



Institute of Acoustics

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Pamela Clements

Technical Contribution

Coloration and Speech Perception
Anthony J Watkins FIOA

The Acoustics World

Noise on the Net – Part 2: Airport and Aircraft Noise
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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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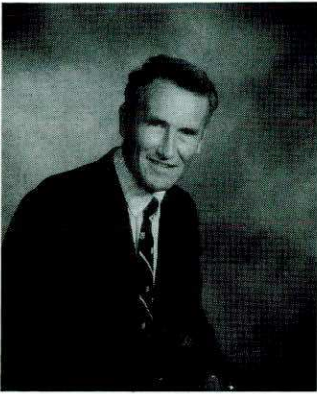
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Dear Fellow Member,

Education, education, education as a policy seemed to work well for Tony Blair at the last General Election and so it has been for the Institute ever since our foundation some 25 years ago. The fact that we took up the challenge and, in conjunction with some of the leading Universities and Higher Education Institutes, brought the IoA Diploma into existence has established the foundation upon which the profession we know today has been built. Over time we have developed the programme we offer, adding new modules and methods of delivery but have maintained its place as a post graduate qualification that is recognised by most employers in our industry. With the growing need for technician level qualification our Certificate of Competence programme has been introduced and now covers four specific areas of sound and vibration work. These are credible achievements that have been brought about by the vision and hard work of a team of Committee Members who willingly give their time to the work involved; their contribution is much appreciated.

You may recall from these pages earlier in the year that Council commissioned an education review chaired by our President Elect to guide our future policy in this important area. With growing numbers of candidates for all the programmes, both here in the UK and overseas, it is important that we keep abreast of developments in, and the demand for, education services within our area of expertise. The report of the review body was accepted by Council at its last meeting and the recommendations will be actioned over the coming months. The most important of these is the appointment of our first professional Education Manager to oversee the development and management of our activities in this area. It is hoped that we can have someone in post early in the New Year and with this increased resource we will be able to move forward with confidence.

As we look back on the past year we can see the results of the reorganisation and consolidation projects that we have been undertaking. These have stabilised our management procedure and resulted in real cost savings; it is the benefits of these that are providing the resources for our first major new spending programme for many years. Let us hope that it is the first of many initiatives that we can undertake to strengthen the services we provide for our members.

With best wishes for Christmas and the New Year, I remain

Yours truly



Ian Campbell

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1 December 1999

REFLECTIONS ON AN IDEAL: TRADITION AND CHANGE AT THE GROSSER MUSIKVEREINSSAAL, VIENNA

Pamela Clements

Introduction

The legacy of twentieth-century auditorium design leans heavily on the legacy of the great nineteenth century concert halls. Of these, the Grosser Musikvereinssaal in Vienna, with its resident orchestra, the Vienna Philharmonic Orchestra, perhaps most closely continues to embody the ideal concert hall sound against which acoustic excellence is judged.

The impetus for this paper came from the author's discovery, in the Archives of the Bau Polizei in Vienna, of a reasonably complete series of architectural drawings of the building, beginning with the initial plans of 1865 and continuing through many renovations until 1957. Photographs in the Archives of the Gesellschaft der Musikfreunde in Vienna, and publications on the history of the Gesellschaft and the Vienna Philharmonic Orchestra, added helpful information.

This revealed that the Grosser Musikvereinssaal, which appeared to be almost an immutable model, had in fact undergone many renovations since it opened in 1870, including a major renovation in 1911 which resulted in significant changes to the hall's architecture. Further research into the music in the hall between 1870 and 1911 revealed a parallel change and some remarkable interrelationships between the hall and the development of the repertoire, orchestra and performance practice.

The purpose of this paper is to share some of the findings of this research into the physical and musical changes in the Grosser Musikvereinssaal between 1870 and 1911, and then to reflect on how this information might influence our thinking about this most studied of acoustical models.

The Changing Model 1: The Hall

Background

The Musikvereinsgebaude – literally the 'Music Society Building' – was designed by the architect Theophil Hansen for the Gesellschaft der Musikfreunde in Wien (Society of the Friends of Music in Vienna). The Gesellschaft had been founded in 1812 to promote the highest perfection in the art of music through public concerts given by its orchestra of eminent amateur (and later professional) musicians. In 1817 it founded the Vienna Conservatory to further these aims through musical training [1]. Though not the first concert-giving organization in Vienna, it was effectively the first with such a serious and lofty purpose [2].

The new building replaced the earlier Gesellschaft building whose 600-seat concert hall had become too small. The building was conceived and built in the era of the grand redevelopment of Vienna after the 1848 revolution, when the perimeter walls of the old city were

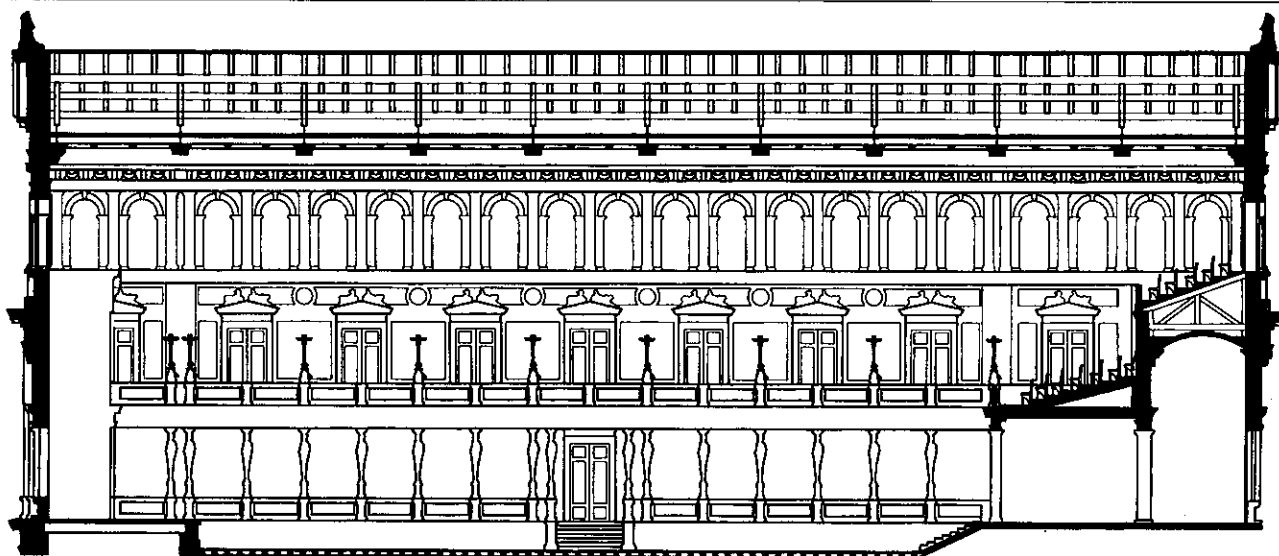


Fig. 1. Long section of the Grosser Musikvereinssaal, based on Theophil Hansen's 1865 drawings. Note the deep beams and balcony fascias above the caryatids, the large gas lights at the balcony rails, the wooden ceiling construction, and the orchestra platform.

demolished, making way for monumental buildings on and adjacent to the Ringstrasse. In keeping with the grandeur of its context and the Romantic musical ideals of the period, the building is in Italian Renaissance style with some Greek stylistic elements.

The building contained a large and small concert hall (the Grosser Saal and Kleiner Saal), accommodation for the Vienna Music Conservatory, offices and other facilities for the Gesellschaft, and spaces for rent to other musical organizations. Bösendorfer and other instrument makers were located there. The Vienna Philharmonic Orchestra also moved its offices into the building, and since then has rented the Grosser Saal for its concerts [3].

The Grosser Musikvereinssaal

The Grosser Saal at the Musikverein is a classic 'shoe-box' concert hall in form – rectangular and narrow, with one balcony, flat ceiling modulated by beams and mouldings, and highly articulated surfaces throughout the room. The platform has adjustable risers that vary the platform area and configuration. Gilded caryatids line the side walls and decorate the organ case, and the ceiling and other surfaces are elaborately decorated and gilded. The room is known as the 'Goldener Saal' both for this decoration and because of the 'golden tones' of music in the room [4].

