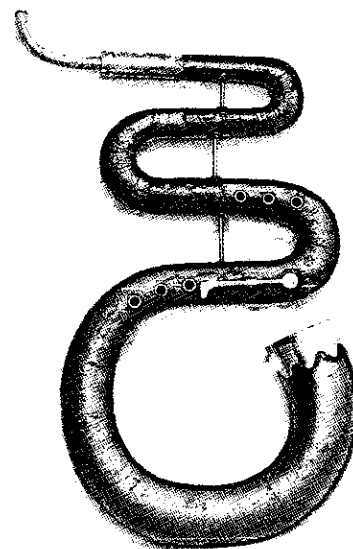


Fig. 10. Serpent by Haye, c. 1820 (photo courtesy of Edinburgh University Collection of Historical Musical Instruments).

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Conclusion

The serpent is a playable instrument because the impedance peaks which have been the basis of our study here give only part of the story of the behaviour of a cup mouthpiece instrument. The lips of the player are capable of exerting a profound effect on the vibrational properties of the air column to which they are coupled, and on sackbut, cornett and serpent it is possible for a skilled player to 'lip' a note well away from the pitch ostensibly dictated by the mode frequencies. Nevertheless, the optimisation of the mode frequencies improves both intonation and tone quality, and a combination of theoretical studies and practical investigations of surviving instruments should help the makers of modern reproductions to produce instruments to stand comparison with those which delighted listeners in the courts and chapels of Baroque Europe.

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References

- [1] J BACKUS, 'Input impedance curves for brass instruments', *JASA*, 60, 470-480, (1976)
- [2] S J ELLIOTT, J M BOWSHER & P WATKINSON, 'Input and transfer response of brass wind instruments', *JASA*, 72, 1747-1760, (1982)
- [3] A P WATSON & J M BOWSHER, 'Impulse measurements on brass musical instruments', *Acustica*, 66, 170-174, (1988)
- [4] R A SMITH, 'Recent developments in brass design', *International Trumpet Guild Journal*, 3, 27-29, (1978)
- [5] B LAWSON & W LAWSON, 'Acoustical characteristics of annealed French horn bell flares', *JASA*, 77, 1913-1916, (1985)
- [6] P A DRINKER & J M BOWSHER, 'The application of noninvasive acoustic measurements to the design, manufacture and reproduction of brass wind instruments', *Historic Brass Society Journal* 5, 107-131, (1993)
- [7] J KERGMARD & R CAUSSE, 'Measurements of acoustic impedance using a capillary: an attempt to achieve optimisation', *JASA*, 79, 1129-1140, (1986)
- [8] D M CAMPBELL, 'Input impedance measurements on historic brass instruments', *Proc IOA*, 9(3), 111-118, (1987)
- [9] D SMITHERS, K WOGRAM & J M BOWSHER, 'Playing the Baroque trumpet', *Scientific American*, April, 104-111, (1986)
- [10] D H KEEFE, 'Woodwind air column models', *JASA*, 88, 35-51, (1990)
- [11] W MATTHEWS, Private communication, (1993)

Further reading

D M CAMPBELL & C GREATER, *The Musician's Guide to Acoustics*, London: Dent, (1987)

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A LYRE FOR PEASANTS AND TRAIPSING WOMEN

Peter F Dobbins MIOA

With dead, dull heavy hums, and dismal moans, and mournful groans, the sober hurdy-gurdy thrums.

Introduction

These less than sympathetic words from Bonnel Thornton's Ode on St Cecilia's Day date from 1749, and are amongst the earliest known references to the hurdy-gurdy by that name. In fact, the device in question has been, and still is, known by literally hundreds of names, and the term hurdy-gurdy has a multitude of meanings. What is meant here by a hurdy-gurdy is a stringed musical instrument with a body similar in shape and size to that of a lute or guitar, as shown in the photograph of a modern English instrument in Figure 1.

Figure 2 shows the main features of the hurdy-gurdy as an instrument with a wooden wheel about 100–150 mm in diameter set in the top plate, or table, on a shaft which is rotated by a handle at the tail end. The strings are stretched across this wheel, which has a smooth rim,

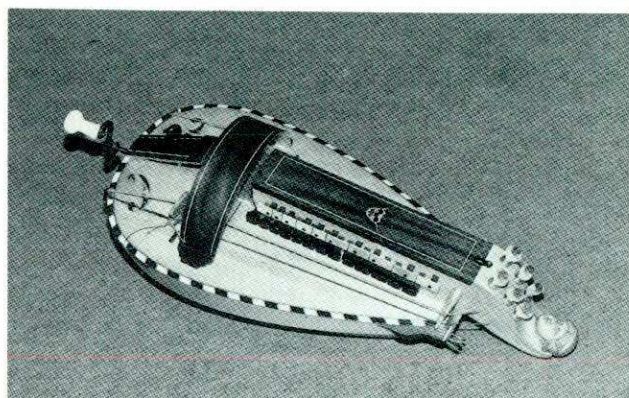


Fig. 1. A modern English lute-backed hurdy-gurdy by Chris Eaton.

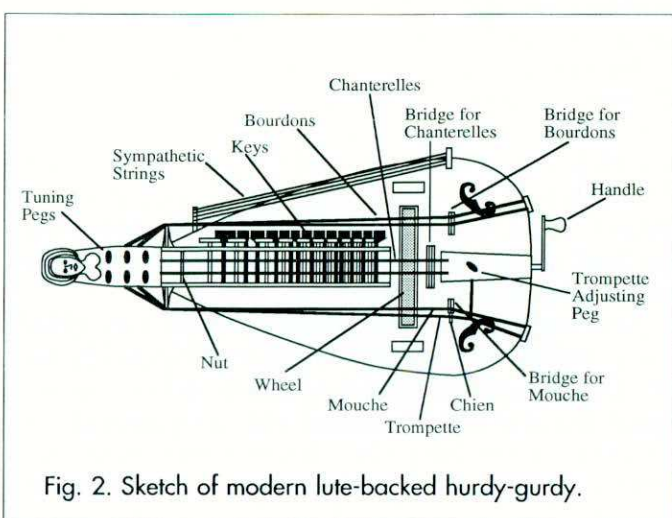


Fig. 2. Sketch of modern lute-backed hurdy-gurdy.

rubbed with rosin, and which excites the strings by slip-stick action in a way similar to a violin. Some of these strings sound continuously as drones and other melody strings (chanterelles) are stopped by a keying arrangement, to provide a chromatic scale over a range of two to two and a half octaves. The trompette is an extra drone resting on a loose bridge (the chien) which is just stable – the string sounds in the normal way unless disturbed, whereupon the chien vibrates with a buzz. The disturbance is applied by jerks of the wrist as the handle is turned and provides rhythmic accompaniment.

Descriptions of the hurdy-gurdy appear in many romances, chronicles, religious manuscripts and learned treatises from the 13th century onwards, notably Michael Praetorius' Syntagma Musicum [1]. More recently, a historical review has been carried out by Palmer [2], a new method has been written by Musckett [3] and an excellent manual on adjustment and maintenance of the instrument has only just appeared (Destrem and Heidemann [4]). Apart from these, however, the accessible literature – in English anyway – is confined to a few descriptive articles, eg Baines [5]. The acoustics of the instrument appears to have received little if any attention to date.

A Short History

The hurdy-gurdy first appears in more or less its modern form in Spain about 1180 in stone carvings on the portals of the cathedrals of Soria and Santiago de Compostela. These depict complete consorts of mediaeval musicians, as described in the accompanying article by Zachary Taylor, and the hurdy-gurdy is represented as a large instrument for two players, one of whom turned the handle while the other used both hands to operate the keys. This version, the organistrum, turned up also in England and France, but was replaced in the 13th century by smaller instruments played by one musician. These were known by names such as symphonie, chyfonie or armonie, although the term symphonie was usually applied to a form where the entire mechanism was enclosed in a rectangular box.

Figure 3 shows some of the shapes that the hurdy-gurdy has evolved through over the past 800 years, with the organistrum and symphonie represented in styles A and B respectively. It will be noted that there seems to be a degree of artistic licence employed in some of these sketches, but the earliest forms are taken from mediaeval manuscripts. Such illustrations, along with carvings in stone, or occasionally in wood, represent our only source of knowledge about the earlier instruments.

The trompette mechanism does not appear until the 15th century. It was first seen in a form generally known as the Bosch style; it is featured in a scene of Hell, part of the triptych 'The Garden of Earthly Delights' by Hier-

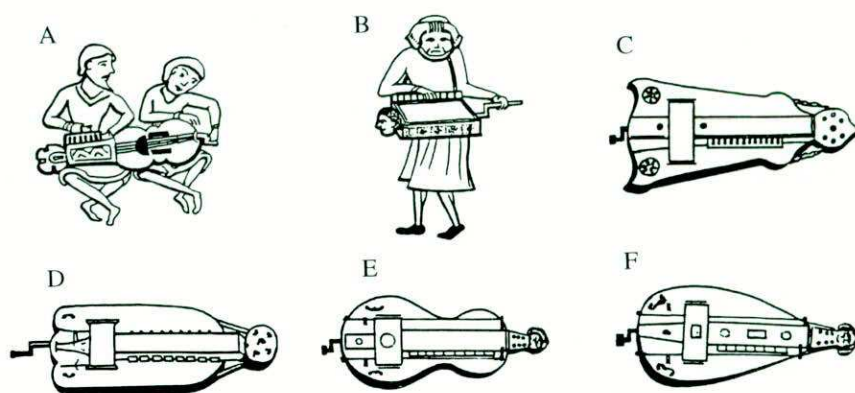


Fig. 3. Different forms of the hurdy-gurdy: (A) Organistrum, 12th and 13th century, (B) Rectangular box-shaped symphonie, 13th-18th century, (C) Typical 16th-17th century form, (D) Bosch form, first seen 15th century and still in use, (E) Guitar shaped hurdy-gurdy, developed in 18th century and still popular, (F) Lute-backed hurdy-gurdy, developed in 18th century and most common form today.

onymus Bosch (c1450–1516) in the Escorial, Madrid. The scene shows the damned being tortured on a harp, hurdy-gurdy, fiddle and several other instruments – the hurdy-gurdy is not singled out as especially diabolical. The hurdy-gurdy is shown in precise detail in this painting (form D in Figure 3): it has six strings, a trompette mechanism and eleven or twelve keys for a diatonic compass of one and a half octaves, so by the 15th century the hurdy-gurdy had all the features of modern instruments.

In the middle ages the hurdy-gurdy had been part of the stock-in-trade of the aristocratic troubadours and minstrels as well as being associated with sacred music, but in later centuries it declined in prestige and became an instrument of (usually blind) beggars. Praetorius [1] called it a 'lyre for peasants and traipsing women'. In the 18th century it enjoyed a revival. By now the instrument was generally called the *vielle à roue* in France, the *Drehleier* in Germany and the hurdy-gurdy or symphony in England, and the modern guitar- and lute-shaped forms (Figure 3, E and F) had made their appearance. Music was written for the instrument by many major composers and it became a status symbol to have a hurdy-gurdy. It was popular even in the great courts of Versailles and Munich, and some excellent instruments were made in this period with superb inlaid decorative motifs, or elaborate painted designs.

Behind the opulence of the upper classes, however, there was also the continuing misery of the lower orders. It was customary for poorer farmers and their families to take to the road during the winter, coming in large numbers from the Savoy region, and they became known as 'Savoyards'. Traditionally they carried a hurdy-gurdy, a marmot in a box, and sometimes a portable peep-show; they spent the winter trying to earn a living by busking and cleaning chimneys. Thus, the hurdy-gurdy had become an instrument of the two social extremes but, in between, it had also established itself as one of the instru-

ments (often alongside bagpipes) used to accompany singing and dancing throughout Europe. Before the end of the 18th century, the golden age of the hurdy-gurdy was over, and it never recovered this former status of pomp and glory, but it has maintained a more steady equilibrium in society in its folk role.

Now, at the end of the 20th century, there are as yet no signs that the hurdy-gurdy is becoming just a museum relic. To the contrary, although no longer played by blind beggars, in many parts of Europe it is regularly heard during festivals, weddings, village ceremonies and in concerts. In central France it is among the instruments routinely to be found in dance bands and a major festival is held every July at St Chartier, Indres, devoted almost entirely to hurdy-gurdies and bagpipes. In England,

along with much of our folk tradition, it disappeared during the two World Wars but shared in the revival of the 1960s and 70s and now, although not common, it is played in many folk groups and early music ensembles.

General Construction

A very brief description of the instrument was given above, and this will be expanded here; refer to Figure 1 for a sketch of the layout. Construction methods and materials are similar to those used in other stringed instruments.

The wheel is located in an opening in the table about 120 mm from the tail end, and for stability is usually laminated, fitted with a rim or built from segments. The shaft is supported by internal struts. A piece of cotton-wool is wrapped round the strings where they touch the wheel to prevent damage to the strings and wheel, and to eliminate scraping sounds. The amount and thickness of cotton wool adds mass to the string and influences the pressure of the string on the wheel; correct application requires some skill and, along with the amount of rosin, has a considerable effect on the sound of the instrument.

The keybox nowadays is wholly on the body, and usually takes up just over half the length of the table. The keys slide in slots in the sides of the keybox. On the stem of each key are two flag-shaped tangents which stop the chanterelles at the appropriate length when the key is pressed. These tangents are adjustable for fine tuning. The keys return to their normal positions by their own weight when released.

Most present day hurdy-gurdies have two melody strings and four drones. The strings are adjusted by pegs (or machine heads) in a pegbox similar to that of a violin except that it is often decorated with a figurehead. Usually there are two low pitched drones known as bourdons (bumble bees), a higher pitched mouche (the fly) and the trompette. The chanterelles are carried by a large central

NAME OF STRING	G-C TUNING			D TUNING	
	Strings Used	Play in C	Play in G	String Used	Play in G or D
1st Chanterelle	Violin D	G ₄	G ₄	Violin A	D ₅
2nd Chanterelle	Violin D	G ₄	G ₄	Violin D	D ₄
Trompette*	Violin D or 'cello A	C ₄	D ₄	Violin D or 'cello A	D ₄
Mouche	Violin D	G ₃	G ₃	Violin D	G ₃ (usually omitted)
Petit Bourdon	'cello G	C ₃	Not Used	'cello G	D ₃
Gros Bourdon	'cello C	Not Used	G ₂	'cello C	D ₂
Sympathetic Strings	Guitar or Banjo B	C ₄ and G ₄	G ₄	Guitar B	D ₄

* The trompette string is often fitted with a device to change the pitch by a tone in G-C tuned instruments

Table 1. The two common tunings

bridge and there are two smaller bridges on either side for the drones which pass across the table on either side of the keybox. Generally, plain gut strings are used for the chanterelles, mouche and trompette, silver wound on gut for the bass drone strings and steel for the sympathetic strings. Violin and 'cello strings are often used on modern instruments. Nylon strings are not recommended.

Tuning of the hurdy-gurdy is somewhat arbitrary, but the two most common arrangements are the G-C tuning, also called the 'Auvergnat' or 'classical' system, and the D tuning, or 'Bourbonnais'. Details are given in Table 1 and, obviously, the Auvergnat tuning easily allows playing in the keys of G and C (major and minor), while the Bourbonnais system enables playing in the keys of D and, to a limited extent, G (major and minor). The trompette rests on its loose bridge, the chien, which slots into a groove at the base of the bridge carrying the mouche. It is adjusted by a peg on the tailpiece from which a short piece of string is arranged so that turning the peg pulls the drone tighter against the wheel. The chien usually has a triangular segment cut from its base so that it rests on two legs, and often a piece of ivory or other hard material is inserted in the table under the outer leg.

Since the 18th century many hurdy-gurdies have been given four or six sympathetic strings, and most have two sound-holes, usually circular or C-shaped. Some are fitted with a device to change the pitch of the trompette by a whole tone for playing in different keys, and all have buttons for attaching the straps needed to keep the instrument under control.

The Sound of the Hurdy-Gurdy

It is of course impossible to describe in words the sound of a musical instrument, but an impression may be formed by considering the similarities and differences between the hurdy-gurdy and more commonplace instruments. Nevertheless, it is strongly recommended that interested readers locate a real live hurdy-gurdy player and hear this fascinating instrument for themselves.

The hurdy-gurdy is a bowed string instrument, so

superficially has much in common with the violin family; a single sustained tone from a hurdy-gurdy sounds much like a similar note on a violin or 'cello, depending on the pitch of the note, although somewhat thinner. The major differences arise when considering the sound of the instrument as a whole.

The first is that the hurdy-gurdy produces a continuous sound on several strings at once, some of them playing the melody and some

of them producing steady drones. From this point of view it is similar to bagpipes, although it should be remembered that the mediaeval fiddle was a drone instrument, as were some varieties of lute, and for music with simple harmonic structures drones provide a convenient way for a single musician to play both the tune and the accompaniment for dance music. The other major difference is the rhythmic effect produced by the trompette and chien. The sound is somewhat reminiscent of a snare drum played with brushes, although brighter and crisper, and is obviously another aid to the single musician playing for dancing. This device, however, did not appear until the early 1600s and is by no means universal today, so will not be considered further here.

The obvious similarities are that both the hurdy-gurdy and the violin have strings that are excited by bowing (by the wheel in the case of the hurdy-gurdy), that the resulting string motion is coupled to a hollow wooden body through a bridge, and that the vibrations of the body are then radiated as sound. It seems reasonable to suppose that the bowing mechanisms are similar in both cases, but this needs some justification. The physics of the violin, and the bowed string in particular, has been the subject of much research over the past century, and in one significant study Saunders [6] conducted experiments involving both conventional bowing and 'mechanical' bowing using a laminated plastic wheel driven by an electric motor. He found that, under similar conditions, the responses obtained by either method were indistinguishable, so in subsequent experiments he used only hand bowing because '... it is more convenient, and musicians accept the results obtained by means of it with less prejudice ...'.

More concrete evidence is provided in Figure 4. This shows the displacement (A) and velocity (B), plotted against time, of a hurdy-gurdy string obtained from recent measurements on a good quality 19th century instrument (to be described more fully below). Considering curve (B) only, it is seen that for most of the period the velocity is slightly positive as the string is

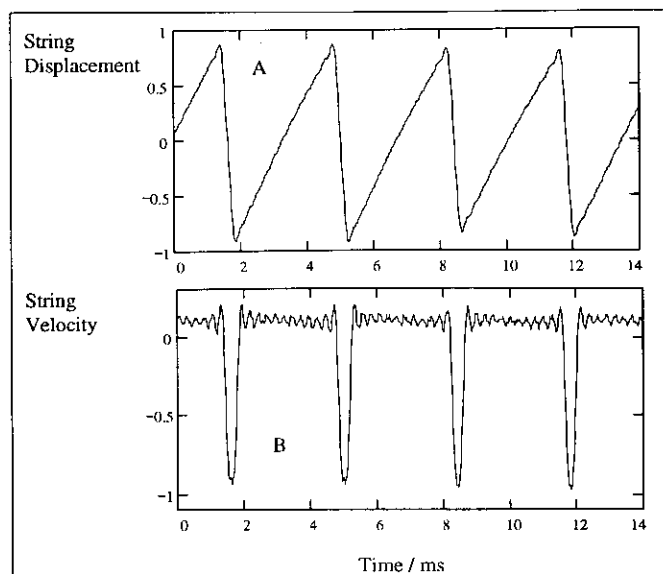


Fig. 4. Measured (A) displacement and (B) velocity of a hurdy-gurdy string sounding D_4 (293.7 Hz).

dragged by the bow, or wheel in the present case, but when friction is overcome as the string displacement reaches its limit, there is a short period of negative velocity as the string whips back to take a new hold on the moving wheel. This behaviour is known as 'slip-stick' motion of bowed strings, and leads naturally to the sawtooth displacement waveform which was first described by Raman [7].

It may be concluded that the vibrations of a bowed string are much the same whether excited conventionally or by a wheel. Such behaviour occurs, however, only over a limited range of bowing force, bowing speed, and bowing position along the string (Saunders [6]); outside these limitations the note becomes raucous and unmusical with too much force for the bowing speed and position, or the solid fundamental tone is lost if the force is too low. This presents no problems for the violinist who can control all these parameters, albeit subconsciously, but in the hurdy-gurdy the wheel position is fixed by the maker, the pressure of the string on the wheel is fixed as part of the players setting-up procedure and, if the trompette is being used, the wheel speed is controlled by the rhythm of the music. Thus, a large part of the hurdy-gurdy player's skill is in the maintenance and adjustment of the instrument, particularly in setting the bowing force by minor modifications to the notches in the bridge where the strings rest and application of cotton wool and rosin.