Currently the room can accommodate 1744 people seated [5] and 300 standing; when the stage is extended the number of seats is reduced to 1656. The measured reverberation time is around 3.05 seconds at mid-frequencies (unoccupied) and 2.0 seconds at mid-frequencies (occupied). Beranek gives a long list of measured acoustical characteristics [6].

Since the opening concert in 1870, the room has

undergone many changes, including the installation of four different organs (in 1872, 1907, 1939 and 1968), repairs of fire damage in 1870 and 1885, installation of electric lighting in 1895, a major renovation in 1911, repair of bomb damage after World War II, rebuilding of the platform several times, replacement of the seats, general maintenance and restoration, and installation of air conditioning in 1995.

Renovations Prior to 1911

The most commonly given reason for the 1911 renovations is fire safety. Fire had been a concern from the beginning: during the night after the concert given by Clara Schumann to open the Small Hall (only two weeks after the Large Hall opened), fire broke out in the cloakroom, apparently as a result of over-heating. The beams in the cloakroom ceiling beneath the Large Hall were severely burned, and the walls and ceiling of the Large Hall were damaged by smoke.

In 1881 a fire in the Vienna Ringtheater resulted in much loss of life, and this prompted serious thinking in the Gesellschaft about how to improve fire safety in the Musikverein building. In 1885, during a masked ball, fire broke out in the ceiling of the Large Hall. Fortunately, the fire was contained and the public was able to leave without panic or injury. Fire safety measures were progressively implemented: in 1895 electric light was installed, and in 1903 the large wooden beams of the Small Hall were replaced with iron beams [7].

Two organs were installed in the Large Hall between 1870 and 1911. The original plans show that from the beginning an organ was conceived as an integral part of the hall. The organ case was in place when the hall opened in 1870, but it was not until 1872 that the organ itself was installed. The organ – manufactured by Lade-

gast – was inaugurated on 15 November 1872, with Bruckner performing and Brahms conducting. Illustrations from 1870 show the balcony terminating on either side of the organ case; when the organ was installed, the balcony was reconfigured to extend in front of the organ and connect both sides of the room (see Figures 2 and 4).

By 1907 musical demands had changed to such an extent that a larger organ, more suited to solo performances, was installed. The new organ – manufactured by Rieger – was built into the existing organ case, with extensions at the lower sides of the case and at the rear of the orchestra platform. The old pipes were retained as decorative, non-speaking pipes only. The console was moved from stage to balcony level, and the centre of the balcony was reconfigured to accommodate it.

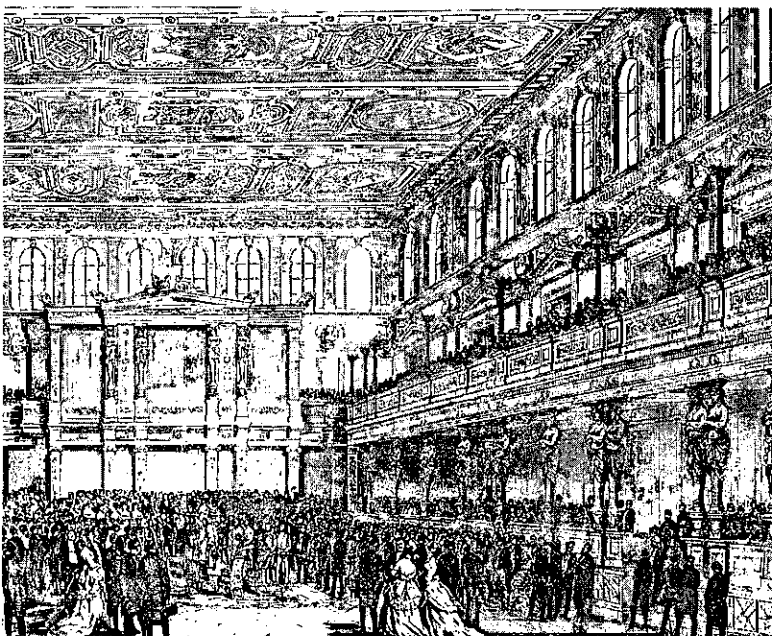


Fig. 2. The Grosser Saal at its inauguration (celebrating the completion of the building) on 5 January 1870. The opening concert took place the next day. The organ was not completed until 1872.

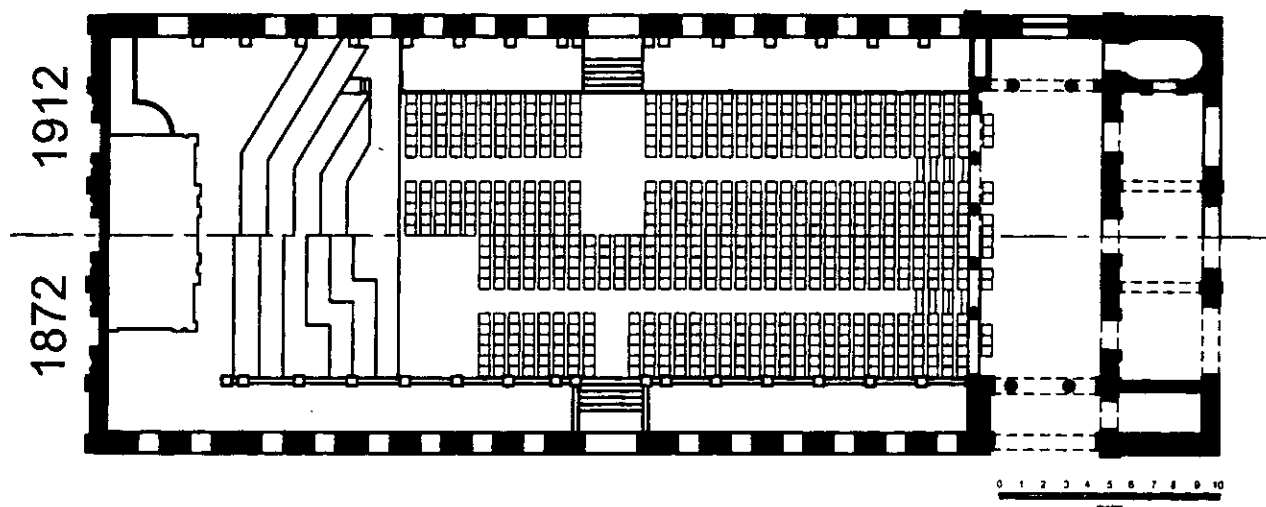


Fig. 3. Plan of the Orchestra Level of the Grosser Musikvereinssaal, ca. 1872 and 1912. The 1872 plan shows the organ, and platform risers based on those shown in an early photograph; the 1912 (post-renovation) plan shows the organ of 1907. The seating right up to the stage and the cross-aisle were added after 1911.

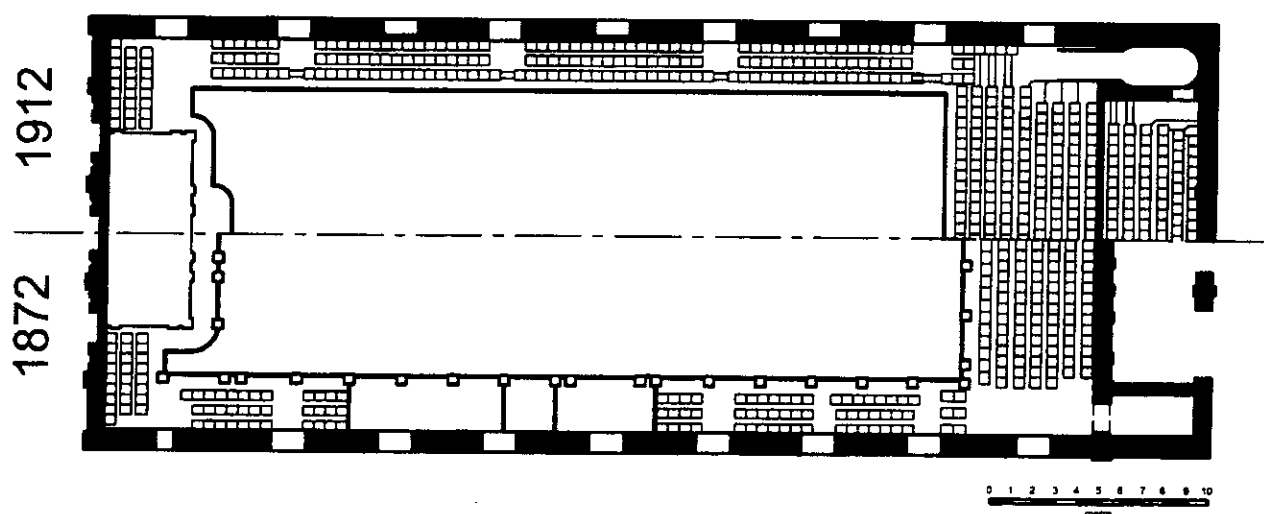


Fig. 4. Plan of the Balcony Level of the Grosser Musikvereinssaal, ca. 1872 and 1912. Note changes in the rear and organ balconies, infilled doorways and improved seating layout. The boxes (for the Kaiser and hall management) were slightly reconfigured in the renovation.