Having determined that the vibrations of a hurdy-gurdy string are essentially similar to those of a violin, the resonant response of the body must be examined. One approach to measuring this response that has proved popular in the study of violins is the 'loudness curve' (eg Hutchins [8]): a violin is bowed as strongly as possible (without vibrato) and the output from a microphone is measured for each of the notes of the chromatic scale. Such a measurement is obviously crude, but is easy to carry out, and is useful in giving an overall picture of the behaviour of the instrument. An alternative is to obtain a more rigorous frequency response by exciting the bridge

with a known signal and measuring the radiated sound level (eg Hacklinger [9]). This approach requires more equipment, but has the advantage of showing the resonances in considerable detail. Problems arise, however, because it is difficult to apply the bridge excitation in a manner exactly analogous to the string vibrations, and the resonances of the strings themselves result in a very complex picture. These procedures are obviously directly applicable to the hurdy-gurdy, and measurements have been carried out on a number of instruments. Results will be presented here for a D tuned, lute-backed hurdy-gurdy made in 1882 by Claude Pimpard of Jenzat in central France. This instrument represents a tradition of hurdy-gurdy making in the Jenzat area dating from the 18th century, and is regarded as an excellent example. It is owned and played professionally by Nigel Eaton, who assisted with the measurements.

In Figure 5, (A) shows a frequency response derived from an impulse response measurement and (B) shows the loudness curves for the two chanterelles plotted against frequency. As expected the response curve is considerably more complex than the loudness curve, but both show major peaks of over half an octave in width and centred on about 500 Hz and 750 Hz. Much of the complexity in the response curve is probably due to individual string resonances. Attempts were made to damp the strings, but this is very difficult, and measurements must be made with the strings in place to give the correct loading of the bridge and sound board.

Clearly, the body of this instrument reinforces sound radiation over most of the bottom octave of both chanterelles, but whether or not this is deliberate on the part of the maker is hard to say. The instrument would have been built specifically for the Bourbonnais tuning and, surely, M Pimpard would have had some idea of what makes a good sound and what does not, but, on the other hand, the 19th century Jenzat makers are thought of by many as cowboys, throwing together instruments with whatever

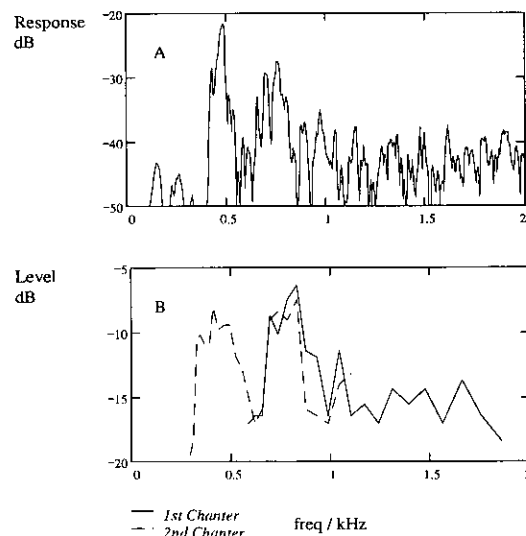


Fig. 5. Measured frequency responses of 1882 hurdy-gurdy by Pimpard: (A) derived from impulse response and (B) loudness curve.

materials came to hand. Additionally, the prominence of these resonances is a little surprising. Although the sound board is fairly thin (4 mm) and made of sycamore (good 'acoustic' wood), it is loaded by the keybox and restrained by the relatively massive internal struts needed to support the keybox and the wheel shaft.

Finally, the specific sources of individual resonances have not yet been identified, although an attempt was made to locate the cavity Helmholtz resonance by blocking the sound holes, but without success. However, when compared with a violin, the internal volume of the body of this instrument is large and the area of the sound holes is small, suggesting that the resonant frequency of the cavity may be below the range considered.

In Conclusion

A musical instrument must be studied in context in order to be comprehended fully. Not only the instrument itself, but the player, the style of music, the acoustics of the environment, and the musical tastes and background of the listeners are involved in the final evaluation. Instrument makers and musicians who have traditionally coped with all these variables intuitively are quite justified in being sceptical of detailed theories based on quantitative measurements of only one or two factors without regard for others. Analysis alone is not enough.

It is hoped that in this short article it has been possible to give a flavour of most of these important topics as related to the hurdy-gurdy and its historical evolution. However, it should be clear that hurdy-gurdies come in a variety of shapes and sizes and are to be found in many musical contexts, and this has been the case throughout their history. Different hurdy-gurdies can sound very different – but they all sound like hurdy-gurdies.

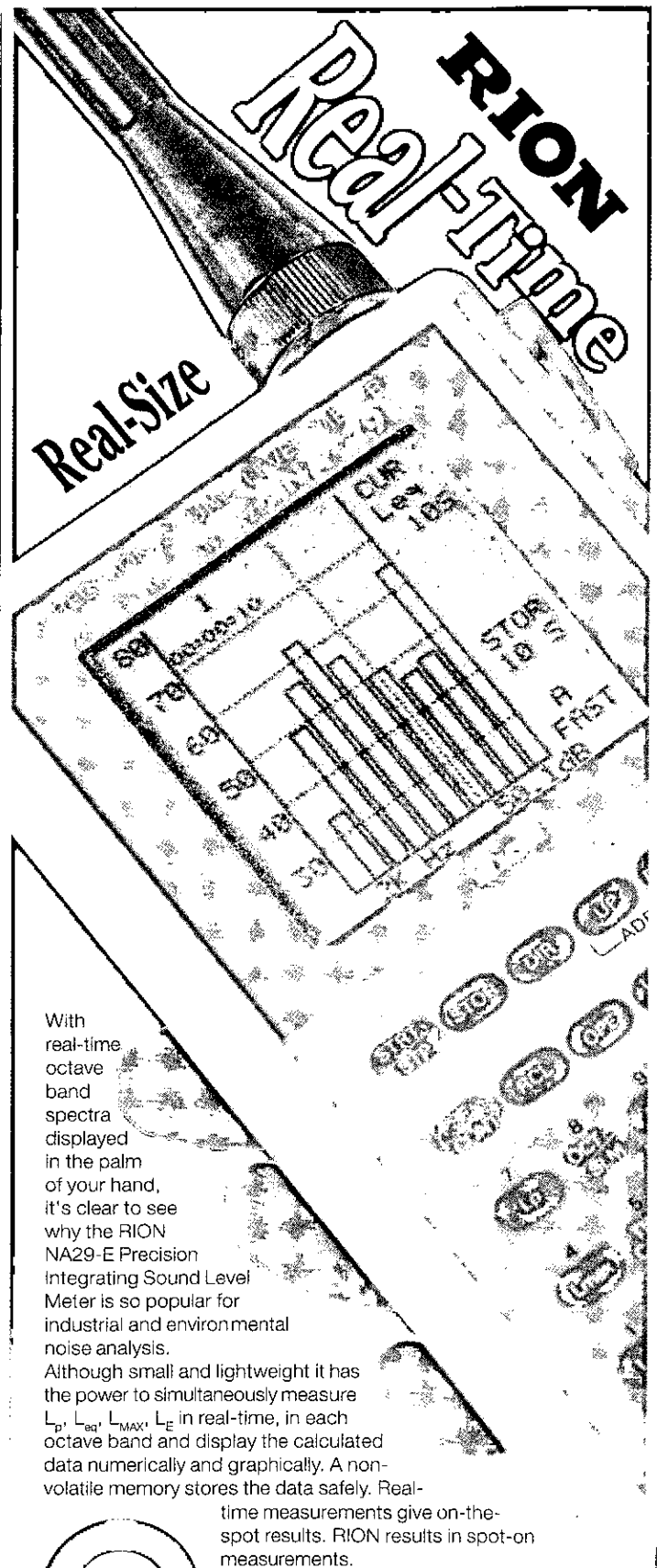
Acknowledgements

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References

- [1] M PRAETORIUS, 'Syntagma Musicum', Vol. 2, Wolfenbüttel, (1618)
- [2] S PALMER, 'The Hurdy-Gurdy', Newton Abbot: David and Charles, (1980)
- [3] D MUSKETT, 'Method for the Hurdy-Gurdy', Hemel Hempstead: Doreen and Michael Musket, (1979)
- [4] P DESTREM & V HEIDEMANN, 'The Hurdy-Gurdy, Adjustment and Maintenance', Riom, France: AMTA, (1993)
- [5] F BAINES, 'Introducing the Hurdy-Gurdy', Early Music, January, 33–37, (1975)
- [6] F A SAUNDERS, 'The Mechanical Action of Violins', JASA, 9(2), 81–98, (1937)
- [7] C V RAMAN, 'On the Mathematical Theory of the Vibrations of Bowed Strings and of Musical Instruments of the Violin Family, with Experimental Verification of the Results: Part 1', Indian Assoc Cultivation Sci Bull, 15, 1, (1918)
- [8] C M HUTCHINS, 'The Physics of Violins', Scientific American, November, 78–93, (1962)
- [9] M HACKLINGER, 'Violin Timbre and Bridge Frequency Response', Acustica, 39, 323–330, (1978)

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STRINGS OF STONE

Zachary Taylor

In the ancient city of Santiago de Compostela in Galicia in North West Spain, the shrine of St James the Apostle attracts pilgrims from all over the world. In the Cathedral treasury there are archives from mediaeval times including music and scholarly theses associated with pilgrimage. Among other treasures of the Cathedral are the carved figures forming the entrance archway called El Portico de la Gloria; an apocalyptic vision of heavenly musicians arranged around the Almighty, carved by the Maestro Mateo in the year 1188. No original instruments of that era have survived, so sculptures of such accuracy are invaluable sources of information to the contemporary luthier. Following many years of research, the author was a principle maker in the team of experts commissioned by the Fundacion de Pedro Barrie de la Maza to replicate the instruments decorating the entrance of the Cathedral. Here he comments on his special task to recreate two of the 19 instruments.

Introduction

Looking at the Portico de la Gloria in the Cathedral of Santiago de Compostela with the object of bringing back to life its instruments of stone poses fascinating problems. Many of these are imposed by speculation with regard to dimensions, materials and methods of construction.

What may be seen on the sculpted masterpiece is easily reported, but, are we seeing in this archway of musicians the instruments of its period or may we assume the possibility that the models used for reference might have been already old? It is not unusual, after all, to find quite ancient instruments being used in the company of newer ones and these in question might well have been an assortment from different eras. This would pertain in any modern symphony orchestra. Logically speaking therefore, the examples carved in AD 1188 may have been modelled on their latest instruments or on some older versions.

I was concerned with the making of the two lutes, (those played by the figures number 9 and number 20, counting from the left when looking towards the archway). These are very similar in shape and size although number 9 is the more complete and may be described thus: it has a straight-sided body rounded at the ends with a flat soundboard, which does not appear to have a soundhole. Three strings, attached at one end of the body by a rectangular tail-piece, are stretched over a bridge, which is retained by their pressure against the soundboard, and extend along a comparatively short neck at the end of which is a pentagonal peg-head. In the peg-head there are holes through which the strings pass to their individual keys, which project through the head at right-angles to the soundboard and have domed grips to facilitate tuning. The lack of soundhole supports the sup-

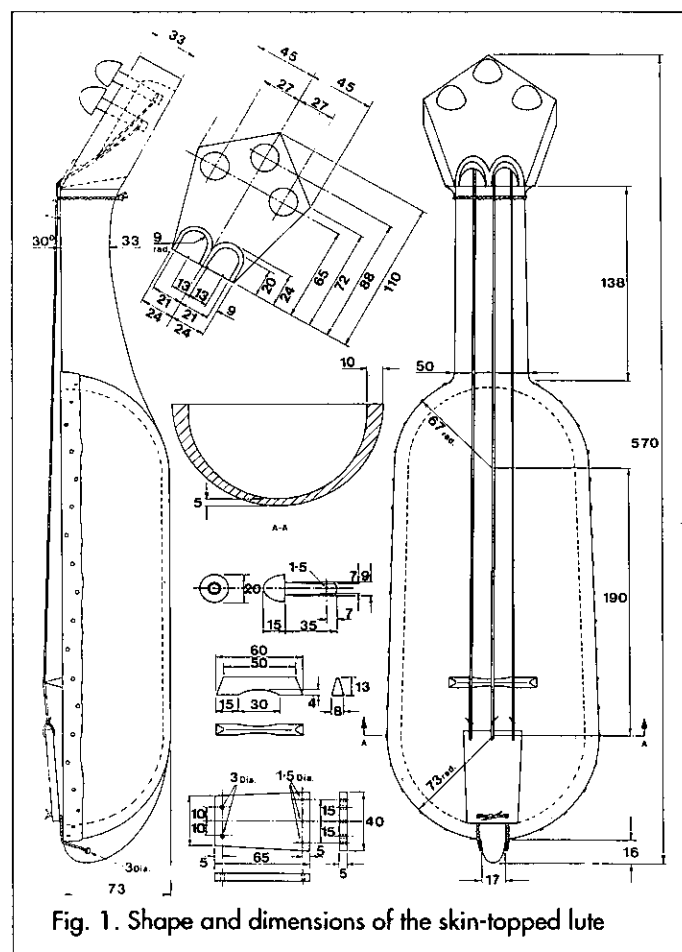
position that the soundboard was made of skin.

In itself, a simple instrument and readily constructible in a variety of ways. And so, the speculations begin! It is worth noting that most instrument makers would consider a wide range of designs and forms before committing themselves to the task of producing their noble creations, so with the idea of comparison I turned to other references. To supplement the visible evidence handed on by the Master sculptor Mateo, one might consider additional iconographical traces contemporaneous with, and earlier than, those of the Portico de la Gloria.

Historical References

The names 'lute', 'laud', 'luth', 'liuto', etc., almost certainly come from the Arabic 'al'ud', and this may well serve to indicate that by this name, meaning literally 'the wood', we already have more than just a descriptive reference to the material from which such instruments are made.

It is well known that the sound-boxes of stringed instruments were made from a variety of natural objects, for example; tortoise-shells, skulls, and vegetables such as gourds. Perhaps the Arabs distinguished the instrument that had been constructed from wood, indeed drawing



attention to the fact by its name, in order to separate it from those using some natural object. It would be interesting to discover from which date the name *al'ud* came into use. Had this family of instruments previously been inspired only by the shape of, and availability of natural objects, and if so, what might they have been called and were their names as descriptive as their younger relative, the lute.

Perhaps the wooden body itself was a development from a hollow log, remembering how so many natural objects were exploited. Tambours, which used skin as an acoustic membrane (in certain cases with strings in contact with the surface to enhance the percussive effects) were common and likely therefore to suggest to a visionary maker the possible use of skin as an attached sound-board. This would undoubtedly give more response than that found in an instrument with a soundboard made from a solid tree trunk. One may readily hear the greater volume from a banjo by comparison with a guitar, for instance.

It is prudent at this point to guard against overstressing the cultural force of Moorish influence, since, despite the name suggesting Arabic propriety, instruments of this family existed before the Islamic conquest. Many of the designs, the organistrum is a good example, have a distinct flavour of the Vatican rather than Mecca. There were Egyptian instruments that answered to almost the same description as the Compostelan lutes nearly 2000 years before Santiago was born! These could easily have found their way into European culture through links with Provence, France, Italy, Spain and England.

Representations of pear-shaped instruments with necks have occurred since then all over Europe, their general

appearance suggesting the probability that the body and neck were made from one single piece. It is seldom, in fact, that a dividing line is marked definitely until the 13th century. So, accepting the hypothesis of an Egyptian rather than Arabic origin simply reinforces the supposition that this variety of lute was carved from one piece. Certainly it has less in common with the multi-ribbed, constructed, lute with the larger body and separate neck of the type with which the Arabs are associated.

It is also possible therefore, that the instruments were imports, in which case the variety of materials that may have been used becomes much wider than might concern us if we choose from woods indigenous to mediaeval Galicia.

Speculation is endless, but fortunately, with this magnificent model to observe in the Portico de la Gloria we are provided with adequate information to make a copy which, at least, follows its dimensional parameters.

Contemplating Materials

If we accept the notion that the lute is to be carved from one half of a solid tree-trunk then attention must be given to the following preferred requirements.

It must be structurally rigid, resist splitting when subjected to the 'pegging' of a skin sound-board, and likewise for the same reason where the tuning keys are fitted in the head.

As to its qualities for potential resonance, this calls for some acoustic reasoning. As may be demonstrated with any sounding body composed in the same manner, that is, from a membrane attached to a supporting member, the major requirement for the latter is that it be rigid. Many examples of drum, for instance, are made from laminated materials which increase stability and diminish resonant potential in the member itself, but giving to the membrane to which it is attached the firm support it needs to permit it to vibrate freely, providing at the same time the required shape and size of sound-chamber associated with the instrument type. Notice that in contemporary hi-fidelity sound reproducers the speaker, or diaphragm, is usually housed in a most rigid and inflexible box to enhance this situation. To test this theory, I have conducted experiments using conventional guitar soundboards attached to bodies made from various materials including one made from laminated plastic covered in thick velvet which, despite its unwholesome appearance, sounded like most normal guitars. I believe that, to a great extent, this is partially true in principle of most stringed instruments, as may be seen in the use of spruces and pines for the soundboard, or diaphragm, attached to bodies of denser, stronger hardwoods. At the same time, if the material chosen has an indirect resonant contribution to the improvement of tone or volume, then obviously it would be preferred.

With regard to the material for the acoustic membrane, in the case of the skin type, given the correct curing process, almost any animal skin of sufficient thickness might be used. A selection would probably include Ox, Horse, Mule, Pig, Goat, Sheep and Dog. The latter may strike the 20th century mind as a barbaric choice, but

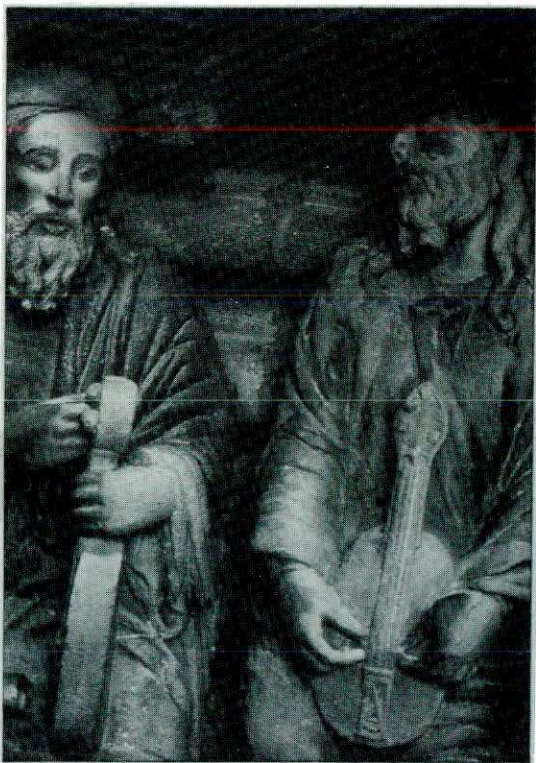


Fig. 2. Details of two lute players

cured dogskin is still preferred for certain traditional percussion instruments. Unlike the other varieties it does not have pores since dogs do not perspire through the skin.

The immediate foregoing assumes that the soundboard has no soundholes, or that they might be small and located beneath the strings and therefore hidden from view in the carved models. There are numerous examples of this type of sound-hole arranged in geometric patterns serving the dual purpose of airway and decoration. It is perhaps unnecessary to elaborate upon the suggestion that the term 'soundhole' is a misnomer since little sound emanates from it. Assuming that vibration of a body or any part of it obliges deformation, it must be safe to assume that an airway incorporated in its design should reduce impedance to such deformation, thus potentially contributing to the prolongation of its reverberance.

On this occasion we were afforded the opportunity of duplicating the bodies of the two instruments as far as physically possible, but with one membrane of skin and the other of wood. Not enough to make conclusive judgments, but a start at least.

The technological procedure in the manufacture of strings, then and now, is beyond the scope of this commentary and therefore will not be pursued. Materials used in the making of strings are many and varied, some of which are considered as follows: the Westphalian monk, Theophilus, wrote an account about wire-drawing in 1100 AD although wire had been made by hammering almost 3000 years ago. With metalwork as advanced in Spain as it was then, metal strings could have been readily available by the 12th century. Although there were various fibres available from which it would have been possible to make strings, I do not know of any authenticated use of such a material, and it is unlikely that any originals could have survived.

Silk was known to have been used for strings on the very oldest of instruments of China, the home of silk production, and it was used in Europe as early as 600 AD. Horsehair, the prime choice for bow-stringing, also works as a vibrating element when twisted and responds well under tension. Gut, seems to occur most frequently and with reference to the possible Egyptian connection, as mentioned earlier, the lute found in the tomb of Har-mose had gut strings intact. This would be my own choice.

Methods of Construction

Assuming that the lute has a hollow body made from wood then it follows that it either be made from carving from a solid piece or constructed by gluing together separate ribs to produce the required shape. Undoubtedly both methods were known to the mediaeval maker but it is more than likely that the former was used based on the following:



Fig. 3. The author, with reproduced lute, alongside the stone original

1. Availability of partly formed natural tree-trunks.
2. The radius at each end of the body being easier to carve from the solid than to form by bending.
3. If made from separate ribs, those at the periphery would need to be thickened to receive the skin-retaining pegs, subsequent application of which would possibly damage the structure.

Since there is a definite line of demarcation between neck and body, one may assume that the neck could be fitted as a separate piece, which would have to be the case if the body were made up of ribs. In the previously stated likelihood of the body being carved from solid however, it could optionally be made entirely from one trunk. This would obviate the necessity for joining at the intersection, therefore being stronger as well as quicker and easier to produce. Neither would there be any need to add a separate fingerboard either for structural or technical reasons, and in any case there does not appear to be one fitted to the Compostelan lutes.

It is not easy to determine whether or not there were frets on the neck, but if they were required they would have surely been tied on by the player.

There is the possibility that the lute could be partly shaped by the use of a lathe. I have successfully used the method of temporarily gluing together two pieces and dividing them after shaping with other instruments. With the opportunity to use a natural log however this reduces the external shaping to a minimum and would diminish the dubious advantages in using machinery. It can be readily seen that a log, if split or sawn into two parts along its length, would yield material enough for a 'matched pair' of lutes, which might well explain the presence of two in the Portico de la Gloria and account for their similarity.

As to the fixing of the skin, this being hygroscopic and softenable with water, it is an uncomplicated procedure to glue it in place whilst wet and elastic. The skin should then tighten as it dries. Wooden pegs, used for additional security to keep the skin in place, pierce the side of the body all round the top at regular intervals on a more or less straight line parallel with the top.

In the case of the lute with the wooden soundboard, a

softwood with a straight and evenly distributed grain is generally used and glued into position on the rim of the body. The lime chosen for the lute body was suitable in this respect and the top was removed by sawing, in order to access the body, and replaced after excavation.

Dimensions of the Lutes

The Portico de la Gloria had been examined, photographed, and considered many times before the commencement of this project but to assist our endeavours the Foundation had provided a substantial system of ladders and platforms to enable actual physical contact with all of the statues, making examination and measurement as easy as if they were the original instruments. We all spent most of the first day in photographing and drawing our designated instruments.

Direct measurement of original instruments is impossible since none have survived from the 12th century, so other references must be used such as may be found in iconographical evidence containing not only instruments, but objects of known dimension in juxtaposition. The human forms in the Portico de la Gloria are a perfect case in point, since they represent musicians actually holding their instruments in preparation for a performance.

The human figures were carved at less than life-size, which meant scaling up to bring our copies to correct proportions. Taking the distance between the pupils of the eyes and the width across the knuckles as an average of 64 mm in the mature human male it was easy enough to compare these measurements on the statues and adjust to make a scale. This turned out to be a convenient 20% increase. The measured amounts were 53 mm on the statues which when uplifted by 20% becomes 63.4 mm. This suggested that in all probability, the sculptor, Mateo, reduced the figures by the simple fraction of one-sixth of normal size. Details of the shape and dimensions so determined are shown in Figure 1.

Making the Lutes

Our workshop was improvised in the Museum of Pilgrimage near the Cathedral. The wood was provided in rough sawn baulks and billets and had been acquired locally as an obligation to use indigenous timbers appropriate to the 12th century. I was offered cherry and sycamore, both rather young in seasoning terms, some poplar that looked somewhat muscular and self possessed, and some excellent walnut which was unfortunately too small for my needs. I settled for a piece of lime. This was selected by elimination because I would not normally choose this wood for a

musical instrument, except for certain parts such as linings or internal blocks. However, I did need a material that would carve well and be relatively light, and lime is generally stable and not given to cracking, so, I cut two blanks and kept my fingers crossed.

Since my undertaking was to make two lutes, this was an opportunity to add some verification to certain major assumptions I had made about their structural features. For example, since no sound-holes were visible in the soundboard then one might assume that either this was made in skin, or if in wood, then possibly there were only small soundholes placed under the strings and therefore not visible in the sculpture. My inclination was to believe the former to be correct, having researched this family of instruments for some years, partly due to the conviction that it was of Egyptian rather than of Arab descent, as referred to earlier.

The need for a hole in the soundboards of instruments which amplify by responsive, reflective or resonant vibration is to permit air to move freely into, and from, the interior of its sound-chamber. Vibration causes deformation of the instrument necessitating a rapid change of its volumetric capacity, therefore free movement of air is essential to the amplification process. This pertains less to an acoustic membrane of skin as may be heard if one listens to a drum with a hole in the skin. Therefore, logically, the lutes may have been skin-topped without a



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RAYNOISE

soundhole, or wooden-topped with small sound-holes obscured by the strings. Suffice it to say that here was an opportunity to compare at least one of the many variables in the possible features of the instrument by making one of each.

Having settled on the lime for both instruments, it was a simple matter to make templates from stiff card, using the drawings we had prepared from the measurements taken earlier, and transfer their peripheral shapes to the squared-up blanks. Excess material was then removed by band-sawing, and carving of the body cavities commenced immediately using spoon gouges. More templates were made to the required shape of the interior of the bowls and applied frequently during the carving. When the form was almost finished a curved scraper was used to finish off the surface. The lime behaved very obligingly, occasionally revealing the odd knot as successive redundant layers were removed, but few of these remained in the attainment of the final surface.

Goat skin was used for the acoustic membrane on the lute number 9 and attached with glue and wooden nails. In the case of the wooden soundboard, as stated above, this was made from lime cut from the mother block and attached by glue to the rim. It was extended to cover the fingerboard and pegged with wooden nails for added security and decoration.

Making them Play

After some trials with various diameters of gut strings, I found a combination that gave a satisfactory tension with a tuning of two G strings an octave apart on the first and third strings, and a D in between. Both instruments worked well with predictably characteristic tone from the wooden and skin tops, although the latter gave a much bigger sound; in fact, with a plectrum, it was powerful enough to part your hair at 40 paces!

The whole ensemble of instruments was a well-balanced consort with the melodic line played on the figure-8 fiddles, supported by harmony on the larger oval fiddles. A decorative arpeggio could have been supplied by the harps and psalteries with the organistrum holding a bass-drone underneath. The lutes would have supplied the necessary rhythmic element from their chordal percussion.

There can be little doubt that this lute could have been played either with the fingers, with a plectrum or with a bow. Its younger relatives, the vihuela de mano, vihuela de pendola, and vihuela de arco, might all have been the same instrument but simply played in their respectively different ways. Judging by the general opinion as to the role played by the lute in the musical tableau, the short neck and few strings would have had a limiting effect on the technique of even the most imaginative of adventurous virtuosi with ambitions to play a melodic line.

Epilogue

Having replicated all of the instruments in the ensemble for my own collection since my return, I feel that some problems associated with reconstruction have been solved. More experiments will continue to be undertaken,

to help solve some unanswered questions about the lutes of the Portico de la Gloria, and more research to fill in the gaps as to their ethnic origins and subsequent evolution. Maybe there is no pure line of descent from a single genealogical source. If it comes to that, there is no clear cut line of development from this instrument to those of the Renaissance or the Baroque. In this respect, one hopes that there will be more research forthcoming to help reduce the need for speculation in the future. What is certain is that this small intimate instrument with its simple charm must have delighted its player and audience alike, and hopefully, those copied from it will continue to do so.

Zachary Taylor is Editor of Woodworker, Argus Specialist Publications, Argus House, Hemel Hempstead, Herts HP2 7ST ♦

Fritz H B Ingerslev HonFIOA

Fritz Ingerslev died on 5 February 1994 in Copenhagen, Denmark aged 81. During his long and splendid career, he made important contributions to many areas of acoustics.

Raised in Copenhagen, he completed his graduate education at the Technical University of Denmark (DTH), receiving his PhD for a thesis on linear and non-linear distortion in electrodynamic loudspeakers, a subject still being researched intensively by a consortium of five Danish companies, four decades after publication.

In 1941, the Acoustics Laboratory of the Danish Academy of Technical Sciences was established; Ingerslev joined the staff and soon became head of the laboratory. In 1954, he was appointed to a professorship at DTH, first in telecommunications and then in acoustics. He remained at DTH throughout his life. With responsibility for the teaching of acoustics, he greatly expanded the DTH programme in the field, and created the Acoustics Laboratory of the Technical University of Denmark for research and instruction. His enthusiastic spirit had a positive impact on his collaborators at the two Acoustics Laboratories with which he was affiliated during his long career, as well as on his colleagues in Danish industry. His laboratory produced dozens of well-qualified graduates in engineering acoustics.

With a special interest in international affairs, he served for many years as a member and secretary of the International Commission on Acoustics (ICA) and was president of the Fourth International Congress on Acoustics (Copenhagen, 1962). As a founder of the International Institute of Noise Control Engineering (I-INCE), he served the organization as the charter president from 1974 until 1988 and as general chairman of INTERNOISE 73 (Lyngby, Denmark, 1973).

He also had a special interest in international standardization and he ensured Denmark had an important influence on their development. From the early 1950s he was active in IEC Technical Committee 29 (Electroacoustics) where he contributed to the standardization of loudspeakers and hearing aids. At the end of the 1960's, he began a twenty-year chairmanship of ISO Technical Committee 43 (Acoustics). He was an HonFellow of the Institute of Acoustics, a Fellow of the IEEE, a Fellow of the Acoustical Society of America and a Foreign Associate of the National Academy of Engineering (USA).

He will long be remembered as a teacher, researcher, internationally renowned acoustician, and for his role in the growth of noise control as an engineering discipline.

William W Lang FIOA

ANNOUNCEMENT and CALL FOR PAPERS

1995 AUDITORIA CONFERENCE

OPERA AND CONCERT HALL ACOUSTICS

(Organised by the Building Acoustics Group of the Institute of Acoustics)

Sussex, UK: February 1995

The opening in 1994 of the first new Opera House in the UK for 60 years (Glyndebourne) has stimulated interest in the acoustics of this special type of music auditorium. The meeting will include contributions from the acoustic consultants to Glyndebourne, and those responsible for three other UK music auditoria. A visit to a new auditorium is planned during the conference. To finalise the conference plans, an early call is made here for further contributions so that the final format of the conference can be resolved.

Offers of contributions on acoustic aspects of opera and concert hall auditoria should be sent in the form of a brief abstract to the Programme Committee Chairman prior to 1 July 1994:

The Programme Committee Chairman:

Jeff G Charles FIOA
Bickerdike Allen Partners
121 Salusbury Road
London NW6 6RG

Tel: +44 (0) 71 625 4411 Fax: +44 (0) 71 625 0250

Those wishing to be placed on the mailing list for further details when available should contact the Institute:

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5 Holywell Hill
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CALL FOR PAPERS

International Conference

UNDERWATER ACOUSTIC SCATTERING

Organised by the Underwater Acoustics Group

Weymouth, 20-22 December 1994

A knowledge of underwater acoustic scattering is essential to many civil and defence applications, including seabed classification, air-sea interactions and the understanding of reverberation. It is now 10 years since the last Institute of Acoustics conference on scattering in the oceans was held and many areas of this topic have advanced significantly in that time. Theoretical developments have been made and the processing speed and memory capabilities of the available technology now permit large amounts of experimental data to be gathered and analysed.

The field of underwater scattering covers a large range of topics and does not seem to be limited by frequency. Furthermore, different frequencies and scattering geometries have their own particular problems to be solved - from backscattering at normal or grazing incidence to bistatic geometries including forward scattering and reflection. Key topics will be addressed by invited speakers, who will set the scene for the contributed papers. All the papers will be published in Volume 16 of the Proceedings of the Institute of Acoustics which will be made available at the conference.

The Invited Speakers will present papers on the following topics:

Paul Crowther, Marconi - Sea Surface Scattering

Darrell Jackson, APL - UW, Seattle, USA - Scattering from the Sea-Bed

Peter Thorne, POL - Volume Scattering by Marine Suspensions

Nicholas Pace, University of Bath - Sediment Volume Scattering

Papers are invited in all areas of underwater acoustic scattering and in particular the following:

Sea surface scattering and scattering from bubbles, bubble clouds or plumes; Seabed scattering from the water-sediment interface and from the sediment volume; Suspended sediments and objects in the ocean volume; Arctic acoustics; Backscatter between normal incidence and grazing incidence; Bistatic scattering and reflection; Reverberation phenomena in deep and shallow water; Techniques for measuring the physical properties of underwater features; Instrumentation, experimental methods, signal processing and data reduction.

Prospective authors should submit an abstract of no more than 200 words to the conference organisers as soon as possible. Successful authors will be notified shortly after 15 July 1994 and will be expected to submit a full typescript of their papers by 23 September 1994 for inclusion in the conference proceedings. The conference will take place from 20 December 1994 until lunch time on the 22 December 1994.

For further information concerning this conference please contact the Conference Organisers:

G J Heald (Tel: 0305 863105) or S A S Jones (Tel: 0305 863461)
Defence Research Agency, Southwell, Portland, Dorset DT5 2JS, UK
Fax: 0305 863446

*Institute of Acoustics, 5 Holywell Hill, St Albans, Herts AL1 1EU. Tel: +44 (0)727 848195 Fax: +44 (0)727 850553.
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ANNOUNCEMENTS

1994 Autumn Conference SPEECH AND HEARING

(Organised by the Speech Group)

**Windermere Hydro Hotel
24-27 November 1994**

Eighty papers accepted for oral or poster sessions on a wide variety of topics, including:

• Speech Analysis • Speech Production • Speech Perception • Auditory Modelling • Speech Recognition • Speech Synthesis • Speech Corpora • Speech Aids for the Handicapped

Programme for the conference will be published in September

10th Annual Week-end Conference Reproduced Sound 10

(Organised in collaboration with AES, APRS, ABTT, The International Institute for Forensic Acoustics and SCIF)

**Windermere Hydro Hotel
3-6 November 1994**

This year a series of seminars on the following topics (with associated workshop discussions) will form the basic framework of the conference:

- **Network Control of Audio and Video Equipment** •
- **Bit Rate Reduction and the Work of the Motion Picture Experts Group (MPEGII)** •
- **Acoustic Design of Studio Control Rooms** •
- **Developments in Speech Intelligibility** •
- **Loudspeaker Technology** •

In addition to the above, which will bring together a number of noted contributors from the international scene, there will be space for contributed technical papers on any aspect of reproduced sound. It is also intended to offer a repeat of the training course entitled "Acoustics for Sound System Engineers" that was run for the first time in 1993. There will also be a manufacturers exhibition and the traditional social and accompanying persons programmes.

Offers of contributions on any aspect of the art and technology of reproduced sound should be sent in the form of a short abstract, indicating whether it is intended that the paper will be offered for the new refereeing procedure, to the Programme Committee Chairman:

Ken Dibble CEng MIOA
Ken Dibble Acoustics
Old Rectory House
79 Clifton Road
Rugby, Warks
CV21 3QG

Tel 0788 541133, Fax 0788 541314

INSTITUTE DIARY 1994

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|--|--|--|--|
| 16 JUNE
IOA Diploma exams, 2 days | 8 JULY
IOA CofC in Environmental Noise Mm'nt Advisory Committee
<i>St Albans</i> | 6 OCT
IOA Medals & Awards, Membership, Publications, Council
<i>St Albans</i> | 11 NOV
IOA CofC in W'place Noise Ass't Advisory Committee
<i>St Albans</i> |
| 16 JUNE
IEng interviews
<i>St Albans</i> | 10 AUGUST
RS10 Programme Committee
<i>St Albans</i> | 14 OCT
IOA CofC in Work-place Noise Assessment exam
<i>Accredited Centres</i> | 16 NOV
London Branch Annual Dinner |
| 22 JUNE
London Branch mtg: Outdoor Sound Propagation
<i>NESCOT, Ewell</i> | 20 SEP
Environmental Noise Group Workshop
<i>Bristol</i> | 19 OCT
London Branch mtg: Design Manual for Roads and Bridges
<i>Croydon</i> | 24 NOV
1994 Autumn Conference
Speech & Hearing, 4 days
Windermere |
| 23 JUNE
CEng interviews
<i>St Albans</i> | 21 SEP
London Branch mtg: Mark Southwood, Union Railways
<i>London</i> | 26 OCT
Eastern Branch mtg: Sound Quality
<i>Norwich</i> | 1 DEC
IOA Meetings Committee
<i>St Albans</i> |
| 24 JUNE
IOA CofC in W'place Noise Ass't Advisory Committee
<i>St Albans</i> | 28 SEP
Eastern Branch mtg: Acoustic Design of Broadcasting Studios
<i>Cambridge</i> | 3 NOV
Reproduced Sound
10, 4 days
Windermere | 2 DEC
IOA CofC in Environmental Noise Mm'nt Advisory Committee
<i>St Albans</i> |
| 30 JUNE
InterNoise '96 Committee
<i>St Albans</i> | 28 SEP
Active Control Workshop
<i>London</i> | 4 NOV
IOA CofC in Env Noise M'ment exam
<i>Accredited Centres</i> | 8 DEC
IOA Membership, Medals & Awards, Publications, Council
<i>St Albans</i> |
| 1 JULY
CEng interviews
<i>St Albans</i> | 29 SEP
IOA Meetings Committee
<i>St Albans</i> | 10 NOV
IOA Education Committee
<i>St Albans</i> | 14 DEC
London Branch mtg: Loudspeaker Design
<i>London</i> |
| 7 JULY
Engineering Division Committee
<i>St Albans</i> | | | |

NON-INSTITUTE MEETINGS

SOCIETY OF ACOUSTICS (SINGAPORE)

The Annual Meeting of the society will be held Wednesday through Thursday 11-12 January 1995, at Novotel Orchid, Western Avenue Singapore.

TOPICS: General Acoustics, Physical Acoustics, Ultrasonics and Bioacoustics, Underwater Acoustics, Architectural Acoustics, Noise and Vibration, Speech and Communication, Transduction and Measurements.

Contact: A/Pro Y C Tong, c/o Acoustical Services Pte Ltd, Innovation Centre, 209-212, Nanyang Avenue, NTU, Singapore 2263. FAX: (+65) 791-3665, TEL: (+65) 791-3242

INTERNATIONAL ASSOCIATION FOR FORENSIC PHONETICS

1994 Annual Conference 9-13 July 1994, Cardiff Institute of Higher Education

Further details, please contact: Martin Duckworth, IAFP Conference Organiser, School of Human Sciences, Cardiff Institute of Higher Education, Cardiff CF5 2YB

UNITED KINGDOM INFORMAL GROUP ON HUMAN RESPONSE TO VIBRATION

The 29th meeting of the group will take place at the Institute of Naval Medicine, Alverstoke from 19 September to 21 September 1994.

Enquiries to: Mrs A Willcocks, Institute of Naval Medicine, Alverstoke, Gosport, Hants, PO12 2DL,

Tel: (0705) 822351 Ext 41893, Fax: (0705) 504823

SIXTH INTERNATIONAL CONFERENCE ON ELECTRONIC ENGINEERING IN OCEANOGRAPHY

(Co-sponsored by the Institute of Acoustics)
Cambridge, 19-21 July 1994

Five sessions covering the following topics: Positioning and Navigation, Underwater Vehicles and their Control, Acoustic Sensing Systems Telemetry, Sensors and Data Handling

Further details and copies of the programme are available from Louise Bousfield, Conference Services, IEE, Savoy Place, London WC2R 0BL. Tel: 071 344 5467. Fax: 071 497 3633.

NOISE NUISANCE – A SOLICITOR'S REVIEW OF THE CURRENT LAW

Philip Barnes

Introduction

The effect that noise can have upon people was first given a statutory basis in 1960 with the Noise Abatement Act, repealed and superseded in 1974 by the Control of Pollution Act. This was strengthened in 1990 by the Environmental Protection Act, and in an effort further to reduce the impact of noise, the Government passed the Noise and Statutory Nuisance Act 1993. This built on previous legislation, and it may therefore be helpful to review what was in place before the 1993 Act, before considering what the 1993 Act has set out to achieve.