The Renovation of 1911

When the major fire-safety renovation was done in 1911, the opportunity was seized to improve facilities for the growing audience, and also to modify the Large Hall in response to the changed requirements of the modern concert, repertoire and orchestra.

The interior of the Large Hall was almost completely gutted. Figures 3 and 4 show plans of the room before and after the renovation [8]. The side balconies were rebuilt using iron beams, so that they now cantilevered freely into the room. This enabled the caryatids that had formerly supported the balconies, together with their substantial pedestals and the deep beams above their heads, to be relocated against the side walls. The enormous light fixtures at the balcony rails were removed, and the balcony and parterre rails were reconstructed to

eliminate the pedestals that formerly had supported the lights and caryatids.

Steps were added to elevate the rear rows of side balcony seats and improve sightlines. Alternate doors along the side balconies were closed off so that the seating could be rearranged to facilitate exiting and add extra seats. Iron beams were used to cantilever the front section of the rear balcony forward into the room, thereby gaining two additional rows of seats. On the main floor, seats were rearranged to improve egress at the cross-aisle and several rows of seats were planned close to the orchestra platform. It seems likely that the seats in the upper rear balcony were unchanged, since early descriptions of the rear balcony describe an 'amphitheatre' (suggesting a steep rake). By this author's estimate almost 150 seats were added to the room.

Text descriptions and photographs show that the original orchestra platform comprised a series of sliding sections that could store away to make a narrow podium with steep stairs, or extend and layer forward for orchestral performances (as shown in Figure 3). In 1911 this stage was enlarged and the risers were reconfigured. With the caryatids now against the side walls, the parterres at the sides of the platform could be eliminated, increasing the usable area for the orchestra by about 50% [9]. The original flooring and wooden supports were re-used. The wood used originally, and in all renovations of the stage since, is a local, soft black pine (Schwarzföhre) of not particularly fine quality [10].

A surviving photograph of the renovation (Figure 5) shows other structural changes including installation of iron lintels above the side doors. There is scaffolding for work on the ceiling, and a pool of water on the floor suggests work on the roof. The 1865 drawings show a wooden beam construction for the roof. However, as now built the main roof beams and trusses are of iron, with secondary beams of wood. It is not clear whether the roof was built like this initially or modified later, either in 1911 or at the end of World War II when the roof was rebuilt after bomb damage.

The ceiling itself is an unusual construction – the gilded decoration is applied to plaster over a system of wooden beams and panels that are suspended on rods from the roof trusses. Above this wooden construction is a layer of white, dusty sand about 3" (75 mm) thick, and on top of this are flat terracotta bricks approx 1" (25 mm) thick. The whole system is designed so that the ceiling load does not bear directly on the side walls but is carried to the walls via the roof beams. It is believed by some that this construction is part of the secret of the Grosser Musikvereinssaal's acoustical excellence, the theory being that this construction allows the ceiling to vibrate in response to the music. It is far more likely, however, that the mass provided by the sand and bricks reduces low-frequency absorption by what would otherwise be a highly absorptive wooden ceiling construction. It is tempting to speculate that the sand and bricks and the iron beams were added in 1911 for fire safety, particularly since the wooden roof of the Small Hall was rebuilt for fire safety in 1903, using iron beams. However, the 1865 drawings show layers of an unknown construction above the wooden ceiling – perhaps sand and bricks, perhaps something else. The question remains open.

In the rest of the building, the

main oval staircases were replaced with wide straight stairs, the Kaiser's private staircase (which interrupted access along the corridors at the western balcony) was removed, other staircases were improved, and exits were added or changed. New entries were added at the front of the building, and a large access 'tunnel' was added right through the building at the ground floor level (running underneath the Large Hall). The cloakrooms were enlarged and ancillary spaces were upgraded.

The Acoustical Significance of the Renovation

Michael Barron has noted the paucity of comment about the acoustical excellence of the Grosser Musikvereinssaal until this century [11]. One's first thought on discovering the extent of the 1911 renovations is to wonder whether the hall's acoustical reputation could belong to the post-1911 hall and not to its earlier form. However, there is evidence that the hall was regarded as acoustically excellent right from the beginning, and that the acoustics were considered to have survived the renovation without harm.

The concert program that opened the hall on 6 January 1870 was chosen both to celebrate the occasion and to test the acoustics. Johann Herbeck was the conductor, with the Gesellschaft Orchestra (which included some members of the Vienna Philharmonic Orchestra) and the Gesellschaft Singverein. The program was:

Beethoven	<i>Egmont Overture</i>
Haydn	<i>Chorus Stimmt an die Saiten</i> from <i>The Creation</i>
Bach Seb	<i>Adagio</i> (Violin: Hellmesberger)
Mozart	<i>Aria from Entführung aus dem Serail</i> (Herr Walter)
Schubert	<i>Der Friede sei mit Euch</i>
Beethoven	<i>Symphony in C minor (No 5)</i> [12]

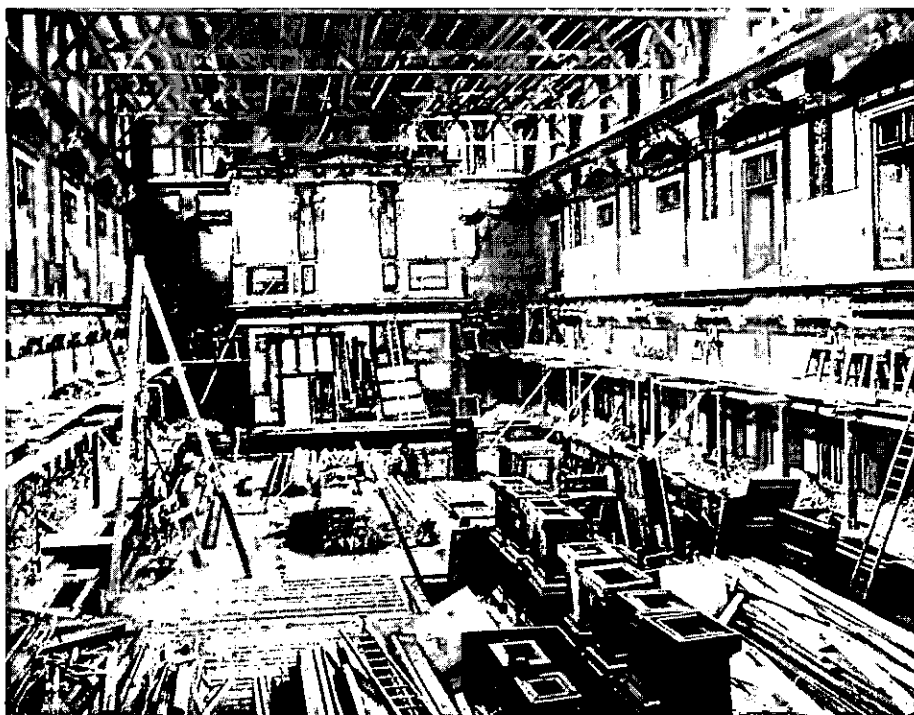


Fig. 5. Renovation work in the Grosser Saal in 1911, in which the balconies were rebuilt with cantilevered iron beams and the orchestra platform was enlarged and reconfigured.