The statutory, and other controls before the 1993 Act were as follows: the Noise Abatement Act 1960; the Control of Pollution Act 1974 ('COPA'); the Environmental Protection Act 1990 ('EPA'); the Common Law of Nuisance – this is not statutory, but a branch of the Common Law of 'Tort'.

With the exception of the Noise Abatement Act (which was subsumed into COPA) these are compared in summary form in the Table at the end of this paper, but it may be helpful to look into each Act, and the Common Law in some greater detail.

The Control of Pollution Act 1974

COPA used the concept of statutory noise nuisance first introduced by the Noise Abatement Act of 1960, which itself added noise as a 'Statutory Nuisance' as that term was defined in the Public Health Act 1936. Unfortunately it gave no definition of what noise as a Statutory Nuisance actually was, and Common Law principles of whether or not something constituted a nuisance therefore still applied. This meant that generally whether or not something actually was a nuisance depended, ultimately, on the view of the Judge hearing the case. Whilst this has the usual merit of allowing flexibility in the law, permitting a Judge to find against innovative characters who might invent some new method of creating a noise nuisance, it also means that it is uncertain whether or not a particular activity is actually a nuisance until the Court has ruled upon the matter.

Much of COPA remains in force, although the general powers of a Local Authority to abate a noise nuisance originally contained in s58 and s59 are now contained in the EPA*, the specific powers of Local Authority relative to construction/engineering sites (s60) and Noise Abatement Zones (s66) remain in force. Section 60 empowers Local Authorities to serve notices limiting use

of certain types of plant or machinery (s60(3)(a)), hours of work (s60(3)(b)) and noise levels (s60(3)(c)) on those who are carrying out the work.

If a notice has been served, and the limits set by the notice breached, then contravention of the notice might itself not be in dispute. However, as always, Local Authorities need to take care that they exercise their powers reasonably and if they have been unreasonable in the imposition of a notice then a Court might find that they had been over enthusiastic in the use of their powers, quash the notice and the Local Authority would need to go back and think again.

For somebody served with a 'notice' under Section 60 COPA, contravention (without reasonable excuse) can lead to a fine not exceeding level 5 (now £5000) in the Magistrates Court with an additional daily sum (maximum £50/day) for any continued non-compliance.

If somebody wishes to know what noise levels would be acceptable to a particular Local Authority, it is possible to apply for a 'consent' under COPA (s61). Although breach of an Order will still lead to a fine this approach allows a Building Contractor or other potential perpetrator of the noise to select appropriate plant and working methods in advance of commencing on site to avoid possible delay and expense due to intervention by the Local Authority (or other individual). Here there should be some objectively measurable defined criteria making it possible for the perpetrator to know what target he must achieve in advance. Breach of the notice then becomes a question of objective fact, rather than subjective assessment for the Court to decide whether the noise was 'too much'.

The penalties for exceeding permitted noise levels can be quite severe, but COPA does allow the perpetrator the 'defence' that the 'best practical means' are being employed (s60(4)(b) and s61(5) and s66(9) of COPA). So if a contractor is breaking up mass concrete on a construction site he does not have to try and do it with a teaspoon. In assessing this 'best practical means' defence, various factors will be relevant, including local conditions, current technical knowledge and the financial implications involved. Generally, the Control of Noise (Codes of Practice for Construction and Open Sites) Order 1984 & 1987 (SI 1984/1992 and SI 1987/1730) should provide appropriate guidance on how to avoid a notice.

People working in locally designated 'Noise Abatement Zones' under COPA (Section 63) should also take care not to exceed prescribed noise levels when working on designated classes of buildings although it is possible to apply in advance to exceed the prescribed level (Section 65). Again, the prescribed noise levels should offer

* Noise nuisance in Scotland is still dealt with under the 1974 Act, sections 57–59. In Northern Ireland noise control and nuisance is regulated under the Pollution Control and Local Government (Northern Ireland) Order 1978.

some measurable objective standard so that the target above which one is liable to receive a notice is at least known in advance.

Criminal activity or responsibility is usually associated with individuals, and 'corporate liability' is not something which can be automatically inferred by the Courts. For this reason Section 87(1) of COPA permits the prosecution of company directors, secretaries, managers and officers where an offence is committed by a limited company.

A major limitation of the Act is the fact that it has no application to street noise. Local Authority powers under s60 COPA apply where construction/engineering works are taking place on 'any premises', and s66 COPA where noise is 'emanating from any premises' in excess of Noise Abatement Zone limits. The definition of 'premises' does not include 'highway', therefore this Act gives Local Authorities no power to deal with noise from the street.

The Environmental Protection Act 1990 (The 'EPA')

The EPA repeals s58 and s59 of COPA but re-enacts them in consolidated form with other statutory nuisances. It deals with noise which is 'prejudicial to health or a nuisance' and allows Local Authorities (s80) and aggrieved individuals (s82) to take action in respect of noise emitted from premises, including land, but – again – not the street (s79(1)(g)).

Helpfully, Section 79(7) of the EPA does define what is meant by 'prejudicial to health' and defines it as meaning 'injurious or likely to cause injury to health'. It is worth noting that it does not say 'likely to cause injury to hearing', so it may be that if constant noise causes annoyance or prevents people sleeping, this may still satisfy the requirement of being 'prejudicial to health'. Unlike the provisions regarding noise from construction sites in COPA, s60, this Act requires the noise to amount to a 'nuisance or to be prejudicial to health'. Technically it may well be possible for a noise to be prejudicial to health, but not a nuisance as suggested above. There is no objective standard against which the noise can be measured, but it will be assessed by reference to case law precedent considering the quality and duration of the noise, the locality and various other matters. Section 79(7) of the Act expands the definition of 'noise' to include vibration, and 'premises' includes land and any vessel – except a vessel powered by steam reciprocating machinery – which means steam engines (s79(7) and s79(12)).

Under the EPA the 'open field' is certainly 'premises', and this definition itself must have been of assistance in stopping 'acid house' parties held in large tents in the middle of the country late at night. Entirely different problems may arise if the fashion moves on to 'acid tent' parties where the entertainment comes courtesy of a steam driven fairground organ.

Section 79(1) of the EPA places each Local Authority under a duty to inspect its area regularly for noise pollution and to make specific investigations of complaints by aggrieved persons living within its area. Having made the

inspection, and concluded that a statutory nuisance exists or is likely to occur or recur the Local Authority may serve an 'abatement notice' on:

- the person causing it (Section 80(2)(a)); and/or
- the owner of the premises (where the nuisance is due to a defect in the structure) (Section 80(2)(b)); or
- the owner or occupier of the premises where you cannot find the perpetrator, or the nuisance has not yet happened (Section 80(2)(c)).

Considering the people who may be served, the 'person causing' the noise is fairly straightforward but employers should, of course, remember that where a nuisance is caused by one of their employees, they may find themselves liable for their employee's actions as the recent case of *NRA v Alfred MacAlpine* (1994) shows. In this case a site operative had discharged cement laden water into a stream thus killing the fish, and the Court was prepared to rule that corporate liability could be imposed by actions of these employees even though they were quite low down the management structure of the company.

Serving an 'abatement notice' on the 'owner of the premises' also makes sense where there is a structural defect, and the third category of persons who could be served with an 'abatement notice' not only makes practical sense, but seems to have been specifically worded to prevent publicized parties from starting. There is a line of appeal against the notice, and the recipient may appeal to the Magistrates Court within 21 days of the service of the notice (s80(3)).

A Local Authority can bring summary proceedings against those infringing notices without reasonable excuse. A fine of up to Level 5 on the Standard Scale (presently £5,000), but up to £20,000 if it is an industrial, trade or business premises, plus 10% (£500) per day if the nuisance continues, may be payable. Under Section 80(1)(b) the Local Authority can also require works to be done in abatement, and these may be expensive.

The Local Authority do have powers to enter any premises (Section 81(7) and paragraph 2 of Schedule 3) to check whether a statutory nuisance exists, or serve an abatement notice, or under Section 81(3) to abate a nuisance themselves where the abatement notice is being ignored. The taking away of the amplifier from particularly noisy parties may well be an effective way of abating continuing noise nuisances, but a Local Authority must use their powers in a reasonable manner, and this would suggest serving 'abatement notices' first before using their own powers to abate (particularly if confiscation of equipment is being considered). Before exercising their powers, a Local Authority should also consider whether it would be prudent to advise the police, who may choose to attend if a breach of the peace is apprehended as a serious possibility if the confiscation of equipment is likely. It is worth noting that the Local Authority are empowered to enter any premises to check if a statutory nuisance exists, not just the premises from which the nuisance emanates. This may be useful for evidence collection, since it is not so much the noise as heard within the premises which is important but the effect

of the noise next door which matters.

Section 82 of the EPA also allows aggrieved individuals to bring summary proceedings against offenders and orders and similar fines to those which might have been imposed had the Local Authority brought the action may result (although the higher fines for industrial premises do not apply). However, it is likely that the Magistrates will wish to hear independent expert evidence on behalf of the aggrieved individual, since if the Local Authority are not acting, it suggests that this is because they do not consider that a statutory nuisance has occurred. Compensation for the expense of bringing the proceedings may also be ordered to be paid to the individual who brought the proceedings (Section 82(12)). This seems to be specifically designed to allow Magistrates to award 'costs' to the aggrieved party to be paid by the perpetrator.

Where there are a number of people on the same premises, all of them causing noise, then co-operation between them in complying with reasonable noise levels will be of real importance. Again, this may particularly affect building sites where many different contractors are working at the same time. Notices can be served on all parties whose total noise creates a nuisance even though individual output did not. (s81(1) as regards powers of local authority, s82(5) as regards aggrieved individuals apply). The usual penalties apply on contravention. For those involved in construction or development work, this is increasingly important because of the continuing move towards a multiplicity of trade contractors all working individually for one management contractor on a particular project. The 'single point' responsibility of the traditional contractor does not exist in these circumstances.

The definition of statutory nuisance also includes any premises in such a state as to be prejudicial to health or a nuisance (Section 79(1)(a) EPA). Whilst this subsection is usually associated with enforcement against the landlord where there is damp in the building or structural unsoundness in the case of Southwark London Borough Council v Ince and Another (1989) the tenants used this type of right in a novel way. Here it was held that Local Authority tenants who were suffering noise from a nearby railway could force the Local Authority to install sound-proofing measures (double glazing etc) – even though the Local Authority was not itself responsible for the noise.

Although there may be 'corporate liability' of the company causing the noise, Section 157 of the EPA also provides for the prosecution of individuals within a company for nuisances for which the Court considers them responsible.

The limitation with this particular Act was again the fact that it did not provide for the control of street noise, since s79(1)(g) only covers 'noise emitted from premises' and 'premises' did not include the street. This gap has now been plugged by the Noise and Statutory Nuisance Act 1993.

Common Law Nuisance

Common Law Nuisance – which is a tort – is a condition or activity which unduly interferes with the use or enjoy-

ment of land. It is therefore necessary for the aggrieved person to have an interest in land in order to enjoy it. This certainly includes freeholders, leaseholders and legal occupiers of land, but would not include trespassers.

Whether a particular activity is actionable in common law nuisance depends upon balancing the conflicting interests of the two competing parties – the one wanting to make the noise and the 'neighbour' suffering its effects. There is no absolute standard, and numerous matters must be considered before a Court will conclude that a particular activity does constitute a nuisance. Criteria such as the time, place, extent (occasional or continuous), manner of performance and effects (transitory or permanent) will all need to be considered. A useful test is whether a particular activity is reasonable given the ordinary usages of mankind 'living in a particular society', but this remains subjective.

There is no need to prove prejudice to health, but it is necessary to take the character of the neighbourhood into account – 'what would be a nuisance in Belgrave Square would not necessarily be so in Bermondsey'. (Sturges v Bridgman (1879)). So if the aggrieved person lives in an already noisy area there would need to be a marked increase in noise above prevailing local standards before he could succeed in an action in nuisance. This also means that if you came to the area where a nuisance prevails, you will have greater difficulty in trying to suppress it, although there are conflicting decisions on this.

The action would be brought against the actual wrong doer, not necessarily the person in occupation of the land, although if an occupier brings an independent contractor onto his land to carry out works then the question of liability of the occupier will depend upon whether he could reasonably have foreseen that what he wanted carried out was necessarily going to cause a nuisance. Clearly it is not going to be his fault if the independent contractor chooses to carry out a perfectly reasonable activity in an entirely unreasonable way which causes a nuisance. (see Matania v National Provincial Bank).

As regards defences, the only real defence is that the activity is not a nuisance. The following are not true defences, although they may be effective in helping a defendant's case: a suitable place; the activity is in the public interest; the best-known means have been taken to prevent the noise; it is only one of many similar emissions of noise in the vicinity.

Serious penalties or injunctions may result if an emission is found to constitute a nuisance at Common Law.

Where Does the Noise & Statutory Nuisance Act 1993 (NSNA) Fit In?

The Act extends the EPA to include 'noise that is prejudicial to health or a nuisance and is emitted from or caused by a vehicle, machinery or equipment in a street'. (s2(b) NSNA creates a new Section 79(1)(ga) of EPA.)

Now environmental health officers, either on their own initiative or after receiving a complaint, can apply the EPA in respect of noise emitted by vehicles, machinery or equipment operating in the street. This is probably wide enough to include compressors and power tools used to

	Control of Pollution Act 1974	Environmental Protection Act 1990	Common Law of Nuisance	Noise and Statutory Nuisance Act 1993
Relevant Sections	58 and 59 (now repealed and re-enacted)	79 (re-enacts Section 58 COPA) lists statutory nuisances Noise is 79(1)(g) "Noise emitted from premises"	Not applicable	2, 3, and 7 insert additions to S.79, S.80, S.81, S.82 and add S.80A and 81A and B to EPA 7 amends S.62 of COPA
Who can take action?	Local Authority S.60	Local Authority (Section XX) or aggrieved individual (Section 82)	Nearby aggrieved 'landowner'	S.80 EPA as amended by S.3 NSNA (Local Authority) S.82 EPA as amended by S.5 (Individual)
Who to take action against	Company officers if Limited Company, Person 'in control'	'person responsible' 'owner' – defective premises 'owner or occupier' if person responsible cannot be found	Perpetrator of the nuisance (and his employer) – not necessarily the occupier of the land	'person responsible' n.b. can include registered keeper of vehicle and operator
Type of Prosecution (civil/criminal)	Criminal	Criminal and civil where criminal sanctions inadequate	Civil Criminal	As EPA
Maximum Penalty	£5,000 + £50/day	S.80 'domestic' £5,000 + 10% per day 'business' £20,000 S.82 no 'business' fines	Damages Injunction	As EPA
Prior "agreed" noise level?	Yes – S.61 Construction sites - possible conditions attached. S.65 Noise Abatement Zone	No	–	No
Defences	Consent under S.61 or 65. ('Best Practicable Means' – factor to be taken into account)	'Best practicable means' 80(7) and 82 (9) if business premises 'Domestic' not available 80(8)(a), 82(10)	None, but consider nature of neighbourhood Temporary Minor Harm Possibly used reasonable care to prevent	As EPA
Action taken	Notice under S.60 limiting noise level, hours of work etc. possibly requiring specific works	'Abatement Notice' under Section 80 'Self Help' under Section 81(3)	Civil action – Damages and injunction	As EPA plus power to enter, remove vehicle and equipment to abate nuisance

break open road surfacing and probably also includes people using power tools on the exterior of buildings who could not previously be said to be 'on the premises'. Note also that the definition restricting the operation of the Act to 'vehicles, machinery and equipment' would seem to suggest that a party aggrieved by noise from constant shouting or singing in the street from, eg, stall holders or workmen may not be protected under the Act, although common law nuisance may arise. The new section could also be used to abate noise from car alarms where the alarm is repeatedly sounding for no proper reason.

Noise emitted by motor vehicles on a highway (including most kinds of motorized plant) is already controlled under the Road Vehicles (Construction and Use) Regulations 1986 (SI 1986/1078) making the driver (or his employer) liable for the emission of any excessive noise avoidable by the exercise of reasonable care. However, under the new Act the 'person responsible' as newly defined in Section 2(4)(b) will be liable to be served with an abatement notice and that includes the person in whose name the vehicle is registered as well as the driver for the time being. Accordingly, plant and equipment hirers (as 'persons responsible') must now ensure that vehicles and equipment that they hire do not infringe this section, or they, as well as the hirer, might face prosecution. Abatement notices in respect of noise from vehicles, machinery or equipment should be served upon the person responsible or by fixing the notice to the relevant offending item. Authorised Local Authority officers have power to enter or open the vehicle, machinery or equip-

ment, using force if necessary and may remove it to carry out any authorised work to the vehicle. A typical example of this being to break into a car to turn off a persistent car alarm.

In the case of machinery and equipment, liability also lies upon the 'person responsible', and that includes any person who is for the time being the operator of the machinery or equipment (and of course his employer). Again, hiring companies dealing in noisy tools and equipment should take care to ensure all necessary steps are taken to minimise excessive noise in use.

Magistrates Courts, where individuals bring complaints, will be obliged to make an abatement order if satisfied that a nuisance exists or likely to recur 'on the same premises or (by s5(2) NSNA) in the same street'.

Conclusion

The net of noise control grows ever tighter. Those carrying out work in the street should be increasingly concerned to ensure that they are not penalised and work is not disrupted through notices, orders and injunctions. In addition to the existing Codes of Practice, there may be new statutory guidelines to deal specifically with street noise, which should at least allow those whose business may be affected by the new controls to know with some degree of certainty what will, and will not be acceptable.

This article expands upon a paper given at an Institute meeting on Noise Nuisance and the Law held on 18 May 1994.

Philip Barnes is a solicitor with Stephenson Harwood, One St Paul's Churchyard, London EC4M 8SH ♦

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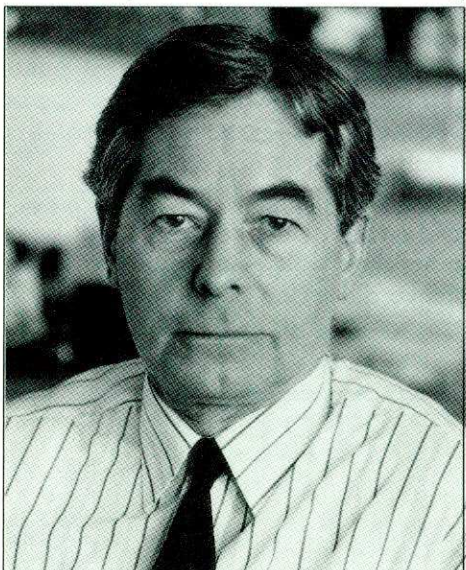
Citations

1994 Rayleigh Medal

Professor E F Evans

Ted Evans has had a distinguished career in education and research in auditory physiology. He has been responsible for significant developments in our understanding of the hearing mechanism.

Professor Evans studied medicine at the University of Birmingham. After short periods as House Physician and House Surgeon he studied for a higher degree in the Neurocommunications Research Unit at the University of Birmingham. His research was concerned with the response of cortical neurones to acoustic stimuli of various forms. He pioneered, in the UK, techniques for recording from single units in the unanaesthetised auditory cortex and from the cochlear nerve in mammals. After two years of research as visiting associate at the



National Institute for Neurological Diseases and Blindness in Bethesda, USA he joined the Department of Communication and later the Department of Communication and Neuroscience, at the University of Keele. He holds a personal Chair in Auditory Phys-

iology and has acted as Head of the Department of Communication and Neuroscience for 12 years, and as Chairman of the Board of Natural Sciences of the University.

His research publications, which number over 160, report a range of contributions to the knowledge of the physiological and psychophysical responses of the ear to acoustic stimuli. Early work was concerned with demonstrating that the sharp tuning of cochlear nerve fibres needed an active, physiologically vulnerable, filtering mechanism in the cochlea, in addition to classical 'travelling wave' mechanics. He provided evidence that physiological auditory frequency selectivity in normal and impaired ears could be accounted for by the physiological properties of the cochlea, and was the first to demonstrate a quantitative agreement between physiological and behavioural measurement of frequency selectivity in the same species. His research has also provided evidence for several of the mechanisms operating in the peripheral and central auditory nervous system. In addition to this fundamental work, he has contributed to a

wide range of applied studies: from the pathophysiology of hearing impairment through the effects of amplified 'pop' music, to cochlea implants.