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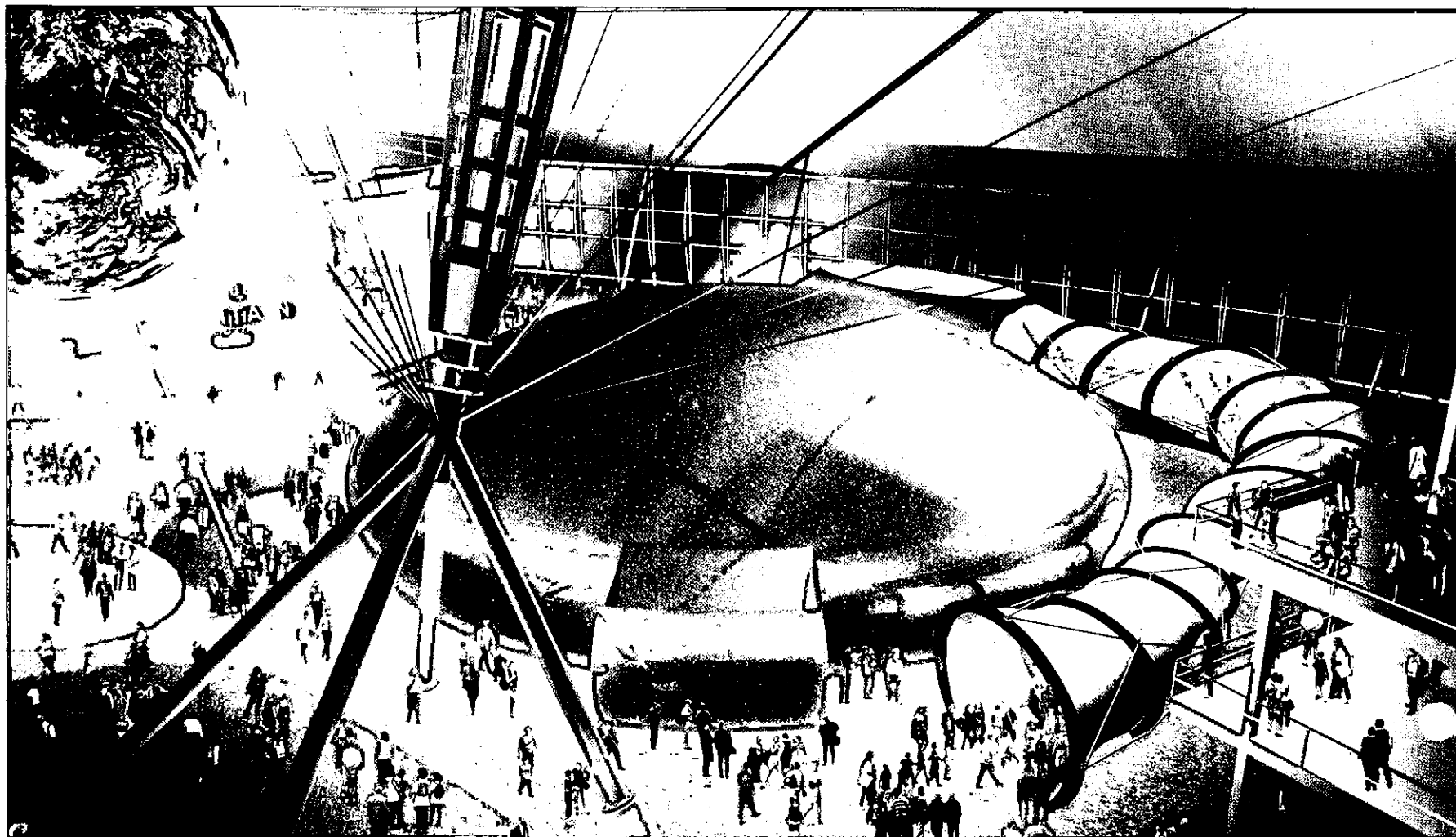


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Franz Grasberger and Lothar Knessl in their book *Hundert Jahre Goldener Saal* report that people found that the acoustics were excellent in all respects (though not saying what these were), and quote the *Blättern der Erinnerung*: 'As large as the hall is, even in the furthest corner one is able to discern the fastest figures with utter clarity and exact ending. Nowhere is there the slightest echo. Human voices as well as the string and wind instruments take on a soft, caressing tone, yet are distinct and clear, sparkling. Every timbre stands out and has its own noble character' [13]. Kralik reports that the Vienna Philharmonic Orchestra must have been pleased to leave the Kärntnertor Theatre, the opera theatre where they previously gave concerts, 'because for symphonic music the acoustics there were not the best – they were regarded as especially clear and pure but the forte sound was considerably dampened' [14]. Taken together, these comments suggest that the acoustics of the original Grosser Saal were both clear and reverberant, with a distinct expression of instrumental colour. These are the defining characteristics of the hall today.

Since the best possible architect had been chosen for the design, it was to some degree taken for granted in Vienna that the hall would be excellent acoustically. Once proved, the acoustics were highly valued but not much commented on [15]. The focus of Gesellschaft and the Vienna Philharmonic Orchestra was then and continues to be on the music and the performance. Such was the focus also of Eduard Hanslick, whose music criticism spans fifty years of concerts in Vienna, many of them in this hall [16].

There seems to have been great trepidation in undertaking the renovation of the Grosser Saal, for fear that

the fine acoustics would be affected. Reports from the time suggest that even the moving back of the caryatids 'was looked upon with fear', and the wood from the orchestra platform was reused in order to 'preserve the fine acoustics' [17].

The hall reopened on 17 October 1911, with another program chosen to celebrate the hall and test the acoustics. Fritz Steinbach was the conductor. The works chosen for this task were:

Beethoven *Violin Concerto*

Beethoven *Symphony No 9*

The outcome of this acoustical test was that the public judged the sound 'still to be ideal' [18].

Looking at the great physical changes to the room we would now consider that the space was likely to have changed acoustically as the result of the renovations – for the better. The original location of the caryatids at the front of the parterres, with the deep beams above their heads connected to the balcony fascias, had formed a veritable barrier between the parterres and the rest of the room (see Figures 1 and 2). Moving the caryatids to the side walls and freeing up the space under the newly cantilevered balconies not only changed the pattern of reflections from the balcony fascias, underbalcony soffits and the side walls, thus changing the arrival time of early reflections and the pattern of scattering around the caryatids, it also could be argued that it effectively added the volume under the balconies (approximately 8% of the room volume) back into the room. The much larger stage area could now accommodate a symphony orchestra of over 100 players. This would have allowed programming of modern works with augmented brass and percussion and a full complement of strings, and

hence different orchestral balances. The new riser configuration would have improved ensemble playing; the under-balcony reflections are likely to have aided on-stage hearing. The rear balcony soffit extension would have added some useful reflections back to the centre of the audience, and was narrow and high enough not to form an acoustical shadow over the seats below. If the sand and bricks were added to the ceiling at this time, the room's bass response would have improved markedly.

On the detrimental side, the increased audience size and the loss of the open, reflective floor area between the platform and the first rows of seats, would have increased mid and high frequency absorption in the

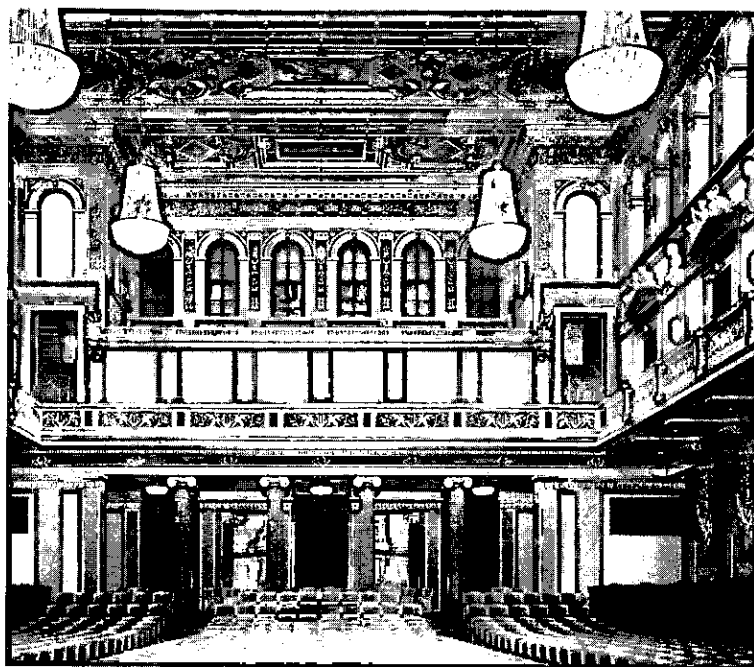


Fig. 6. A contemporary photograph of the Grosser Saal looking towards the rear, showing the caryatids at the side walls, cantilevered side balconies, and rear and upper rear balconies. The standing places are behind the columns at the rear of the main floor.

room. But this change may be more in theory than in fact: early illustrations show the hall very crowded with standees and seats right up to the orchestra platform, so the total audience numbers may not have changed much.