Professor Evans is a Fellow of the Royal College of Physicians of London and a Fellow of the Institute of Acoustics and the Acoustical Society of America. His research has been recognised by the award of the James Yearsley Medal by the Royal Society of Medicine and the J S Macrae Medal by the Royal Victoria Hospital, Belfast. He has presented many named lectures, including the Fifth Knowles Lecture at the University of Southampton and the Sandoz Lecture of the Institute of Neurology on three occasions.

Professor Evans has acted on the editorial boards of several scientific journals and is presently a member of the board of the European Journal of Neuroscience. His membership has been valued by many scientific advisory and management committees. He is a member of the US National Research Council on Hearing, Bioacoustics and Biomechanics and is Chairman of the Hearing Research Committee of the Medical Research Council.

The Institute of Acoustics is pleased to award the Rayleigh Medal in 1994 to Professor E F Evans for his contributions to knowledge in the field of auditory physiology.

Honorary Fellowships of the Institute of Acoustics

Alan Richard Dove

Alan Dove's initial technical experience was in the area of pneumatic systems engineering. After National Service and a period as a Patent Examiner, he entered the Factory Inspectorate in 1969. It was here that he soon established an interest in noise and was the first specialist to work full time on this topic. He established what is now the HSE's noise and vibration laboratory.

Shortly after the HSE was formed he moved to the Policy Division responsible for, among other things, policy on noise and vibration and remained in the Division for 18 years until his retirement in 1993. During this time Alan Dove was responsible for providing advice to the Health and Safety Commission and Executive and to ministers, also for the drafting of official documents and publications on behalf of HSE and its various committees. These included the code of practice on Noise at Work in 1972, the



report 'Audiometry in Industry' and in 1987 proposals for legislation and guidance on noise which led to the 1989 Noise at Work Regulations.

He represented UK interests during the development of various proposals for European Community Directives and their subsequent negotiations at Council of Ministers Working Groups. He was also responsible for HSE's general efforts to promote public understanding of the hazard to hearing created by loud sounds of all kinds. One initiative was the campaign centred around the theme 'What is your hearing worth?'.

Alan has played an influential role in the development of noise standards: His work has involved listening to the opinions of all sorts of interest groups such as scientists, industrialists and trades unionists. He was usually instrumental in finding an approach which most people could live with and which would improve the standards of workers without imposing excessively bureaucratic burdens on industry.

The Institute of Acoustics is pleased to award an Honorary Fellowship to Alan Dove for his contributions to workplace noise control and standardisation.

George Hans Vulkan

George Vulkan's professional expertise is in the area of environmental noise assessment and control, particularly from transportation sources.

Following National Service his first job was with London Transport's Research Department, where he was



dealing with problems related to the Underground System. He developed an active interest in acoustics shortly after joining the LCC in 1959 and became closely involved in the organisation and execution of the London Noise Survey. Later he worked

on the development of the Greater London Council's noise guidelines and the Council's noise policy. At this time he was active in the Institute of Physics Acoustics Group and was joint secretary with Jack Blitz. He was also a member of the British Acoustical Society before the formation of the Institute of Acoustics.

George held the posts of Head of the Noise Group and Head of Environmental Sciences with the Greater London Council. His major activities were related to the Noise Insulation Regulations, noise from Concorde and Public Inquiries for airport and heliport development. He was also concerned with the introduction of the London

Lorry Ban which came into force shortly before the demise of the GLC.

Recently, George has used his wide experience as a consultant to Union Railways on noise aspects of the long awaited high speed rail link to the channel tunnel.

The Institute of Acoustics is pleased to award an Honorary Fellowship to George Vulkan for his work in environmental noise assessment and control.

Group and Branch Reports

Speech Group

Members of the Group are advised that the three vacant places on the Group Committee have been filled by David Howard, Laurie Moye and Steve Young.

Christine Cheepen of the University of Hertfordshire has taken over from Mark Huckvale as editor of *Speak-easy* and has joined the Institute's Publications Committee.

Briony Williams, Secretary

South West Branch

A highly successful regeneration of the South West Branch occurred on 23 March at the University of the West of England, Bristol. The response from an extensive mail drop of members and Local Authority Environmental Health Departments was very encouraging with thirty members indicating renewed interest; perhaps surprisingly, there were some 60 Environmental Health Officers from the south west, South Wales and the general area extending up to the Malvern Hills wishing to be involved.

An ad hoc committee of Norman Pittams, Stan Simpson (both UWE), Steve Peliza (consultant) and Mike Squires (Exeter City Council) was formed to organise the first year's programme until the AGM in March 1995. Cathy Mackenzie from the Institute office attended as did Bob Peters, Vice President for Groups and Branches. Bob also presented Diplomas and Certificates of Competence to successful candidates from the University.

A lively evening followed with contributions on the theme of 'Noisy Neighbours'. Steve Peliza spoke on 'Early Morning Noise', Keith Horton of Woodspring DC on 'Late Night Parties', Martin Williams of Brüel & Kjær on the 'The Matron System'. Norman Pittams presented a contribution on 'Party Wall Insulation' and Tim Clarke of Bristol City Council spoke on 'Mediation, an EHO's Point of View'.

Two more meetings are planned and these are 'Design, Production and Testing of Fans' at NuAire's premises on 23 June and 'Underwater Acoustics' at BAe-SEMA in November. The Branch committee has also agreed to host a Environmental Noise Group's workshop at UWE, Bristol in September.

Even in the current economic climate there is seemingly considerable enthusiasm for Institute activities at Branch level in the south west and continuing success is confidently envisaged.

Norman Pittams, Chairman

20th ANNUAL REPORT OF THE COUNCIL 1993

Summary

During 1993, the Institute continued to act as the professional body representing acoustics in the UK.

A range of services was provided for the membership. The services are being continuously improved and developed.

Six editions of the Institute journal, 'Acoustics Bulletin', were published and a range of technical meetings held. Courses were run for the Diploma in Acoustics and the Certificates of Competence in Workplace Noise Assessment and Environmental Noise Measurement. The Engineering Council renewed the Institute's status as a nominated/affiliated body. Members are urged to take advantage of the routes to CEng and IEng offered through the Institute.

A working party has been set up to examine the Institute's role in Continuing Professional Development for all those members who may wish to participate in such a scheme. The working party will also consider the role which the Institute might play in meeting the CPD needs of other related professional bodies, with our conference, meetings and Branch activities. It will be particularly concerned with the needs of Institute members who are also members of such bodies.

Head Office accommodation is now firmly established in St Albans. The office suite is well organised and equipped; members are encouraged to visit the office and use the small reference library. Thanks are due to the staff for their commitment and enthusiasm which ensure the smooth running of the office and many of the Institute activities.

Standing Committees

The operation of the Institute is guided by Council through Standing Committees concerned with Membership, Meetings, Publications, Education and Medals and Awards. There is also a Committee of the Engineering Division.

Medals and Awards

The Rayleigh Medal in 1993 was presented at the Spring Meeting to Professor M A Bruneau, who has been responsible for the development of the very active research and teaching at the University of Maine in Le Mans. He also plays an important role in the scientific and professional life in acoustics in France.

The A B Wood Medal was awarded to Dr M D Collins for his research contributions to the numerical modelling of complex ocean acoustic phenomena. Also at the Spring Meeting, Honorary Fellowships of the Institute were awarded to Professor B L Clarkson and Professor D W Robinson. Professor Clarkson has enjoyed a distinguished career in research and education. Professor Robinson holds an international reputation for his research in hearing and his contribution to standards on workplace noise.

Membership Committee

The growth in membership has been maintained during the past year and the statistics are shown in the Tables 1 to 4. A more rigorous system for dealing with members who do not pay their subscriptions promptly has been introduced and will be applied in 1994.

Many applications for membership come from Hong Kong, which is the most rapidly expanding Branch. The Membership Committee's consideration of these applications has been facilitated during the year by advisors in Hong Kong, whose local knowledge assists immeasurably in assessing the education and experience of applicants.

A list of membership advisors has been in existence for many years but has not been well publicised. This list has been updated and will be more widely used in future. The Code of Conduct has been given a new format, although still containing the same guidance and rules. The disciplinary and appeal procedures which will be adopted in the event of transgression have been spelt out in order to bring the Institute into line with Engineering Council procedures.

Meetings Committee

In total, eleven meetings were held, including three major conferences (see Table 5). Attendances were significantly up on last year. In line with the increasing 'Europeanisation' of Institute activities, the Spring Conference at Southampton was a joint venture with the Société Française d'Acoustique. Over 40 of their members participated. In another new initiative, the Reproduced Sound 9 Conference featured a training course on Acoustics for Sound System Engineers. The course was a great success, with 27 members registered. The Autumn Conference on Environmental Noise was the 20th event to be held at the Windermere Hydro and was a considerable success, with a record attendance of 184 delegates. A successful bid was made to I/INCE for the Institute to host Internoise '96 in Liverpool.

Publications Committee

Acoustics Bulletin continued in its new format, with regular features, such as Acoustics and Europe, Consultancy Spotlight and the Bulletin Board. Many technical contributions have been included and a special issue was produced on Neural Networks. Each member of the Institute received a copy of the 1993 Register of Members. The first three issues of the new European journal, *Acta Acustica*, were published in 1993. It is hoped that more papers on applied acoustics topics will be submitted.

The Publications Committee has been given the responsibility for overseeing the library at headquarters. It was decided that, initially at least, this should be a reference library. It is planned to appoint a librarian in 1994 to catalogue the contents.

In order to make Institute conferences more attractive, a refereeing system for contributed papers is to be introduced.

Education Committee

In 1993, 133 students completed the requirements for the award of the Institute's Diploma and the Institute's revised Tutored Distance Learning Programme was offered for the first time preparing students for the 1994 examinations. At the three examinations held in February, May and October, a total of 146 candidates were awarded the Certificate of Competence in Workplace Noise Assessment; this makes a total so far of 860. A Certificate of Competence in Environmental Noise Measurement was established during the year and at examinations held in June and November a total of 56 candidates were successful.

Engineering Division

As a result of representations by the Institute, the Engineering Council renewed the Institute's affiliation as a nominated body for a further period. In its review, the Engineering Council recognised the excellent track record of the Institute as a learned society but identified a number of administrative deficiencies in relation to procedures for the operation of the Division. The Institute has resolved these issues by the establishment of a headquarters function for the Engineering Division, the amendment of certain review procedures in the consideration of candidates for CEng and the appointment of a part time Engineering Division Manager, Eurling Dennis Playle CEng.

A scheme for the registration of Incorporated Engineers, for which the Institute has full nominated body status, has been established and the way is now clear for members to proceed with applications for registration as CEng or IEng, as appropriate.

Specialist Groups

The Institute as a whole reflects the broad span of the science of acoustics and a number of Groups have developed to foster closer contacts between members in various specialisms.

Building Acoustics Group

The Group's main activity in 1993 was planning and organising the technical programme of the Institute's Autumn Conference on Environmental Noise. Delegates represented a wide range of interests - including EHOs, academics, consultants and researchers. As well as a full programme of papers, the conference included lively workshops on many topics of current interest and a visit to a wind farm. A proposed meeting on the conflicting requirements of natural ventilation and sound insulation had to be cancelled because of the lack of contributed papers.

Electroacoustics Group

The Group held no activities during 1993. However, it is still the intention to promote the Group in association with the very successful Conferences on Reproduced Sound. Anyone wishing to help should contact Head Office.

Environmental Noise Group

This is a new Group of the Institute, bridging the gap which was felt to exist between the Building Acoustics Group and the Industrial Noise Group. At the 1993 Autumn Conference, there was encouraging support for

the Group and several members came forward to offer their assistance. From those, a committee was formed with the aim of achieving a good geographical representation, together with a good mixture of consultants and EHOs. With the inevitable potential overlap between this group and the BAG and the ING, representatives of each of those Groups will also attend Committee meetings of the Environmental Noise Group. The first meeting of the Committee has been held and plans for the development of the Group are being formulated.

Industrial Noise Group

The Group organised one successful meeting, on External Vehicle Noise and Impending Legislation in March 1993. Members of the Industrial Noise Group have played an important part in the development of the Institute's Certificate of Competence in Workplace Noise Assessment and it is intended to formalise the links between the Group and the Certificate of Competence Advisory Committee. It is planned to produce a Newsletter to circulate to all Certificate holders and to all Industrial Noise Group members.

Musical Acoustics Group

The Group's main contribution this year was a one-day session at the Spring Conference. Seven papers were presented on topics ranging from discussions of new musical scales based on clock chimes to investigations of the acoustical function of more conventional musical instruments. Contributions from the SFA membership included one paper from the Le Mans group, noted for their excellent work on wind instruments, and an invited lecture by Xavier Boutillon on violin acoustics. The group has again decided against the organisation of one-day visits, but has continued to invest effort in the production of its Newsletter.

Physical Acoustics Group

During the year the Physical Acoustics Group which is organised jointly with the Institute of Physics, held two meetings: Mathematical Modelling of Ultrasonic Wave Propagation at the Institute of Physics Congress, Brighton, and Annual Review of Progress in Physical Acoustics at the Sheffield Hallam University. Both meetings were technically excellent and well attended. The Group also co-sponsored: the British Institute of Non-Destructive Testing (NDT) Annual Conference; IEE Ultrasound in the Process Industry and IEE NDT of Civil Engineering Structure. It has been decided to try to link future meetings to other related conferences or congresses. As an experiment, a meeting on ultrasonics in NDT will be held as part of the next British Institute of NDT Conference and the next general review of Progress in Physical Acoustics will form a part of the IOP Annual Congress.

Speech Group

The Speech Group held three technical meetings during 1993. The first meeting, at the University of York, was on the theme of Analysis and Synthesis of Natural Voice. It was combined with a demonstration of one of the systems described and was followed by the AGM. The second technical meeting, at the University of Edinburgh, was on the theme of Human Interaction with Speech Technology. It included two demonstrations of speech systems. The

third technical meeting, at the University of Newcastle, was on the theme of Acoustic Analysis of Disordered Speech and Voice.

The Speech Group's newsletter, 'Speakeasy' continued to appear during 1993 (three issues), with its mixture of conference announcements and reports, job advertisements, discussion and news items from the field.

Underwater Acoustics Group

In 1993 the Underwater Acoustics Group saw a fuller programme of meetings and activities than has been possible for some time. The Group supported the Spring Meeting, with sessions on underwater acoustics. These were organised in collaboration with the SFA, with the result that two full days of good quality papers were contributed and the sessions were very well attended. Additionally the Group ran two International Conferences, one at Bath University in April on Acoustic Classification and Mapping of the Sea Bed and one at Birmingham University in December on Underwater Acoustic Communication, Navigation and Positioning, as well as a one day meeting at Bath University in September on The Acoustics of Advanced Materials.

Regional Branches

The Regional Branches of the Institute of Acoustics have been established to further the technical and social activities of the Institute at a more local level. The East Mid-



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lands, North East, South West and Yorkshire and Humberside Branches did not hold meetings during 1993. Plans are in hand to revitalise these Branches under the guidance of the Vice-President with responsibility for Groups and Branches.

Eastern Branch

The Eastern Branch was very active in 1993. Two afternoon meetings were held jointly with the Institute of Environmental Health Officers and five evening meetings were held, including the Annual General Meeting at British Telecom Research, Martlesham, in November. The Branch has Members from throughout East Anglia and meetings were held at Ipswich, Cambridge, Colchester, Bury St. Edmunds, Norwich and Needham Market. The number attending varied from about a dozen to over fifty for the afternoon meetings. The afternoon meetings proved to be very popular with those Members who are Environmental Health Officers and will continue in 1994. The following topics were covered: Talking to Computers; The Building Regulations; Motor Sport Noise; PA Systems; Light Aircraft Noise and the new PPG, Planning and Noise.

London Branch

The monthly evening technical meetings proved both popular and informative, with average attendance of about 25. A varied selection of topics was covered, which ranged from Pop Concerts to Helicopters, taking in Acoustics, Noise Nuisance and a Politician's Viewpoint from Nirj Deva, MP, on the way. A few members enjoyed the annual dinner and were entertained by the speaker, Peter Allaway.

North West Branch

The branch has had a reasonably successful year with five meetings drawing an average attendance of over 20 members. Two social events however received little support. The evening meetings were held in the Manchester offices of BDP Acoustics and the lecture topics covered Blast Noise Propagation, Active Acoustics, PA Systems for Entertainment, Safety and Fireworks and EC Standards. A technical workshop on Planning and Noise proved the most popular event.

Scottish Branch

A combined AGM and Branch meeting was held in July at the James Watt Conference Centre of the National Engineering Laboratories, East Kilbride, by invitation of the management of the Noise Engineering Section of the Flow Centre. Members were given information on NEL's Wind Energy Programme and technical presentations on wind turbines. Following the presentations, members were transported by Land-Rover to the National Wind Turbine Centre's test site at Myres Hill to observe windmill noise tests first hand. On returning to the conference centre, the meeting concluded with the AGM.

Southern Branch

The Branch held only one meeting in 1993. This was at the usual venue, Winchester Guildhall, and was well attended by approximately 20 members. The speaker was Keith Rose, who gave a very entertaining talk on The Acoustic Design of Broadcasting Studios. The meeting concluded as usual in the hostelry opposite.

Grade	1992	1993	Applied	Elected
HonFellow	11	13	-	2
Fellow	220	219	4	4
Member	1077	1137	119	100
Associate Member	348	394	125	119
Associate	249	226	43	43
Student	25	44	28	28
Totals	1930	2033	-	-
Key Sponsor	3	3		
Sponsor	16	18		

Table 1. Details of Institute Membership

	1992	1993
Building Acoustics	546	506
Electroacoustics	124	136
Environmental Noise	0	484
Industrial Noise	789	617
Musical Acoustics	114	138
Physical Acoustics	99	102
Speech	87	103
Underwater Acoustics	133	152

Table 2. Group Membership

	1992	1993
East Midlands	162	187
Eastern	145	163
London	393	461
North East	52	57
North West	215	236
Scottish	78	86
South West	129	139
Southern	270	310
Yorks/Humberside	91	97
Hong Kong	131	152
Overseas	119	139

Table 3. Details of Branch Membership

	1992	1993
Architectural Practice	17	18
Consultancy	357	498
Industry/Commerce	250	329
Education	205	215
Public Authority	330	415
Research & Development	190	218
Other	109	65
Retired	n/a	57

Table 4. Details of Employment Category

Topic, Date & Venue	Attendance
External Vehicle Noise and Impending Legislation 4 March 1993 London	62
Background Noise in Planning and Nuisance 5 April 1993 South Bank University	57
Acoustic Classification and Mapping of the Sea Bed 14/16 April 1993 Bath	141
Acoustics '93 Spring Conference (joint with SFA) 20/23 April 1993 Southampton	197
Environmental Vibration 19 May 1993 London	50
Acoustical Measurements and NAMAS Accreditation 15 June 1993 NPL	51
Acoustic Properties of Advanced Materials for Underwater Applications 15 September 1993 Bath	40

Reproduced Sound 9 28/31 October 1993 Windermere	134
Autumn Conference, Environmental Noise 18/21 November 1993 Windermere	184
The Noise Insulation (Railways, etc.) Regulations 6 December 1993 London	41
Underwater Acoustic Communication 20/21 December 1993 Birmingham	38

Table 5. Meetings Attendance

Chairmen of Committees and Sub-committees

EDUCATION: Dr Roy Lawrence FIOA
 CERTIFICATE OF COMPETENCE IN ENVIRONMENTAL NOISE
 MEASUREMENT ADVISORY BOARD: Dr John Goodchild
 MIOA
 CERTIFICATE OF COMPETENCE IN WORKPLACE NOISE
 ASSESSMENT ADVISORY BOARD: Dr Bob Peters FIOA
 DIPLOMA IN ACOUSTICS AND NOISE CONTROL, BOARD OF
 EXAMINERS: Dr John Bowsher FIOA
 ENGINEERING DIVISION: Professor Peter Lord HonFIOA
 MEDALS & AWARDS: Professor Peter Wheeler FIOA
 MEETINGS: Bernard Berry MIOA
 MEMBERSHIP: Alex Burd FIOA
 PUBLICATIONS: Professor Bill Ainsworth FIOA

Specialist Groups

BUILDING ACOUSTICS: Chairman Jeff Charles FIOA, Secretary
 Dr Les Fothergill FIOA
 ELECTROACOUSTICS GROUP: Secretary Dr James Angus
 FIOA
 ENVIRONMENTAL NOISE: Chairman Steve Turner MIOA, Sec-
 retary Brian Parker MIOA
 INDUSTRIAL NOISE: Chairman Dr Bob Peters FIOA, Secretary
 David Bull FIOA
 MUSICAL ACOUSTICS: Chairman Dr Bernard Richardson
 MIOA, Secretary Dr Jenny Zarek MIOA
 PHYSICAL ACOUSTICS (Joint with the Institute of Physics) Chair-
 man Dr Daryl Almond, Secretary Professor Richard Challis
 SPEECH: Chairman Dr Steve Young FIOA, Secretary Dr Briony
 Williams MIOA
 UNDERWATER ACOUSTICS: Chairman Dr Peter Dobbins
 MIOA, Secretary Dr Lynn Lipscombe MIOA

Regional Branches

EASTERN: Chairman David Bull FIOA, Secretary Terry Metcalfe
 MIOA
 EAST MIDLANDS BRANCH: Branch is awaiting reorganisation
 LONDON: Chairman John Simson MIOA, Secretary John
 Miller MIOA
 NORTH EAST: Chairman Brian Oakes FIOA, Secretary Stephen
 Arnott MIOA
 NORTH WEST: Chairman Michael Ankers FIOA, Secretary Mrs
 Nicola Alexander MIOA
 SCOTTISH: Chairman Patrick Corbishley MIOA, Secretary
 Ronald McLaughlin MIOA
 SOUTHERN: Chairman Graham Parry MIOA, Secretary Dr Ian
 Flindell MIOA
 SOUTH WEST: Branch awaiting reorganisation
 YORKSHIRE & HUMBERSIDE: Branch awaiting reorganisation
 HONG KONG: Chairman Dr Westwood Hong FIOA, Secretary
 A Li

Table 6: Institute Personnel 1993

Windfarm Noise

London

17 February 1994

This meeting was organised by Mark Legerton of the DTI Energy Technology Support Unit, who had previously arranged the workshop session at the 1993 Autumn Conference at Windermere. The topic was clearly a popular choice as 105 delegates attended, virtually filling the lecture theatre at the Society of Chemical Industry.