On balance, the renovation of 1911 would seem to have changed or even improved aspects of the room's acoustical character. Why then was the change not commented upon at the time? Was it perceived? The room is remarkably beautiful, and this colours (golden) the phycho-acoustic response to the room. The renovation was done by Ludwig Richter, a former student of Theophil Hansen. This association would have encouraged trust in a good outcome. The musicians performing were of the highest calibre, and familiar with the acoustical characteristics of the room prior to renovation. Beethoven's 9th symphony is a wondrously joyful and uplifting work, and very familiar to the musicians and the audience. And, given the predilection of audiences and musicians to experience changed acoustics as necessarily a change for the worse, perhaps the acoustics needed to have been significantly improved in order to be thought not to have changed at all.

The Changing Model 2: The Music

Background

The Vienna Philharmonic Orchestra is an association of members of the Vienna State Opera Orchestra (the Hofoper at that time). It was formed in 1842, and initially held only a few concerts per year. The orchestra barely survived the 1848 revolution, but in the 1860s it was reinvigorated and entered a period of strength and increasing artistic excellence. Its subscription concerts began in 1860; after moving to the Musikverein 1870 it

gave eight subscription concerts plus a few special concerts per year.

While the Vienna Philharmonic Orchestra concerts were built around symphonies and concertos, initially the Gesellschaft concerts were strongly oriented towards vocal music, with oratorios, masses, lieder, and choral works far outnumbering symphonic works. In 1900 the Wiener Konzertverein Orchestra (which eventually became the Vienna Symphony Orchestra) was founded, and became the regular orchestra for the Gesellschaft concerts. It was not until 1922 that the Gesellschaft concerts changed to focus primarily on symphonic music [19].

From the beginning, the Grosser Musikvereinssaal was also home to many other types of performances and events. The Family Strauss gave popular promenade concerts in the hall for the first twenty years; drinks were served to the crowd sitting at tables. There were formal balls, masked balls, pageants, commemorative events, opera performances by students of the Conservatory, student performances, choral concerts, poetry and prose readings, and 'first-artist' evenings, in which a performance was followed by dancing. Today, the hall is almost constantly in use, with orchestras from all over the world added to the list of performers.

The Composers

The Musikverein is unique among concert halls in its close association with the development of the Western symphony concert tradition. Consider: when the hall opened, Beethoven, Haydn, Schubert, and Mozart formed the core of the programs. By 1912, with the centenary celebration of the founding of the Gesellschaft, they had been joined by Brahms, Bruckner, Goldmark, Mahler and Richard Strauss. Of all these composers, only Goldmark is no longer represented in the 'standard' concert repertoire. All were Vienna natives or lived there for important periods of their musical lives.

Brahms and Bruckner were closely associated with the Musikverein from its beginning. Bruckner was a teacher of organ and theory at the Conservatory. Brahms was conductor of the Gesellschaft Orchestra between 1872 and 1874. They both conducted their own works in the Grosser Saal, and many of their works were first performed there. Both initially found acceptance through the Gesellschaft concerts: for Brahms with his lieder and choral works and for Bruckner with his masses and choral works. In 1876, both Brahms and Bruckner conducted their own symphonies (both in C minor) in the Grosser Saal, performed by the



Fig. 7. The Wiener Konzertverein Orchestra (which served as the Gesellschaft Orchestra) with Director Ferdinand Löwe in 1902. The violins are seated antiphonally; the wind and brass sections are somewhat augmented (note the bass clarinet and the Wagner tuba); the harp is now a permanent member of the orchestra; and the double basses are (characteristically for Vienna) across the rear. The console of the original organ is behind the basses. The electric lights were installed in 1895.

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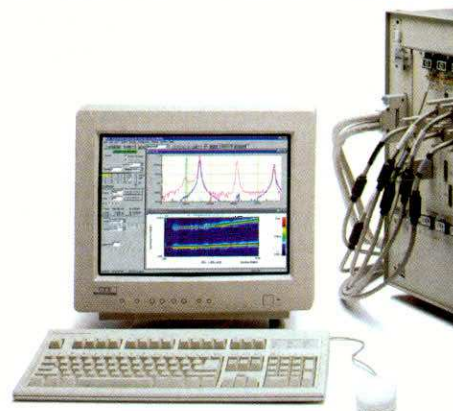
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Gesellschaft Orchestra. By the 1880s Brahms's symphonies were readily performed by the Vienna Philharmonic Orchestra, but Bruckner's symphonies were more controversial. Initially the Philharmonic elected not to perform his second or third symphonies, and when the Orchestra performed his third symphony in 1877 it was a debacle; it was not until the late 1880s and 1890s that Bruckner's symphonies were programmed and gained due recognition – in the Goldener Saal.

Mahler had been a (brilliant) student at the Vienna Conservatory in the 1870s, and hence his early listening and performing experiences were shaped in this very building. Mahler returned to Vienna in 1897 to become conductor of the Vienna Hofoper, a post he held until 1907 when bitterly conservative and anti-Semitic attacks finally forced him to resign. He was conductor of the Vienna Philharmonic Orchestra from 1898 to 1901. Controversy raged over his conducting style, his symphonies, and changes he made to the orchestration of some of Beethoven's works for performance by the Vienna Philharmonic Orchestra in the Grosser Saal. He conducted the Vienna Philharmonic in performances of his early symphonies in the Grosser Saal, but took his later works elsewhere (usually to larger venues).

Because the 'standard' concert hall repertoire has

become so universal, it is easy to underestimate the importance of the Grosser Saal as a partner in the musical development of the late nineteenth century. Brahms, Bruckner and (to a different degree) Mahler all listened to and worked with the sound of music in this hall for so many years that it can be argued that the sound that they were writing for was the sound of the Grosser Saal [20]. At the very least, the hall would have been a generative model for an imagined ideal sound.

This connection between the acoustic qualities of the Grosser Musikvereinssaal and the composers who wrote for it, or whose musical imaginations were influenced by it, is probably the most direct connection between composer and hall since Bach was writing for Thomaskirche in Leipzig or Haydn for the Great Hall at Esterháza. Add to this the importance of the music of Brahms, Bruckner and Mahler in the present-day symphonic repertoire, and the influence of the sound of the Grosser Saal as an acoustical model can be seen as remarkable.

The Orchestra

In the 1870s the Gesellschaft orchestra probably numbered around 60 players, depending upon the works performed, and it seems that it may have remained relatively small – perhaps because it was not a permanent orchestra, perhaps because of its focus on choral music.



Fig. 8. The Vienna Philharmonic Orchestra on stage in the Grosser Saal. (© 'Foto Fayer')

A photograph dating to the turn of the century still shows an orchestra of this size (see Figure 7) [21]. The Strauss family orchestra also numbered around 60 players in 1870 [22].

The Vienna Philharmonic Orchestra, on the other hand, began to grow in size relatively early. Photographs of the orchestra show 78 members in 1864, 100 in 1885 and 114 in 1910 [23]. The Grove Dictionary of 1878-1889 gave the string section alone as 67 players. However, these figures are misleading because not all members of the orchestra played in every performance, and prior to the 1911 renovation it would have been virtually impossible for all of these musicians to cram onto the platform. Table 1 shows that before the renovation even in crowded conditions only 82 musicians could be accommodated in the functional platform area; for larger orchestral settings musicians could have been located in the rear corners of the platform or behind the caryatids in the parterre; otherwise the orchestra platform would have been extended forward into the room, thus reducing the number of audience seats (see also Figure 4).

Illustrations of the opening Gesellschaft concert show the chorus standing in front of the orchestra – the practice of the time. Photographs show that by the early 1890s the positions were reversed – the choral risers were now located behind the orchestra. While for choral concerts in the early years the orchestra would have stood to play, for symphonic concerts both the Gesellschaft and the Vienna Philharmonic orchestras were probably seated: it is thought that the practice of performing seated originated in Vienna [24].

The sound quality of the Vienna Philharmonic Orchestra, the 'Vienna sound', is legendary [25]. This sound has to do with instruments in all sections of the orchestra that are unique to Vienna, [26], in particular the Vienna horn, oboe and timpani. Nikolaus Harnoncourt describes the Vienna horn as 'almost gleaming', the Vienna oboe as 'pure and abundant' [27]. The Vienna string sound was founded on locally-made instruments with a distinct character and a playing technique so specialized that it is known as 'the Vienna string school'. In fact, all of the instruments have playing techniques specific to Vienna, which have been handed down for generations through training at the Vienna Conservatory and within the orchestra itself. This line stretches back directly to musicians who knew and worked with Beethoven, Mozart, Haydn, and Schubert, and hence the Vienna Philharmonic Orchestra has a special feeling for and understanding of their works. Added to this is the orchestra's

independence as a self-governing group of musicians, that influences its dedicated approach to music and its own performance style [28].

Although the Viennese musical instruments were developing throughout the nineteenth century (and into the twentieth), [29], the greatest change was in the woodwinds and brass in the last quarter of the century, just when these instruments were gaining new roles in an ever enlarging orchestra. The enthusiasm for exploring the musical possibilities of large orchestras, begun by Berlioz and furthered by Wagner, was taken up in Vienna by Bruckner, Mahler, and Richard Strauss, all of whom were experimenting with writing for enormous forces and the new and improved instruments. At the same time, it was becoming the norm for late-nineteenth-century conductors to use large orchestral forces with contemporary instruments to perform works by earlier composers. This is the context for the controversy over Mahler's rescoring of Beethoven.

Wagner also influenced the Vienna Philharmonic Orchestra's approach to performance. In 1872 he conducted the Orchestra in the Grosser Saal in a highly controversial interpretation of Beethoven's *Eroica* symphony and in excerpts of his own works; in 1875 there were three *Götterdämmerung* concerts which prompted Wagner to proclaim the Vienna Philharmonic Orchestra to be the best orchestra in the world. In 1875 also, Wagner's close associate Hans Richter became conductor of the Vienna Hofoper and of the Philharmonic, with the result that the Opera – and the Philharmonic – seemed 'fully delivered into the hands of Wagner' [30].

Thus the years between 1870 and 1911 saw tremendous musical development and change as the late Romantic repertoire and orchestra took shape. A curious aspect of this great change is that it took place in the early configuration of the Grosser Saal, with its restricted orchestra platform. It would take the 1911 renovation before these late Romantic developments could be fully realized in the room.

The Sound of the Room

While in Vienna, the author listened to many concerts in the Grosser Musikvereinssaal, by several different orchestras playing a range of works from the Classic through to late twentieth century periods. These musical experiences ranged from sublime to disappointing. It was a revelation to discover that this wonderful hall is easy to overplay by an orchestra unaccustomed to its acoustical demands, and to hear the resulting sound – harsh, unbalanced and over-loud. Such a sound in another hall would be

regarded as a severe acoustical detriment, but in this hall it is recognized that the orchestra's performance practice needs to be accommodated to the room. The room calls for a 'little fantasy' in performance, but can be dangerous because the acoustic response is such that it is easy to become imprecise [31]. Nevertheless, when orchestra, repertoire and performance practice are perfectly accommodated to the Grosser Musikvereinssaal's acoustical character, the musical experience

Area per musician	Number of musicians (1870)	Number of musicians (1911)
16 ft ² (1.49 m ²)	82	125
18 ft ² (1.67 m ²)	73	111
20 ft ² (1.86 m ²)	65	100

Table 1: Accommodation for the Orchestra Before and After the Renovation

there is truly sublime and its acoustic reputation wholly deserved.

Such is the sound of the Vienna Philharmonic Orchestra playing in this room. The musicians take a chamber-music approach to performance, listening to and working with each other and constantly shaping their sound in response to each other and to the room. The strings allow their sound to resonate, their articulation is soft, attacks are not too direct, phrasing has a strong sense of the overarching line, playing is legato, with an imperceptible change of bow. They play together at any price, even if the rhythm yields a little. When the lower strings play in their highest registers, the aim is to allow their tone colour to shine through rather than blending with the higher strings. The woodwinds play without vibrato, working rather with the special palette of tone colors of each of the instruments. An ideal of the Vienna horn sound is to begin so gently that the attack is inaudible and the listener is unaware of when the sound really begins. Horns and trumpets blend into the string sound, yet their overtones are rich and distinct. The timpani has a distinct, coloured sound that is never 'ordinary', even in a full fortissimo. Especially in antiphonal sections, and when different instruments are in dialogue, one can hear the players shaping and responding each others' instrumental colours. The sound is simultaneously blended and distinct. Even when the brass play fortissimo the string sound is full. And the fortissimos are vast and tremendously loud, yet rather than assaulting they are deep and richly coloured. Other words to describe the sound include: silky, resonant, sweet, melded, luminous, delicate, evenly textured, breathlessly intense . . . [32].

Nikolaus Harnoncourt states that the Vienna sound developed in the period between 1860 and 1920 and became 'the ideal instrument for the music of that age' [33]. For virtually all of this time the Grosser Musikvereinssaal, with its distinctive acoustical character, provided the context for this development. The room itself must therefore be seen as a defining element in shaping the Vienna sound. Room and music are inextricably linked.

Reflections on the Model

What is this most influential of acoustical models? From all of the above, one could argue that the model is not the 1870 hall, but the 1911 version, with the Vienna Philharmonic Orchestra playing a repertoire dominated by late Classical and Romantic works by Austrian and German composers. Or one could argue that the model is the Grosser Musikvereinssaal that we experience, physically and musically, today; a model only somewhat changed from the 1911 version. In this sense, it is a wholly contemporary model.

What does this model offer for acousticians as we seek to learn from and evolve beyond it? Knowing that the hall's acoustical excellence was able to support the music and allow it to flourish through a period of enormous change can give us courage as we wonder what direction music will be taking fifty years from now. Knowing that the conservative impulse of a great musical

tradition was also able (if gradually) to incorporate the radical and new can help us treasure our musical inheritance even as we open up to new directions. And we can expect that, as with the Musikverein, acoustically excellent halls will in the future be modified in order to respond to changing musical times.

The model demonstrates clearly that the highest level of acoustic excellence is realized through the music and the manner of its performance; hence the model contains both music and acoustics. There is more work to be done in exploring the interrelationships between music and acoustics, and this may be fertile ground in our search for a deeper understanding of acoustical excellence and for additional measurable parameters. The Grosser Musikvereinssaal may be the ideal location for this research, because the Vienna Philharmonic Orchestra is so finely aware of responding to its acoustic conditions, and because without such adjustments the sound of music in the hall can be less than ideal.

What lies ahead? Not literal imitation of this concert hall (even if it were possible), but a greater level of acoustic understanding that will open up possibilities for new geometries, new materials, new music. The Grosser Musikvereinssaal offers a guiding principle as we push the limits: when orchestra and music are perfectly accommodated to the hall's acoustical character, the musical experience is sublime. It is this ideal of the sublime that we carry with us into the next century.

Special thanks are due to Dr Clemens Hellsberg of the Vienna Philharmonic Orchestra, Dr Otto Biba and his associates at the Archive of the Gesellschaft der Musikfreunde in Wien, for assistance with this research, and to the Magistrat der Stadt Wien for access to the drawings held in the Archives of the Bau Polizei. Photographs 2, 5, 6 and 7 are reproduced with the permission of the Gesellschaft Archive and photograph 8 with permission of the Vienna Philharmonic Orchestra. Thanks also to Michael Ferguson for his remarkable CAD work.