The morning session of presentations was opened by Martin Lawson, Head of the Department of Aerospace Engineering at Bristol University, who gave a thorough review of the various sources of aerodynamic noise associated with wind turbines. Some of the sources were demonstrated with the aid of a replica of a 1934 toasting fork! A new prediction model was outlined and comparison with noise data from a wide range of wind turbines have an rms accuracy of 1.6 dB(A).

Next, Jeremy Bass from Renewable Energy Systems Ltd assessed the performance of various sound propagation models and discussed the appropriateness of their application to windfarm sites. His general conclusion was that none of the models repayed the investment of effort required for their use. He suggested that a more profitable approach might be to develop a simple empirical model.

Andrew Bullmore from Hoare Lee and Partners described the sources and effects of tonal noise and outlined some of the procedures which are under development for the assessment of tonal components. He emphasised the variability of tones from wind turbines and considered some of the measurement problems this causes.

Malcolm Hayes of the Hayes McKenzie Partnership dealt with the assessment and rating of windfarm noise. He produced an interesting list of descriptions of the various characteristic sounds emanating from wind turbines, such as 'swishing, wooshing, chomping and

thumping', and linked these to the physical sources. He also summarised the various standards which are used in assessing windfarm noise. The morning session closed with a paper by Alistair Mackinnon from the National Engineering Laboratory which gave a valuable preview of a number of documents under development which deal with sound power measurement.

After lunch the meeting continued with a number of brief presentations and a discussion period.

Mark Legerton explained the objectives and recent activities of the DTI Working Group on Wind Turbine Noise. The group are reviewing recent experience, relating measured data to complaints

and defining a framework for the measurement and assessment of noise. The group plan to provide indicative noise levels thought to offer a reasonable degree of protection to windfarm neighbours and to encourage best practice in turbine design and windfarm siting and layout. Martin Edwards of Windelectric Ltd and David Snow of Powergen gave brief case studies of measurements at a number of sites.

The final hour of the meeting provided an opportunity for an open forum during which a wide range of issues were discussed.

Meeting proceedings are now available from the Institute office, price £18 (members) £25 (non-members). *Bernard F Berry FIOA*

Large Vocabulary Speech Recognition

Cambridge University Engineering Department

17 March 1994

This one day meeting, organised by the Speech Group, was intended to be a follow-up to a similar meeting held 2 years ago at Cambridge. A total of ten papers were presented and during the lunch-break there were a number of demonstrations of speech recognition systems. Once again, the meeting was very popular and over 90 people attended.

The morning papers covered mainly research topics. Eluned Parris from Enigma began the session with a paper entitled 'Acoustic Modelling using Continuous Density HMMs with Linear Discriminant Features'. The paper described some of the problems encountered when using LDA with mixture Gaussians and described a solution based on treating each mixture component as a separate class. Results were presented on both the SCRIBE database and a 44-hour radio database. In both cases, substantial error reduction was achieved and also it was discovered that 25% of the system parameters could be discarded with no loss of performance.

The second and third papers considered the problem of building context-dependent models with

limited data. Roger Moore from DRA described a new type of HMM unit in a paper entitled 'Context Adaptive Phones: an approach to vocabulary-independent automatic speech recognition' and Dave Ollason from British Telecom discussed the merits of various types of parameter tying scheme in a paper called 'Variable pool-size, tied parameter systems for context-dependent subword unit speech recognition'. The morning session ended with papers from Peter Howell from UCL on 'The relationship between speech production and speech perception in vowel stress and plosive judgements' and a paper by Nigel Sedgewick from Cambridge Algorithmica on 'Recent Work on Recognition by Synthesis'. Although different in approach, both speakers were reminding the audience that models of speech production may have a significant role to play in future speech recognition systems.

The afternoon session was more system oriented. In a paper called 'Speaker Independent Telephone Speech Recognition using Subword Units', Ranjit John described recent work at GEC in which 'phonicle' subword units had been successfully

used to implement speaker independent isolated word recognition over the telephone. The following two papers then described the large vocabulary speech recognition systems built by the Cambridge University Speech Group for the ARPA November 1993 Wall Street Journal evaluation. First, in a paper called 'Connectionist Large Vocabulary Speech Recognition', Mike Hochberg described the ABBOT system which uses a recurrent neural network phone probability estimator to feed a simple HMM-like Viterbi decoder. The system is notable in that it has far fewer parameters than conventional HMM-based systems and it requires much less computation during recognition. This was followed by a paper called 'The HTK Large

Vocabulary Speech Recognition System' in which Phil Woodland described a tied-state HMM-based recogniser built using the HTK toolkit. This system returned the lowest error rate of any system on three of the four ARPA tests entered and it had the second lowest error rate on the fourth. As an example, in the 5000 word closed vocabulary test using a trigram language model, it had an error rate of 4.9%.

The final two papers of the day addressed the problem of language modelling. First, in a paper called 'Combining Knowledge Sources to Re-order N-best Speech Hypothesis Lists', Manny Rayner from SRI described various experiments in which grammatical and n-gram constraints were combined in order to reduce errors in the ATIS task. The

combination technique used was novel in that it considered both positive and negative examples from the training data. Finally, Tony Rose from Nottingham Trent University presented a paper called 'Language Modelling for Large Vocabulary Speech Recognition: Corpus-based techniques and their limitations' in which he described various types of language model developed originally for hand-writing recognition.

Overall, the day was notable for the marked progress that has clearly been made since the first IOA meeting on this topic two years ago. Vocabulary size has been increased by a factor of ten or more yet word error rates are the same or better. It will be interesting to see what is reported at the same meeting in two years time!
Steve Young

1994 Proceedings

Volume 16 Part 1
'Windfarm Noise'
£18 (members), £25 (non-members)

Volume 16 Part 2
'Acoustics 94' (1994 Spring Conference)
£35 (members), £45 (non-members)

Volume 16 Part 3
'Noise Nuisance and the Law'
£18 (members), £25 (non-members)

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Measurement of the Acoustical Properties of Biological Tissues

London

15 February 1994

The meeting was held at the Institute of Physics Belgrave Square Headquarters. It was organised by the joint Institute of Acoustics/Institute of Physics Physical Acoustics Group in collaboration with the British Medical Ultrasound Society and the Institute of Physical Sciences in Medicine.

The meeting was attended by 38 delegates and divided into three broad sessions, the morning being devoted to the techniques, the early afternoon to the measurement of fluids and soft tissue and the final session to the measurement of bone.

The morning session, which was chaired by Professor Richard Chailis, examined in detail some of the problems associated with making *in vivo* measurements and suggested possible improvements both in technology and technique along with suggesting that models, both physical and mathematical, may help us to overcome some of the problems we encounter.

Tony Evans gave a wide rang-

ing overview of the various methods used in the ultrasonic measurement of tissue and some of the associated pitfalls.

The first afternoon session, which was chaired by Dr Tony Evans, dealing with bio-fluids and soft tissues demonstrated the power of acoustic techniques to measure parameters from the very small (protein molecules) to the relatively large (cardiac muscle). Of particular appeal was a multi-modality approach using visual and ultrasonic macroscopy to produce collagen maps in tumours.

The final session, chaired by Dr Christian Langton, covering bone measurement also looked at models as an aid to understanding the propagation of ultrasound in this physically complex and poorly understood medium. The papers on bone measurement and the question and answer sessions associated with them both demonstrated that this is likely to be a fruitful field of future investigation.

Daryl Almond

News from BSI

New and Revised British Standards

BS 5750 : Quality systems.

Part 14: 1993 (equivalent to EN 60300-1, ISO 9000-4 and IEC 300-1). Guide to dependability programme management. This outlines the essential features of a dependability programme, planned and managed to produce products that will be reliable and maintainable. No current standard is superseded.

BS 6840 : Sound system equipment.

Part 2: 1993 (equivalent to IEC 268-2 including Amd No.1). Glossary of general terms and calculation methods. This covers general terms for components and is a new edition, introducing technical changes but does not reflect a full review or revision of the standard, which will be undertaken in due course. It implements CENELEC HD 483.2 S2 and supersedes BS 6840 : Part 2: 1988.

BS 7385 : Evaluation and measurement for vibration in buildings.

Part 2: 1993 Guide to damage levels from groundborne vibration. No current standard is superseded.

BS 7706 : 1993 Guide to calibration and setting-up of ultrasonic time of flight diffraction (TOFD) technique for the detection, location and sizing of flaws. This covers the use of two probe version of TOFD to detect, locate and size flaws. It supersedes DD 174: 1988.

BS 6402 : 1994 (equivalent to IEC 1252) Electroacoustics – Specifications for personal sound exposure meters. This specifies meters to measure sound exposure as the time integral of the square of the instantaneous A-frequency-weighted sound pressure. It supersedes BS 6402 : 1983.

BS 6840 : Sound system equipment.

Part 11: 1994 (equivalent to IEC 268-11 (inc Amds 1 & 2)) Specification for application of connectors for the inter-connection of sound system components. This specifies application and contact arrangement designations for circular and concentric connectors. It implements CENELEC HD 483.11 S3. This edition introduces technical change but it does not reflect a full review or revision of the standard, which will be undertaken in due course. This supersedes BS 6840 : Part 11: 1988.

BS 7750 : 1994 Specification for environmental management systems. This specifies requirements for the development, implementation and maintenance of management systems aimed at ensuring compliance with stated environmental policy and objectives. This supersedes BS 7750 : 1992.

BS 6288 : Magnetic tape sound recording and reproducing systems.

Part 1: 1994 (equivalent to IEC 94-1) Specification for general conditions and requirements. This supersedes BS 6288 : Part 1: 1982.

BS 6955 : Calibration of vibration and shock pick-ups.

Parts 1 to 19: 1993.

Amendments

BS 0 : A standard for standards.

Part 1: 1991 Guide to the general principles of standardization. Amendment No 1.

Part 2: 1991 Guide to BSI committee procedures. Amendment No 1.

Part 3: 1991 Guide to the drafting and presentation of British Standards. Amendment No 1.

BS 5750 : Quality systems.

Part 8: 1991 Guide to quality management and quality systems elements for services [ISO 9004-2]. Amendment No 1. Note: This amendment implements EN 29004-2: 1993 as a British Standard.

BS 6955 : Calibration of vibration and shock pick-ups.

Part 0: 1988 Guide to basic principles [ISO 5347-0: 1990]. Amendment No. 2. Note: this amendment implements Technical Corrigendum No 2 to ISO 5347-0: 1990.

BS 2750 : Acoustics – Measurement of sound insulation in buildings and of building elements.

Part 9: 1987 Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it. [ISO 140-9: 1985]. Amendment No 1.

DD ENV 28041: 1993 Human response to vibration – Measuring instrumentation. Amendment No. 1.

BS 6288 : Magnetic tape sound recording and reproducing systems.

Part 2: 1990 [IEC 94-2: 1975] Specification for calibration tapes. This amendment implements EN 60094-2: 1993 as a British Standard and dual numbers BS 6288: Part 2: 1990 with BS EN 60094-2: 1994.

Part 5: 1989 [IEC 94-5: 1988] Specification for electrical magnetic tape properties. This amendment implements EN 60094-5: 1993 as a British Standard and dual numbers BS 6288: Part 5: 1989 with BS EN 60094-5: 1994.

BS EN Publications

The following are British Standard implementations of the English language versions of European Standards (ENs).

BS EN 352 : Hearing protectors – Safety requirements and testing.

BS EN 352-1 : 1993 Ear muffs. This does not deal with ear-muffs within, or for attachment to, a helmet or with electronic or amplitude sensitive devices. This supersedes BS 6344 : Part 1: 1989.

BS EN 352-2 : 1993 Ear plugs. This does not deal with electronic or amplitude sensitive ear plugs. This supersedes BS 6344 : Part 2: 1988.

BS EN 458 : 1994 Hearing protectors – Recommendations for selection, use, care and maintenance – Guidance document. This gives guidance to suppliers, purchasers, safety authorities and wearers. No current standard is superseded.

BS EN 24869 : Acoustics – Hearing protectors.

BS EN 24869-3 : 1994 Simplified method for the measurement of insertion loss of ear-muff type protectors for quality inspection purposes. This describes a method for measuring insertion loss and to investigate production spreads of performance and change with age. This supersedes DD 192: 1990.

BS EN 25136 : 1994 (equivalent to ISO 5136 (inc Corr 1)) Acoustics – Determination of sound power radiated

into a duct by fans – In-duct method. This gives a method for testing ducted fans to determine the sound power radiated into a duct on the inlet or outlet side of the equipment. No current standard is superseded.

BS EN 60094 : Magnetic tape sound recording and reproducing systems.

BS EN 60094-1 : 1994 (equivalent to IEC 94-1) Specification for general conditions and requirements.

BS EN 60094-2 : 1994 (equivalent to IEC 94-2 (inc. Corr & Amd 2)) Calibration tapes. This is implemented as a European Standard by amendment to BS 6288 : Part 2: 1990.

BS EN 60094-7 : 1994 (equivalent to IEC 94-7) Specification for cassettes for commercial tape records and domestic use.

BS EN 61043 : 1994 (equivalent to IEC 1043) Specification for electroacoustics – Instruments for the measurement of sound intensity – Measurement with pairs of pressure sensing microphones. This ensures well defined performance for instruments used for the determination of sound power according to ISO 9614-1. No current standard is superseded.

BS EN 61094 : Specification for measurement microphones.

BS EN 61094-2 : 1994 (equivalent to ISO 1094-2) Primary method for pressure calibration of laboratory standard microphones by the reciprocity technique. This specifies a primary method of determining pressure sensitivity to establish a reproducible and accurate basis for the measurement of sound pressure. No current standard is superseded.

BS EN 61101 : 1994 (equivalent to IEC 1101) Specification for absolute calibration of hydrophones using planar scanning techniques in the frequency range 0.5 MHz to 15 MHz. This provides a technique for the calibration of a hydrophone by means of a transducer of known output power. No current standard is superseded.

BS EN 61102 : 1994 (equivalent to IEC 1102) Specification for measurement and characterization of ultrasonic fields using hydrophones in the frequency range 0.5 MHz to 15 MHz. This defines acoustic parameters, derived from intensity parameters and measurement conditions when using calibrated piezoelectric hydrophones in liquids of acoustic fields. No current standard is superseded.

BS EN 61205 : 1994 IEC 1205 Specification for ultrasonics – Dental descaler systems – Measurement and declaration of the output characteristics. This defines standard methods of measurement and specification of the essential vibration characteristics of ultrasonic dental descalers. No current standard is superseded.

BS ENs implemented by amendment

BS EN 20140 : Acoustics – Measurement of sound insulation in buildings and of building elements.

BS EN 20140-9 : (also numbered as BS 2750 : Part 9: 1987 and equivalent to ISO 140-9) Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it. This is

implemented as a European Standard by amendment to BS 2850 : Part 9: 1987.

Proposed for Confirmation

BS 6415 : 1983 Specification for audio-frequency calibration tape for transverse track video recorders.

British Standards Reviewed and Confirmed

BS 5942 : High fidelity audio equipment and systems; minimum performance requirements.

Part 1: 1980 Specification for general requirements.

BS 6840 : Sound system equipment

Part 6: 1987 Methods for specifying and measuring the characteristics of auxiliary passive elements.

Part 8: 1988 Methods for specifying and measuring the characteristics of automatic gain control devices.

British Standards Withdrawn

BS 6344 : Industrial hearing protectors.

Part 1: 1989 Specification for ear muffs. This is superseded by BS EN 352-1 : 1993.

Part 2: 1988 Specification for ear plugs. This is superseded by BS EN 352-2: 1993.

DD 174: 1988 Guide to the calibration and setting up of the ultrasonic time of flight diffraction (TOFD) technique for the location and sizing of flaws. This is superseded by BS 7706 : 1993.

BS 6288 : Magnetic tape sound recording and reproducing systems.

Part 1: 1982 Specification for general conditions and requirements. This is superseded by BS EN 60094-1: 1994.

DD 192: 1990 Method for the measurement of insertion loss of ear-muff type protectors (simplified method for quality inspection purposes). This is superseded by BS EN 24869-3: 1994.

New Work Started

BS 4142 : Method for rating industrial noise affecting mixed residential and industrial areas. This will amend BS 4142 : 1990 to clarify certain aspects of the procedure which some users have found difficulty in interpreting.

DD ENV 60268 (Technical Report) Sound system equipment.

Part 16: Methods of measuring the capability of a sound system to deliver intelligible speech (IEC 268-16.)

BS EN 60849 : Sound systems for emergency purposes.

BS 6840 : Sound system equipment.

Part 5: Methods for specifying and measuring the characteristics of loudspeakers – Amendment No. 2: Clause 26 – Method of measurement of magnetic stray field of loudspeakers. This will amend BS 6840 : Part 5: 1990.

Specification for apparatus with loudspeaking facilities for connection to public switched telephone networks run by certain public telecommunications operators – Essential requirements.

This will provide a standard to match and to work with NET 4/ETS 300 001.

European New Work Started

EN 583 Ultrasonic examination.

Part 6: Time of flight diffraction technique as a method for defect detection and sizing.

Ultrasonic inspection – Part 2 Spheroidal graphite iron castings.

International New Work Started

Building acoustics – Measurement of impact sound improvement on light-weight floors.

IEC 268 (Technical Report) Sound system equipment.

Part 5: Loudspeakers. Amendment: Clause 26 – Method of measurement of stray field of loudspeakers. This will amend IEC 268-5.

Part 16: Methods of measuring the capability of a sound system to deliver intelligible speech.

IEC 849 Sound systems for emergency purposes. This will revise IEC 849.

ISO 5344 Vibration and shock – Electrodynamic test equipment for generating vibration – Methods of describing equipment. This will revise ISO 5344.

ISO 7626 Vibration and shock – Experimental determination of mechanical mobility – Part 1: Basic definitions and transducers. This will revise ISO 7626-1.

ISO 13090 Mechanical vibration and shock – Safety aspects of tests and experiments.

ISO 13091 Mechanical vibration and shock – Measurement and interpretation of vibrotactile perception thresholds of coupled industrial machines and industrial gas turbines.

Measurement of the lowest resonance frequency of loudspeaker cones. This will define the method of measurement to determine the frequency of the lowest resonance of a loudspeaker cone.

ISO 14016 Guidelines for environmental assessments.

ISO 14017 Guidelines for initial environmental reviews.

ISO 14000 Environmental management systems – General guidelines on principles and their applications.

ISO 14001 Environmental management systems – Specifications with guidance for use.

ISO 14002 Environmental management systems – Guidelines on special considerations affecting small and medium enterprises.