References and Notes

- [1] Major references for the Gesellschaft were: Franz Endler, ed, *Der Wiener Musikverein*, Vienna: Edition Wien, 1988; Franz Grasberger and Lothar Knessl, *Hundert Jahre Goldener Saal: Das Haus der Gesellschaft der Musikfreunde am Karlsplatz*, Vienna: Gesellschaft der Musikfreunde in Wien, nd; Richard von Perger and Robert Hirschfeld, *Geschichte der K K Gesellschaft der Musikfreunde in Wien*, 2 vols, Vienna: Gesellschaft der Musikfreunde in Wien, 1912; and Eva Anyan, Otto Biba and Manfred Wagner, *Goldene Klänge: Künstler im Musikverein*, Vienna: Gesellschaft der Musikfreunde in Wien, Adolf Holzhausens, 1995.
- [2] Mary Sue Morrow, *Concert Life in Haydn's Vienna: Aspects of a Developing Musical and Social Institution*, Stuyvesant, NY: Pendragon Press, 1989, gives an excellent account of Viennese concert life prior to the founding of the Gesellschaft. The Liebhaber Concerts of 1807-08 had similar ideals, but did not endure (Morrow, p63).
- [3] Major references for the Vienna Philharmonic Orchestra were: Heinrich Kralik, *Das Grosse Orchester: Die Wiener Philharmoniker und ihre Dirigenten*, Vienna: Wilhelm Frick Verlag, nd; Clemens Hellsberg, *Demokratie der Könige: Die Geschichte der Wiener Philharmoniker*, Vienna: Kremayr & Scheriau,

1992; and Herta and Kurt Blaukopf, *Die Wiener Philharmoniker: Wesen, Werden, Wirken eines grossen Orchesters*, Vienna: Paul Zsolnay, 1986.

[4] *Hundert Jahre*.

[5] Including people seated at the rear corners of the orchestra platform.

[6] Leo Beranek, *Concert and Opera Halls: How they Sound*, Woodbury, NY: Acoustical Society of America, p600.

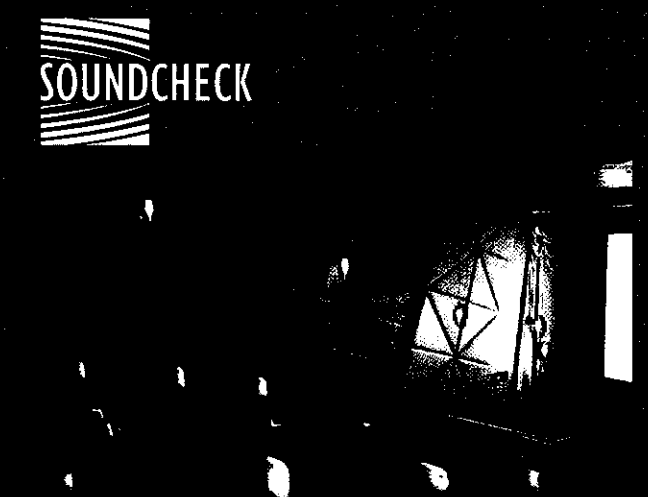
[7] 'Iron' rather than 'steel' is the term used in the source documents.

[8] The section and plans have been redrawn from scanned copies of the original drawings. There are discrepancies in scales and details between the various surviving drawings, so the drawings as published here should be regarded as 'works in progress'. It is hoped that eventually it will be possible to create accurate and dimensionable plans based on the original source documents.

Since no 'as-built' plans were found for either 1870 or 1911, the plans shown in Figures 4 and 5 are composites, derived from the surviving 1865, 1890, 1911 and 1938-39 plans. The 'ca 1872' version was chosen to represent the original design, since it includes the organ. The 'ca 1912' plan is based on the 1911 drawings showing proposed changes to the hall. Some of the details in both plans have been adjusted using later plans, text descriptions and photographs.

The 1872 riser layout was derived from an early photograph. The caryatid layout at the stage comes from plans dating to 1938-39, but it is likely that this is how it was built in 1911. The seating plans for the main level are derived from 1890 and 1911 drawings, plus later photographs; no seating is shown at the parterre because no definitive plan was located. All of the parterre and main level seats were removable for balls and other events.

[9] The usable area in 1870 was 121.5 m² (1308 ft²); after the renovation it increased to 185.8 m² (2000 ft²).



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[10] Information from Dr Otto Biba, Director of the Gesellschaft Archive.

[11] Michael Barron, *Auditorium Acoustics and Architectural Design*, London, E & FN Spon, 1993, p71.

[12] Concert programs are listed in *Hundert Jahre*.

[13] *Hundert Jahre*.

[14] Kralik, p31.

[15] The author is indebted to Dr Otto Biba for these observations, and for the information that the opening concerts in 1870 and after the renovation were regarded as acoustical 'trials'.

[16] Eduard Hanslick, *Vienna's Golden Years of Music, 1850-1900*, ed. Henry Pleasants, New York: Simon and Schuster, 1950, and his several other books of music criticism. This author had hoped to find in Hanslick's reviews a great source of information on how the acoustics of the Musikverein were perceived at the time but, alas, Hanslick's interests lay elsewhere. He appears to have taken the quality of sound in the hall for granted.

[17] [18] *Hundert Jahre*.

[19] Endler, p148.

[20] C Floros, 'Brahms, Bruckner and the Vienna Philharmonic', in *Klang und Komponist: Ein Symposium der Wiener Philharmoniker*. Congress papers published by Hans Schneider, Tutzing, 1992. Floros makes this observation in relation to Brahms and Bruckner.

[21] *Hundert Jahre*.

[22] Endler, p238.

[23] Blaukopf, pp11, 23, 173.

[24] See Daniel J Koury, *Orchestral Performance Practices in the Nineteenth Century: Size, Proportions and Seating*, Ann Arbor, Michigan, UMI Research Press, 1986, p175. In the 1880s, under Hans von Bülow's direction the Meiningen Court Orchestra stood to play.

[25] While the 'Vienna sound' is most commonly associated with the Vienna Philharmonic Orchestra, aspects of this sound quality can be heard also in the other orchestras in Vienna, particularly the Vienna Symphony Orchestra, many of whose members were also trained at the Vienna Conservatory, and which performs and rehearses regularly at the Musikverein.

[26] *Klang und Komponist*, cited above, contains many useful papers on the Viennese instruments and performance practice. See especially papers by Dolezal, Horvath, Nagy, Plangovsky, Schuster and Harnoncourt.

[27] Nikolaus Harnoncourt, 'Die klangliche Identität eines Orchesters', from *Klang und Komponist*.

[28] Hellsberg, *Demokratie*.

[29] The change from gut to steel strings occurred gradually between 1920 and 1960 (Harnoncourt).

[30] Kralik, p38; though Kralik goes on to say that under Richter the Vienna Philharmonic was able to bridge the differences between conservative and progressive factions in Viennese musical life. Richter had studied at the Vienna Conservatory; he was conductor of the Vienna Philharmonic Orchestra from 1875 to 1898. In 1876 he conducted the first performance of Wagner's *Ring Cycle* at Bayreuth.

[31] The author is indebted to Dr Clemens Hellsberg, President of the Vienna Philharmonic Orchestra, for these observations.

[32] *Klang und Komponist*, and notes taken during performances in the Grosser Saal.

[33] Harnoncourt, 'klangliche Identität', p64.

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Anthony J Watkins FIOA

Introduction

When a sound travels through the transmission channel between the source and the listener its spectral envelope is often distorted because of the channel's uneven frequency-response characteristic. This brings about 'coloration' of the sound that the listener receives. Transmission channels that color sounds in this way can be 'natural', such as a room with its reflecting surfaces, or artificial, such as a telephone line. The consequences of coloration for the perception of speech are considered in the light of perceptual experiments on the identification of speech sounds that are distinguished primarily by characteristics of their spectral envelopes.

The Haas Effect and the Precedence Effect

Auditory space may be distinguished from visual space in several ways. One way in which auditory space is distinctive concerns the perception of sound that is reflected from surfaces in the listening space. The auditory perception of such reflections seems to be quite unlike the visual perception of reflected light. Consider some of the perceptual properties of visual reflections, as for example, when a house is seen from across Lake Windermere on a still day. The house's reflection in the lake is seen as separate from the house itself, and in a different direction. Also, if the reflection is obscured while the house remains visible, the house looks the same. The auditory perception of reflected sound exhibits none of these properties. This was shown in part by Haas [1], who studied the perception of speech that contained a single echo. He found that this reflection became fused with the direct sound so that only one sound was heard. This fusion is obtained for echo delays up to about 20 ms [2]. Haas also observed that the reflection contributes substantially to the loudness of the speech, and that with suitably short delays it can even improve intelligibility a little. This 'Haas effect' is often accompanied by a qualitatively different binaural effect, whereby the directional information in the first arriving, 'direct' part of the sound dominates the direction heard for the overall sound. This 'precedence effect' was demonstrated by Wallach et al [3] who presented a brief click over headphones, along with an echo of the first click that was delayed by 2 ms. The experiment varied the interaural time difference of either the echo click, or the first click, and it was found that varying only the echo in this way had hardly any effect on the direction heard for the whole sound. On the other hand, large changes in the overall sound's direction were heard when the interaural time difference of the first click was altered. The Haas effect and the precedence effect can often occur together in various sounds,

and they have sometimes been considered as different aspects of the same basic phenomenon. However, the Haas effect can occur at relatively long time-intervals between the direct sound and echo, where the precedence effect is less apparent. So it is probably best to consider the two effects separately [4, 5].