Draft British Standards for Public Comment

93/213391 DC Acoustic noise measurement techniques for wind turbine generator systems (possible new British Standard) [IEC 88 (Secretariat) 30].

93/507722 DC ISO 8253-3 Acoustics – Method for conducting speech audiometric tests – Part 3: Speech audiometry (ISO/DIS 8253-3).

93/507729 DC ISO 11689 Acoustics – Systematic collection and comparison of noise-emission data for machinery and equipment (ISO/DIS 11689).

93/508224 DC Acoustics – Reference zero for the calibration of audiometric equipment – Part 7: Reference threshold of hearing under free-field and diffuse-field listening conditions (ISO/DIS 389-7).

93/409152 DC Guide to design requirements for measurement laboratories.

93/716456 DC EN 30819 Mechanical vibration and shock – Hand-arm vibration – Method for the measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand (ISO/DIS 10819: 1993) (prEN 30819).

93/716472 DC ISO 5347 Methods for the calibration of vibration and shock pick-up.

Part 20: Primary vibration calibration by the reciprocity method (ISO/DIS 5347-20).

94/201310 DC Ultrasonics – Flow measurement systems – Flow test object (Possible new British Standard) [IEC 87 (Secretariat) 62].

94/201311 DC Ultrasonics – Field safety – Part 1: Classification scheme for medical diagnostic fields (Possible new British Standard) [IEC 87/62B (Secretariat) 63/218].

94/201753 DC IEC 1260 Electroacoustics, octave-band and fractional-octave-band filters (Possible revision of BS 2475 : 1964) [IEC 29 (Secretariat) 274].

94/201755 DC Amendment No. 1 to IEC 1161 Ultrasonic power measurements in liquids in the frequency range 0.5 MHz to 25 MHz – Radiation force balance – Assessment of measurement uncertainties. (Possible amendment to BS EN 61161: 1994 when published) [IEC 87 (Secretariat) 61].

94/500683 DC ISO 11820 Acoustics – Testing of silencers in situ (Possible new British Standard) (ISO/DIS 11820).

94/501654 DC BS EN 23822 Acoustics – Laboratory test on noise emission from appliances and equipment used in water supply installations – Part 2: Mounting and operating conditions for draw-off taps and mixing valves. (pr EN 23822-2).

94/701704 DC EN 1299 Vibration isolation of machines – Information for the application of source isolation (prEN 1299).

94/701722 DC ISO 10816 Mechanical vibration – Evaluation of machine vibration by measurement on non-rotating parts – Part 2: Guidelines for large land-based steam turbine sets in excess of 50 MW (ISO/DIS 10816-2).

94/202601 DC IEC 1094-4 Measurement microphones – Part 4: Specifications for working standard microphones (Possible new British Standard, BS EN 61094-4) [IEC 29 (Secretariat) 270].

94/302724 DC ISO 13663 Welded steel tubes for pressure purposes – Ultrasonic testing of the area adjacent to the weld seam for the detection of laminar imperfections (ISO/DIS 13663).

94/502113 DC Revision of ISO 4871-2 Acoustics – Declaration and verification of noise emission values of machinery and equipment. (Possible new British Standard) (ISO/DIS 4871-2).

94/502144 DC BS ISO 9614 Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 2: Measurement by scanning (ISO/DIS 9614-2).

94/703406 DC Revision of ISO 2631 Mechanical vibra-

tion and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements (ISO/DIS 2631-1).

Draft International Standards

94/501643 ISO/DIS 10534 Acoustics – Determination of sound absorption coefficient and impedance or admittance by the tube method.

Other documents not issued as DPCs

EN 60118 Hearing aids.

EN 60118-0 Measurements of electroacoustical characteristics. Amendment No. 1: 1994. (Identical to Amendment 1: 1994 to IEC 118-0: 1983). The text of the amendment has not been issued as a draft for public comment by BSI. As a consequence of implementing this European amendment, BS EN 60118-0: 1993 Amendment No. 1: 1994 will be published.

EN 60118-7 Measurements of performance characteristics of hearing aids for quality inspection for delivery purposes. Amendment No. 1: 1994. (Identical to Amendment 1: 1994 to IEC 118-7: 1983). The text of the amendment has not been issued as a draft for public comment by BSI. As a consequence of implementing this European amendment, BS EN 60118-7: 1993 Amendment No. 1: 1994 will be published.

EN 60651: 1994 Sound level meters.

CENELEC has published the European Standard EN 60651: 1994 due to the conversion of HD 425 S1: 1983 into a European Standard. The text of the proposal has not been issued as a draft for public comment by BSI. As a consequence of implementing this European amendment, BS 5969: 1981 will be renumbered as BS EN 60651: 1994.

EN 60804: 1994 Integrating – averaging sound level meters.

CENELEC has published the European Standard EN 60804: 1994. It is identical to IEC 804: 1985 and its Amendment 1: 1989. The text of the proposal has not been issued as a draft for public comment by BSI. As a consequence of implementing the European Standard, BS 6698: 1986 and its Amendment No. 1 (AMD 6324: 1991) will be renumbered as BS EN 60804. CENELEC has published the Amendment A2 to European Standard EN 60804: 1994. It is identical to IEC 804: 1985 and its Amendment 2: 1993. The text of the proposal has not been issued as a draft for public comment by BSI. The United Kingdom is obliged to implement EN 60804/A2 as amendment No. 1 to BS EN 60804: 1994.

IEC Publications

IEC 1220: 1993 Technical Report. Ultrasonics – Fields – Guidance for the measurement and characterization of ultrasonic fields generated by medical ultrasonic equipment using hydrophones in the frequency range 0.5 MHz to 15 MHz. This will be implemented dual-numbered as a British Standard.

IEC 651 Sound level meters. Amendment No. 1. September 1993 to IEC 651: 1979. This will be implemented when harmonised by CENELEC.

IEC 804 Integrating-averaging sound level meters. Amendment No. 2: September 1993 to IEC 804: 1985. This will be implemented when harmonised by CENELEC to amend BS 6698: 1986.

IEC 1102 Measurement and characterisation of ultrasonic fields using hydrophones in the frequency range 0.5 MHz to 15 MHz. Amendment No 1: September 1993 to IEC 1102: 1991. This will be implemented when harmonised by CENELEC.

IEC 68-2 Environmental testing – Part 2: Test methods.

IEC 68-2-65: 1993 Test Fg: Vibration, acoustically induced. This will be implemented when harmonised by CENELEC.

IEC 645-2: 1993 Audiometers – Part 2: Equipment for speech audiometry.

IEC 1043: 1993 Electroacoustics – Instruments for the measurement of sound intensity – Measurement with pairs of pressure sensing microphones. This will be implemented when harmonised by CENELEC.

IEC 1205: 1993 Ultrasonics – Dental scaler systems – Measurement and declaration of the output characteristics. This will be implemented when harmonised by CENELEC.

IEC 118 Hearing aids.

IEC 118-0 Measurement of electroacoustical characteristics. Amendment No. 1: January 1994 to IEC 118-0: 1983. This will be implemented when harmonised by CENELEC.

IEC 118-7 Measurement of the performance characteristics of hearing aids for quality inspection for delivery purposes. Amendment No. 1: January 1994 to IEC 11807: 1983. This will be implemented when harmonised by CENELEC.

ISO Standards

ISO 5136: Acoustics – Determination of sound power radiated into a duct by fans – In-duct method. Technical Corrigendum 1: 1993 to ISO 5136: 1990.

ISO 140-2 Acoustics – Measurement of sound insulation in buildings and of building elements.

Part 2: Determination, verification and application of precision data. Technical Corrigendum 1: 1993 to ISO 140-2: 1991.

ISO 5347 Method for the calibration of vibration and shock pick-ups.

Parts 1 to 19: 1993.

ISO 9902: 1993 Textile machinery acoustics – Determination of sound power levels emitted by textile machines – Engineering and survey methods. This will be implemented as BS ISO 9902: 1993.

ISO Expression of uncertainty: 1993. Guide to the expression of uncertainty in measurement. This will be implemented as PD 6461: Part 3.

ISO 3743-1: 1994 Acoustics – Determination of sound power levels of noise sources – Engineering methods for small, moveable sources in reverberant fields.

Part 1: Comparison method for hard-walled test rooms. This will be implemented as BS ISO 3743-1: 1994.

ISO 10332: 1994 Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes –

Ultrasonic testing for the verification of hydraulic leak tightness. This will not be implemented as a BS because of absence of UK interest.

American Petroleum Institute (API) Publications

API 307: 1992 An engineering assessment of acoustic methods of leak detection in above ground storage tanks.

Approved Safety Standards

Consumer Protection Act 1987 Part II General safety requirement, The Approval of Safety Standard Regulations 1987 (SI 1987/1911); Regulations 2 and 3. Notice No.12.

The safety provisions of the following standard have been approved by the Secretary of State a standard of safety for the purposes of Section 10(3) of the Consumer Protection Act 1987:

BS 6344 : Industrial hearing protectors

Part 1: 1989 Specification for ear muffs.

The above information was provided by Ms Nicole Porter MIOA of NPL from the November 1993 to April 1994 editions of BSI News.

Hansard

15 December 1993

Denham Aerodrome (Noise Pollution)

Mr Richard Page (Hertfordshire, South-West): I present a petition on behalf of the residents of Maple Cross in the district of Three Rivers just north of Denham aerodrome. This petition can be added to several others which have already been presented by hon. Members in the House who represent constituencies to the south, east and west of the aerodrome. The petitioners suffer from the noise pollution of light aircraft using Denham aerodrome, especially those undertaking circuit training and bumps.

Therefore, the petitioners call upon the House to pass legislation as a matter of urgency to implement the provisions of the 'Review of Aircraft Noise legislation - Announcement of Conclusions' paper dated March 1993 following the consultation paper 'Control of Aircraft Noise' published in August 1991; and that such legislation should establish a range of noise control levels for designated aerodromes, especially those where circuit flying is permitted; and that such legislation should include provisions whereby the polluter pays for the cost of remedying any breach of the legislation and meeting any conditions which may be imposed by the lead authority to reduce substantially the noise generated by light aircraft; and that frequency of aircraft engaged in circuits and bumps should be restricted when flying from aerodromes in the vicinity of residential areas and that they be precluded from such operations on all weekends during the months of June to September inclusive; and that the House gives the Secretary of State powers to designate such aerodromes where circuit and bumps are permitted as distinct from those where normal take-offs and landings are permitted for light aircraft travelling between one aerodrome and another.

Wherefore your petitioners....

Railways (Noise)

Mr Rowe: To ask the Secretary of State for Transport when he expects to announce his final decision about the compensation and protection arrangements relating to noise on (a) existing railway lines in Kent and (b) proposed new railway lines in Kent.

Mr Freeman: On (a), I agreed during the Adjournment debate initiated on 13 January by my right hon. Friend the Member for Tonbridge and Malling (Sir J Stanley), Official Report, column 432, to reflect on the legal opinion which he had received, through the local authorities concerned, on the subject of compensation for those with properties alongside existing rail routes to the channel tunnel. I shall clarify the position to the House as soon as possible.

On (b), Union Railways has incorporated extensive noise mitigation measures in the design of the channel tunnel link and it will be for Parliament to decide, when considering a hybrid Bill to approve the project, on the adequacy of the measures. Meanwhile, the Department of Transport is currently consulting on draft regulations which will bring the arrangements for noise insulation for new railways in line with those for new highways, by making properties alongside eligible for insulation where noise exceeds certain levels. All comments on the coverage of the regulations, will be considered carefully before regulations are laid before Parliament.

Mr Dobson : To ask the Secretary of State for Transport if he will publish a full list of all organisations to whom his Department sent, and from whom it has received responses, regarding the consultation letter on noise insulation regulations for new railways and other guided systems, together with the addresses of each such organisation.

Mr Freeman (holding answer 18 January 1994): The Department issued 210 copies of the consultation papers to local authorities, professional institutions, railway operators, local action groups and others. A list of the original addresses for the consultation letter of 11 October 1993 was placed in the Library of the House at the time, with a set of the consultation documents. Some 200 further copies have since been issued in response to inquiries. The consultation period has therefore been extended by two months and responses will now be accepted until 28 February. I shall subsequently inform the House of the Government's conclusions on the response to the consultation. However, it is not our practice to identify those organisations or individuals who respond to consultation exercises.

11 January 1994

Noise

Mr Butterfill: To ask the Secretary of State for Transport what proposals he has for noise insulation for commercial premises in respect of noise from new railways; and what consideration he gave to including such premises or problems arising from ground-borne noise in the draft noise insulation regulations upon which consultation is now taking place.

Mr Freeman: The purpose of the proposed regulations is

to provide, for new railways, arrangements which relate equitably to those already applicable to the insulation of dwellings near new roads; commercial premises were not therefore considered for inclusion. The regulations provide for sound insulation; this would not be effective against ground-borne noise, which involves different technical factors and is therefore specifically excluded.

• 10 February 1994

Noise Pollution (Compensation)

Mr Wallace: To ask the Secretary of State for Defence what is his Department's policy with regard to compensation of residents living in close proximity to RAF bases in respect of increased or excessive noise pollution and if he will make a statement.

Mr Hanley: Since 1985, following a detailed examination of noise created by military aircraft, it has been my Department's policy to offer sound insulation grants to the owners/occupiers of houses in the vicinity of operational airfields which fall within certain scientifically defined noise contours. In cases where noise exceeds a higher level, the Department may offer to acquire the particular property concerned. There is also scope to provide compensation for the depreciation in value of property resulting from the bringing into use of new public works.

The Department's compensation scheme is a voluntary one but follows closely statutory schemes of the Department of Transport at civil airports.

To date, more than 30 such schemes have been introduced; these are reviewed at five-yearly intervals unless operational changes are such that an earlier review is warranted.

Noise Insulation

Mr Soley: To ask the Secretary of State for Transport if he will bring the west London line for rail freight within the scope of the draft noise insulation regulations.

Mr Freeman: Ministers will consider all responses to the current consultation exercise before deciding whether the draft regulations should be amended prior to their submission to Parliament. Meanwhile, British Rail remains willing to discuss with the local authorities concerned the possibility of jointly funded noise mitigation schemes for appropriate locations on the West London line.

31 March

Channel Tunnel Rail Link (Voluntary Purchase)

Sir John Stanley: As my hon. Friend the Minister for Public Transport knows, I have had to detain him and the House many times over the past two or three years on the issue of compensation for those who are unfortunate enough to have homes immediately adjacent to the existing rail routes to the channel tunnel. Today, I shall deal with a different but related issue – the position of those who are unfortunate enough to find their homes in the path of the new route, by means of the high-speed rail link, between London and the channel tunnel.

....two criteria will have to be satisfied before individuals can use the concession. First, they have to demonstrate hardship.... The other critical requirement is that the predicted noise disturbance must be above the proposed

threshold for noise insulation. Here the Government are in danger of making a significant error. The consultation period on the Department of Transport's proposed new noise insulation regulations for railway lines ended in February, and we await the Government's conclusions. However, all the hon. Members who represented constituencies in London, Essex and Kent along the route of the new high-speed rail link believe that the Government are setting the threshold for noise disturbance far too high.

The higher the threshold is set, the fewer the people who will qualify for noise insulation – or, in this case, for having their homes acquired under the voluntary purchase scheme. Indeed if the Government persist in setting noise thresholds too high, the concession may prove almost worthless. Almost no properties at all may be able to use the scheme under the concession.

As my right hon. Friend knows, among local authorities and residents in the affected areas there is total unanimity on what the noise threshold should be. That level is set out in the papers that I know my right hon. Friend has received.

The standard is described – at least in Kent – as the Kent noise standard, but the paper was sent out not only by the Kent district councils and by Kent county council, but by the London borough councils, the Surrey district councils and the Essex district councils, all of which have agreed a basis for the new noise insulation threshold. Of course, it is materially lower than the threshold that the Government originally proposed. I urge my right hon. Friend to adopt the local authorities' Kent noise standard, in preference to that suggested in the consultation paper...

.... Fourthly, I am asking that the owners of those properties outside the safeguarded zone should be helped by the Government in the following way. When the Government lay before the House the noise insulation regulations, they should introduce a noise insulation threshold that is more reasonable, significantly lower and preferably the Kent noise standard. That acoustic threshold would ensure that those who face disturbance from the channel tunnel rail link trains, but who live outside the safeguarded zone, will be able to benefit from the voluntary purchase scheme and escape the blight.

Mr Andrew Rowe... The issue of noise is important. As my right hon. Friend the Minister for Public Transport knows, many of us are deeply concerned about the intention to build a line capable of running trains at 180 mph, while building in the noise protection necessary for trains that run at 140 mph. It seems that, if the capacity to run faster trains exists, as soon as the signalling is capable of absorbing it, whoever runs the line in future will undoubtedly run faster trains. As I understand it, that will have considerable effects on noise. I hope that that will be part of the current planning....

The Minister for Public Transport (Mr Roger Freeman):

Once again, my right hon. Friend the Member for Tonbridge and Malling (Sir J Stanley) has done the House a service by raising specific issues; he has certainly focused my attention and that of the officials in the Depart-

ment....it may be helpful to my right hon.Friend and to my hon. Friend the Member for Mid-Kent (Mr Rowe) if I put on record a number of the points that relate generally to the voluntary purchase scheme.

Since the debate on 13 January, we have announced the route of the new channel tunnel rail link, with the exception of Ashford and Pepper Hill where we expect to reach a decision in the next few weeks. When we announce our conclusions, we shall be able to safeguard the entire route. We have also issued formal safeguarding directions for the route, except for the two exceptions that I mentioned.

Those directions came into force on 25 February, and are essentially a planning mechanism so ensure that conflicting development does not take place on land required for the purpose of an undertaking – in this case, the rail link. They also initiate the statutory blight arrangements for affected homes. Union Railways wrote to all those affected at the time, and has also produced a guide to property purchase procedures for the rail link, from which my right hon. Friend the Member for Tonbridge and Malling has quoted.

Two safeguarded zones have been defined in the safeguarding directions and shown on the plans that accompany them. One is for land required for surface works, and the other is largely for land above deep-bored tunnels. The surface safeguarding creates a right to statutory blight compensation where homes and some other properties would be wholly or substantially required.

So that those affected know where they stand, all those homes included in the surface safeguarding zone will be offered voluntary purchase without the need to demonstrate a statutory right to compensation. Purchase will be on the same basis as if the houses were being acquired under a compulsory purchase order. The owners will be paid the market value of the home as if the rail link proposal did not exist, plus home loss payments, legal and agents' fees and disturbance costs as appropriate.

If agreement cannot be reached on voluntary purchase, blight notices may be served by the property owners qualifying, and any disputes can then be settled by the Lands Tribunal. That tribunal would also settle any disputes on statutory compensation for compulsory purchase and compensation for loss of value due to the physical effects of the operation of the rail link on the surface or in the tunnel under part 1 of the Land Compensation Act 1973.

Compensation under that Act is a statutory right, and may be claimed 12 months after the start of use of the rail link. That is simply because time is needed to assess the actual impact, whether in tunnel or on the surface of the railway once it is operational.

Advanced predictions of the physical effects, such as re-radiated noise, would probably not be sufficiently precise and could cause later problems associated with overpayment and underpayment. It would not be right for compensation to be available from an earlier date than the normal 12 months, especially as, during the construction period, and for a time thereafter, the property market

may well be distorted by the effects of the project. There could be difficulty in assessing the effects of any long-term drop in the value of homes.

However, exacting design aims have been set for the rail link, not only for noise, but for all other areas of potential environmental impact, such as vibration. Our paper on property purchase and compensation policy explains that the thinking behind this is that it is better to limit the environmental intrusion at source, as far as reasonably practicable, by putting the rail link in a cutting or providing mitigation in the form of noise barriers and landscaping, than to rely simply on compensation....In addition to the homes included in the surface safeguarded zone, as my right hon.Friend the Secretary of State for Transport said in his January announcement, any other homes that may be affected by operational noise above the proposed threshold for noise insulation contained in the draft railway noise regulations will qualify for purchase in cases of hardship.

As with highway schemes, hardship needs to be proven, and each case is looked at individually. Those who think that they may qualify for the scheme should contact Union Railways. I should stress that the scheme is not a statutory requirement, and that decisions are entirely at the discretion of Union Railways.

As I have said, homes within the surface safeguarded zone will be offered voluntary purchase. In line with long established practice for underground railways, purchase is not available for homes above bored tunnels. The practical evidence of underground railways in use is that their impacts are not sufficiently serious to justify purchase.

Land within 40 m of the centre line at a tunnel portal has been surface-safeguarded. Where land within the criteria for both surface and sub-surface safeguarding, the surface safeguarding will always prevail. Where tunnels are shallow-less than 9 m below the ground – the land above would normally be subject to surface safeguarding.

In addition, we have made it clear that property surveys will be undertaken of potentially affected homes both before and after construction of the rail link, and any damage caused by construction, including settlement due to tunnelling, will be put right. Any loss of value of homes caused by the physical effects of the rail link in operation in tunnel – from re-radiated noise, for example – may qualify for compensation under part 1 of the Land Compensation Act 1973....I also take on board my right hon. Friend's point about what the distinction is between underground rail tunnels and broad-gauge rail link tunnels in terms of re-radiated noise. We have little experience, because we have not built such tunnels before. I am happy to repeat that if, as a result of reradiated noise – that is when the building itself vibrates as a result of the movement of the trains – there is any reduction in value, under the Land Compensation Act there will be payments. That, of course, comes after the tunnel is open and the trains are running.

On my right hon.Friend's second point, I undertake – I shall take official advice to reflect on the need to issue, or to have issued by Union Railways, fresh advice. There will be a new letter to all those affected who live over tunnels,

not only to set out the best scientific evidence we have on settlement and re-radiated noise, but to explain precisely what the rights of the owners of the properties are. I shall read the record to ensure that I have covered my right hon. Friend's point. I hope that he is satisfied with that answer.

Thirdly, I also believe that my right hon. Friend, and my hon. Friend the Member for Mid-Kent, have deployed powerful arguments in relation to the definition of properties that will or will not be seriously affected by the safeguarded route. That must be a matter of judgment – I understand that – but it is in a category wholly different from whether a property is affected by the hardship scheme or not outside the safeguarded zone.

I understood my right hon. Friend to be referring to the safeguarded zone and to properties that might or might not be seriously affected. He has deployed powerful arguments there, and I shall reflect on whether it might be sensible to seek to clarify the position and perhaps – I can give no commitment from the Dispatch Box – whether there might be some reference to an independent party to establish whether a property or land is or is not seriously affected.

Fourthly there is the question of the land outside the safeguarded zone. Not only properties affected by noise above the threshold may qualify for the hardship scheme, in some cases others will qualify. I refer my right hon. Friend to paragraph 4.4 of the document issued by Union Railways.

Union Railways must define hardship, because this is a voluntary ex-gratia scheme. However, I take my right hon. Friend's point about the noise threshold. The higher the threshold, the fewer properties will be purchased: we shall therefore pay close attention to the advice offered by local authorities.

I look forward to a debate later in the year – but, I trust, before the House rises for the summer recess – on noise thresholds, for which we shall seek the House's approval.

21 April

Noise Pollution

Sir Anthony Grant: To ask the Secretary of State for the Environment what measures are being taken to reduce the various forms of noise pollution; and if he will make a statement.

Mr Atkins: The independent noise review working party established by my Department in 1990 considered noise pollution in all its forms and we have subsequently implemented over half its recommendations.

The Environmental Protection Act 1990 strengthened the statutory nuisance legislation which is available for local authorities to control noise from domestic, industrial and commercial premises. These powers have been further extended by the Noise and Statutory Nuisance Act 1993 to control noise from vehicles, machinery and equipment in the street. My Department has, jointly with the Home Office, issued specific guidance on how best to use statutory powers to control all forms of noisy parties and issues general advice about how to pursue noise complaints.

Separating noisy activities from those most likely to be affected by them can be achieved by a variety of formal and informal mechanisms. We hope shortly to publish a planning policy guidance note which will describe how the planning system can be used to minimise the adverse impact of noise for example on residential development.

We also continue to liaise with and support professional and other bodies who are keen to develop and publish their own codes of practice for minimising noise. Codes currently in preparation include guidance on clay pigeon shooting and stock car racing.

There is much concern about the rising number of complaints about neighbour noise and we are keeping under review the effectiveness of legal and informal remedies.

We believe that mediation services have an important role to play in resolving such disputes in a more cost-effective and appropriate way. My Department has funded two pilot studies in order to give local authorities a clearer picture of the benefits of establishing such services.

Extracts provided by Rupert Taylor FIOA

New Publication

European Engineering Yearbook 1994

The European Engineering Yearbook, the first edition of which is now available, is a vital reference source for all those concerned with the development of engineering in Europe. It is the result of a new initiative by FEANI, the European federation of national engineering associations, and is designed to provide a yearly review of developments and issues in European engineering, as well as to promote the opportunities for training and career development across Europe.

The first edition of the Yearbook contains articles by engineers from almost 20 European countries and focuses on the key issues facing the profession in the final years of the 20th century and the latest developments in engineering education and training. It also includes articles describing the experience of working as an engineer in different European countries and outlining the varying economic and social roles played by engineers throughout the continent. The opening section of the book is on FEANI itself, and gives details of all the national member organisations.

The European Engineering Yearbook is published by Cambridge Market Intelligence in London at a price of UK£10.95. All orders and requests for information should be sent to: Cambridge Market Intelligence Ltd., London House, Parkgate Rd, London SW11 4NQ. Tel: 071 924 7117; Fax: 071 403 6729.

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New Products

NOISE CONTROL CENTRE

Absorberline

Since the implementation of the Noise at Work Regulations many factory and industrial units have sought to isolate areas of high noise generation through the installation of controlled areas and test cells.

The Noise Control Centre's 'Absorberline' wall cladding system is designed specifically for these purposes and is available in pre-formed sections or as part of an Noise Control Centre package in which all elements of a noise attenuation problem would be considered and a 'tailored solution' fabricated and installed to suit.

The Absorberline system offers a simple technique of applying a sound absorption panel, protected by perforated metal facing, to existing wall surfaces.

The Absorberline panel is comprised of a tray formed from perforated galvanised or prefinished sheet from BSC colourcoat plastisol range, which contains a specially constructed rock fibre core faced with a black woven glass cloth. The panels are inserted into retaining channels top and bottom - no vertical supports are required other than at corners or finishing points.

The perforated facing provides mechanical integrity and allows the noise incident upon the surface to enter the mineral fibre, and to be absorbed through conversion to heat energy.

For further information contact Jeff Craske, Industrial Noise Control Division, The Noise Control Centre, Charles House, Toutley Road, Wokingham, Berkshire, RG11 5QN. Tel: 0734 774212, Fax: 0734 772536.

CEL INSTRUMENTS

Ono Sokki CF-5200 Series FFT

Analysers

The new CF-5200 Series of FFT analysers from Ono Sokki are more than four times faster than the CF-360 which they replace. The new

models provide a very fast real-time measurement rate of 20 kHz and a planned upgrade to 32 kHz.

The dual channel analyser offers a variety of high speed analysis options including real time octave band, RPM tracking, Sound Intensity and Wigner Distribution.

A 16-bit A/D converter provides for a high accuracy and contributes to a high 90 dB dynamic range by combining 32-bit calculations. The instrument boasts a 9.4" TFT colour LCD screen offering a high definition display of all results, a 3.5" floppy disc drive and a high speed printer.

The CF-5200 series also features the 'Quick Expert' easy operation system. Single keys are used to select the measurement type, eg Vibration, Sound Intensity, etc and all parameters are set on the screen with detailed instructions for each function.

Further information is available from CEL Instruments Ltd, 35-37 Bury Mead Road, Hitchin, Herts, SG5 1RT. Tel: 0462 422411, Fax: 0462 422511.

CEL Instruments is a Key Sponsor of the Institute

CLEF DIGITAL SYSTEMS

ARTOS - Audio Real-Time Operating System

Clef Digital Systems announced the release of ARTOS (Audio Real Time Operating System) at the Audio Engineering Society Convention in Amsterdam. ARTOS has been optimised specifically for multi-channel audio processing and is particularly useful for those applications based around a set of algorithms whose configuration can change in real time.

For DSP systems in a PC environment, the programmer can access a number of control routines written in C, which permits the PC to load and run ARTOS applications on the DSP. This approach enables you to use a PC development system, later replacing it with target system hardware with the minimum of porting problems.

ARTOS applications consist primarily of a set of real-time Processors and Controllers. ARTOS

takes care of I/O, real-time multi-tasking, and provides routines to add, remove or change Processors, and to wire and rewire inputs and outputs. All this is done in real time with minimum overhead and with the consistency of hard wired boxes.

ARTOS processes audio on a sample by sample basis so the group delay is less than 25 micro-second.

ARTOS is currently available for the TI C30-C40 family of DSPs. These bring the advantage of cost effective floating point performance, which eliminates digital artifacts and noise. Future releases will include DSPs from Motorola, AT&T and Analogue Devices.

Further details are available from Clef Digital Systems Ltd, 6A Science Park, Aberystwyth, Dyfed, SY23 3AH. Tel: 0970 626601 Fax: 0970 626458.

DIAGNOSTIC INSTRUMENTS

Enhancements for PL202 Real Time FFT Analyser

The PL202 Real Time FFT Analyser is a portable instrument used to diagnose problems in rotating machinery, acoustics and mechanical structures.

The new, enhanced features include Harmonic, Peak or Octave band numerical listings, High Pass-Filtering at 2, 10, 70 Hz to remove unwanted 'interference', Bode plot format and further ESPTM filter ranges for rolling element bearing condition monitoring.

The PL202 utilises Di-CardTM technology which is essentially a PCMCIA 'credit card' memory interface which can effectively provide access to infinite memory storage and the ability to run specialised application. The PCMCIA interface has been improved to allow for card storage of up to 2 MByte, in addition to the 512 Kbytes available inside the PL202.

For further information, please contact Tony Cumming, Product Engineer, Diagnostic Instruments Ltd., 264 West Main Street, Whitburn, West Lothian EH47 0LB. Tel: 0501 743031, Fax: 0501 743933.

OSCAR ENGINEERING

System Oscar

System Oscar is a patented noise control system providing the means to form acoustic enclosures and barriers, acoustic walls, operator havens, work offices, etc.

It has been created with an aesthetically pleasing appearance and designed to allow simple speedy assembly procedures. In achieving its exceptionally good appearance and undemanding installation qualities, SYSTEM OSCAR has maintained very high acoustic performance characteristics.

SYSTEM OSCAR is fully described in literature which is available from the Marketing Department, Oscar Engineering Ltd., Four Brands Hatch Park, Fawkham, Kent, DA3 8PH. Tel: 0474 873122 Fax: 0474 879554.

News Items

AcSoft

New Concerto Acoustic Measurement System Runs on a Notebook

01dB have released Concerto, a new acoustics measurement and analysis system, which, for the first time, allows Type 1 measurements to be performed on a notebook PC.

Concerto consists of a small battery powered data acquisition unit, with direct connection of microphones and preamplifiers, which communicates with the notebook via the parallel port, giving high speed and low power consumption. High quality sigma-delta A/D conversion is performed in the unit, with gain and filtering as required by international sound level meter standards.

The environmental/occupational noise package dBENV, features the same powerful features of the Aria platform, such as datalogging of Leq, Peak and calculation of Ln values, according to standards. Capturing of audio records for playback and identification is also possible, with the addition of frequency analysis of records in octaves, third-octaves and narrow bands.

For further information contact: John Shelton, AcSoft Ltd, 6 Church Lane,

Cheddington, Leighton Buzzard, LU7 0RU, Tel: 0296 662 852, Fax: 0296 661 400

ICL

NAMAS Accreditation

ICL's Environmental Engineering Laboratories in Manchester, part of The Design (IT) Shop launched earlier this year, have received accreditation from the National Measurement Accreditation Service (NAMAS).

Measurements covered include acoustical noise emissions, performance under shock and vibration, and the effects of thermal and climatic conditions.

Computers and peripherals, domestic appliances, electrical and electronic components, medical equipment, office equipment, radio, TV and telecommunications equipment are among the products tested in the laboratories.

SOUND ATTENUATORS

European Success

Sound Attenuators Ltd recently completed a £250,000 plus contract at Le Mans University in France.

This major acoustic test facility was the subject of a design competition which was won by Ove Arup and Partners in London and their acoustic consultants, Arup Acoustics. The facility was constructed by Sogea Atlantique and Sound Attenuators Ltd manufactured and installed all of the acoustic equipment.

The heart of the facility is the hemi-anechoic chamber of approximately 2200 cubic metres into which some seven thousand 1200 mm anechoic wedges were fit-

ted to achieve a 70 Hz cut-off frequency.

For further information please contact Alan Fry, Sound Attenuators Ltd, Eastgates, Colchester, Essex CO1 2TW, Tel: 02026 866911

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BRÜEL & KJÆR IRELAND

New company set up in Ireland

Brüel & Kjær has reinforced its commitment to the Irish market by setting up Brüel & Kjær Ireland.

The new company is represented by Garry Duffy, who already has extensive experience in the technology and the marketplace.

For further information contact Garry Duffy, Brüel & Kjær (Ireland). Tel: (010 353) 1 6608822. Fax: (010 353) 1 6608296.

Larson Davis Ltd

Larson Davis Inc is the new owner of Industrial and Marine Acoustics Ltd and the company will be known as Larson Davis Ltd.

For further information contact Alan Boyer, Tel: 0642 491565



NAMAS ACCREDITED CALIBRATION LABORATORY

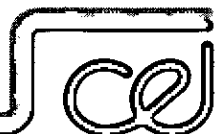
Located at the CEL Instruments factory in Hitchin is a National Measurement Accreditation Service laboratory capable of offering the following calibration activities:

- Calibration of CEL-177, CEL-182, RFT 05 001, B&K 4220 and B&K 4230 sound level calibrators in 1/2" configuration.
- 1kHz pressure sensitivity verification for microphone types CEL-186/2F, CEL-186/3F, CEL-192/2F, CEL-192/3F, B&K 4133 and B&K 4134.
- Calibration to BS 3539:1986 of most sound level meter kits fitted with the above microphones plus B&K 4155, 4165 and 4166 microphones.

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The Editor
Acoustics Bulletin

Sir,
I read with interest the article by Herbert Müller in Volume 19 No 1 with particular attention to the section dealing with vehicle noise. Bearing in mind that the thrust of the article is on EU legislation to control noise, I would like to add the following information to the debate on Motorcycle noise. The motorcycle is conspicuous by its noise for the following reason. This company and its affiliates in France, Holland and Spain undertook a survey last year of over 3500 motorcycles in use in five cities. More than a third of them were fitted with non original 'racing' exhausts. Our tests on these types of products can show an increase in acceleration noise using R362 of more than 20 dB(A) over the EU standard. Surely this is the cause of conspicuous noise?

These owner modifications have been evident for years, certainly

during the whole of the duration of EEC78/1015 which is the fount directive that covers motorcycles. The limits were lowered in EEC87/56 but this makes no difference if the vehicles in use are modified for noise increases. Until this point is recognised there is no point in researchers and regulators thinking that changing the new vehicle limits will have any effect.

One small corrective point. EEC87/56 is voluntary. Stage II of this forms the basis of the regulations for 1997 but motorcycles will then be under Sole Vehicle Type Approval which will be mandatory and consequently all separate Directives will be mandatory.

Mandatory or not, this does not deal with owner modification and I argue that EU vehicle legislation is not the right place for control of 'aftermarket' parts such as race exhausts. The point of sale is better as it can be monitored by Trading Standards Officers, rather than trained vehicle inspectors after the accessory has been purchased and

used on the road creating the need for vehicle inspection. All the manufacturer of these parts has to do is stamp it 'fit for road use' or 'not for road use' and the seller and buyer in the shop know where they stand.

I am, yours, etc.
Alan Baker MIOA

Motad International Ltd, Walsall

Internoise '96 Liverpool 30 July - 2 August 1996

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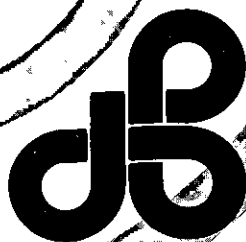
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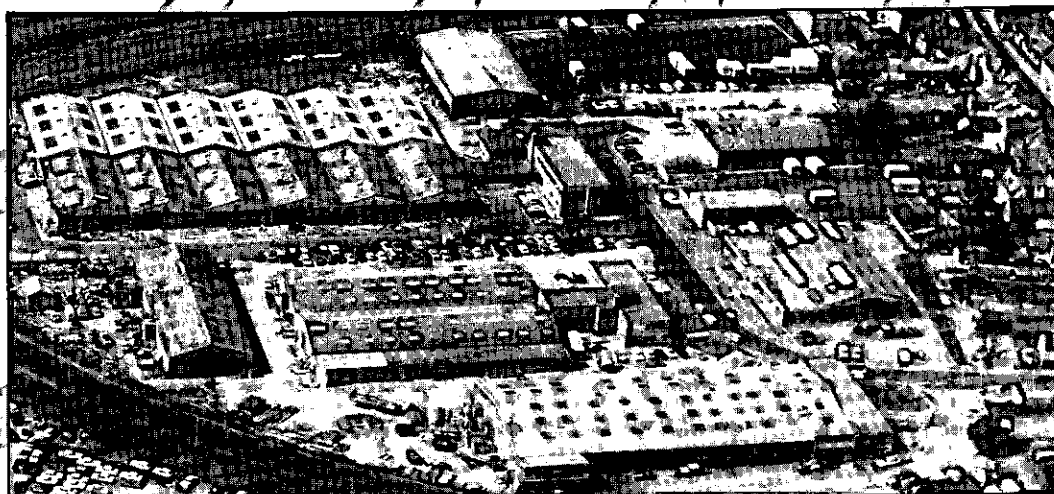


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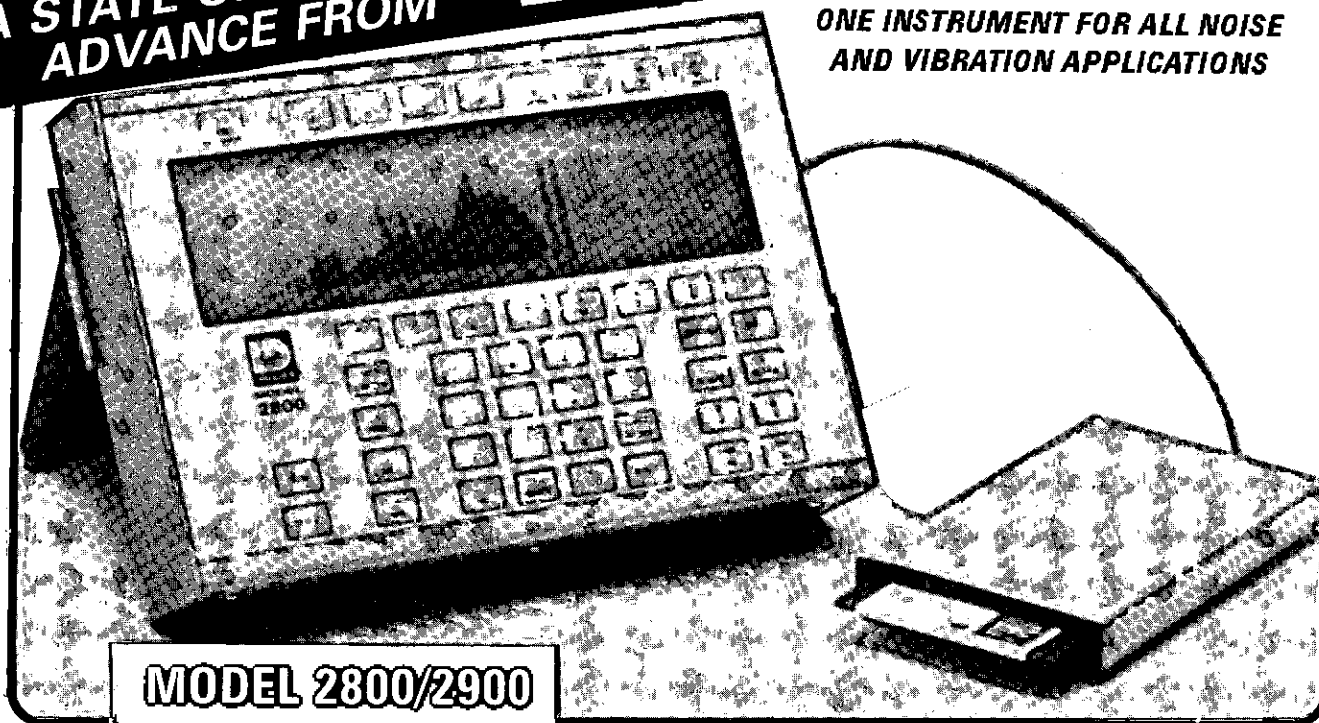
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