Coloration Effects

A further property of the perception of a sound with reflections is the 'coloration' that the reflections contribute. Again, this property is not shared by visual perception of the house and its reflection in the still lake. If a breeze should ruffle the surface of the lake, the reflection is distorted, but perception of the actual house is unchanged by this. However, when reflections of sound are distorted versions of the direct sound, the distortion does seem to affect the quality of the overall sound. This was shown in a lecture room demonstration referred to by Gardner [6]. The demonstrator mingled with the audience while holding a miniature speaker. This poor quality speaker could only deliver the higher frequencies properly so it would normally give a tinny sound. However, this little speaker was wired up so that it played the same signal as a large high quality loudspeaker that was placed in a fixed position at the front of the lecture room. It seemed to listeners that all the sound in the room was coming from the little speaker, as long as it was closer than the large speaker was. At the same time, the sound that this little speaker seemed to be producing had the rich and full qualities of the large loudspeaker that was more distant. Thus, the Haas effect occurs so that only one overall sound is heard, the precedence effect occurs so that the overall sound's direction is determined by the first sound that arrives, while the later-arriving 'reflections' contribute to the overall sound's 'colour'. Consequently, it was only when the demonstrator switched off the high quality speaker that the tinny quality of the miniature speaker could be heard.

An analogous but hopefully fictitious version of the situation referred to by Gardner is illustrated in the cartoon overleaf.

Binaural Hearing

In certain circumstances binaural hearing mechanisms can reduce coloration, as was shown by Zurek [7]. He considered the dichotic situation that arises when a flat-spectrum noise-source is located straight ahead of the listener, and a single reflection comes to the listener from one side. The reflection considered was specular, which means that all frequencies are reflected by an equal amount. Adding such a reflection brings about spectral-envelope perturbations in the signals at each ear. These 'combfilter' patterns have a peak at a frequency that is

the inverse of the reflection's latency as well as peaks at integer multiples of this frequency. The valley floors (tips of the comb's teeth) are at frequencies half way between the peaks (on a linear frequency scale). The reflection's latency will be different at each ear because its angle of arrival adds an interaural delay to the reflection's latency at one ear. This reduces the interaural correlation of the sound's spectral envelopes in a way that depends on the reflection's latency and its angle of arrival. Zurek [7] suggested that this might give rise to suppression of coloration if the monaural representations of spectral magnitude are summed binaurally. When such a summation is applied to combfilter patterns that arise from reflection latencies that differ by an interaural delay, it will give rise to a smoother spectral-envelope than that of either of the monaural patterns alone. This idea was supported by Zurek's [7] experiments where the reflection's amplitude was varied, and listeners were required to detect its presence. The reflection was much harder to detect in dichotic conditions than it was in diotic control conditions where each ear received the same combfilter pattern. This was true for reflection latencies shorter than about 5 or 10 ms when the interaural delay was 0.5 ms.

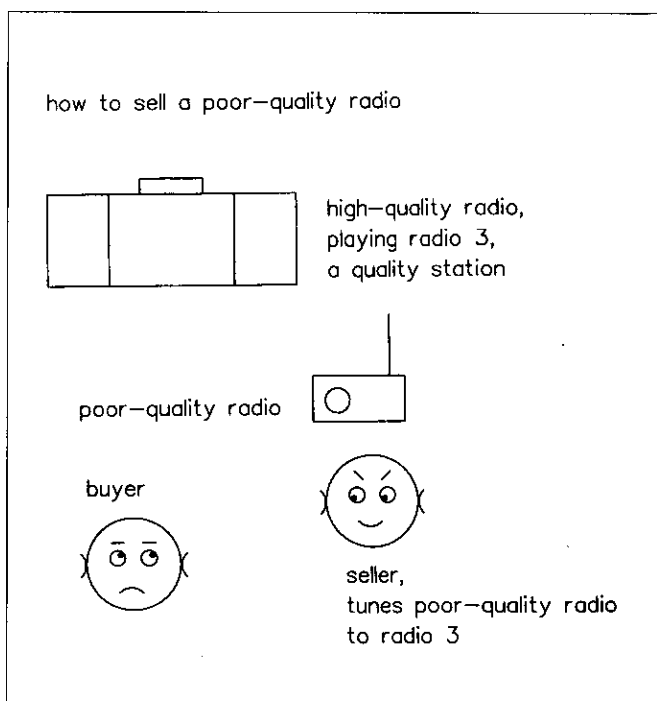
The sort of binaural mechanism that Zurek [7] points to here is limited in its ability to compensate for the spectral-envelope distortion that arises from reflections. One problem is that spectral smoothing by binaural summation can never completely eliminate the distortion. Perfect smoothing would arise if the spectra at each ear were the exact inverse of each other, but interaural decorrelation of spectra that arises through the introduction of an interaural delay is very unlikely to have this precise effect. Furthermore, the decorrelation that interaural delays do introduce depends on the angle of the reflections' arrival, while the distortion itself is brought about by the reflections' delay pattern. As these two factors are largely independent in everyday reverberation patterns it follows that there will commonly be combinations of angle of arrival and reflection pattern that give little or no reduction in coloration after binaural summation.

A further limitation of binaural summation is that it does not reduce coloration effects that arise from reflections that are non-specular, ie, when a sound's frequencies are reflected by unequal amounts. Spectral perturbations that arise in this way will be interaurally correlated, so that the resulting coloration effects will persist when there is binaural summation.

Nevertheless, some authors have suggested that there is some binaural suppression of coloration, or 'de-coloration', that occurs even with reflection patterns that give rise to interaurally correlated distortions of the spectral envelope [8,5]. These authors observe that monaural listening in everyday room conditions can sometimes make coloration seem more apparent than it is when listening binaurally. If there really is some suppression here then it might happen when the precedence effect occurs [9]. Another possibility is that de-coloration goes hand in hand with the Haas effect, so that it happens when there is perceptual integration of early reflections with the direct sound. Watkins [10] tested these ideas in an

experiment that measured the effects of coloration on vowel quality. A continuum between two vowels was produced and then a 'two-part' filter distorted each step. The beginning of this filter's unit-sample response simulated a direct sound with no distortion of the spectral-envelope. The second part simulated a reflection pattern that distorted the spectral envelope. A delay between the direct part and the reflections' part simulated the travel-time difference between direct and reflected sound. The reflections' frequency response was designed to give the spectral envelope of one of the continuum's end-points to the other end-point. Filtered sounds were presented over headphones for listeners to identify. It was found that the reflections in two-part filters had a substantial influence because sounds tended to be identified as the positive vowel of the reflection pattern. This effect was not reduced when the interaural delays of the reflections and the direct sound were substantially different. Also, when the reflections were caused to precede the direct sound, the effects were much the same. By contrast, in measurements of lateralization of these sounds the precedence effect was obtained. Here, the lateral position of the whole sound was largely governed by the interaural delay of the direct sound, and was hardly affected by the interaural delay of the reflections.

The dissociation between coloration effects and spatial effects seen here would seem to arise because of the way that different parts of the signal are processed by the different perceptual mechanisms that are involved. Perception of the vowel's quality involves processing relatively long portions of the signal, and this type of processing is characterised by binaural summation across different interaural delays. Thus, early reflections contribute to this attribute of the sound. On the other hand, the lateral position of these sounds seems largely to be governed by the characteristics of their onsets, as long as these are sufficiently sharp. Thus, the sort of processing



involved in establishing the lateral position of the sound uses only short parts of the signal, and this processing is characterised by dominance of the onset's interaural delay over the subsequent interaural delays in early reflections [11].

It might be considered advantageous for binaural hearing to behave in the way described here. Early reflections contain misleading information about the sound's direction so it makes sense for the system to suppress this information, while favouring the generally accurate directional information in the sound's direct part. The precedence effect might therefore be taken as an indication that binaural mechanisms are good at compensating for spatial distortion that might arise from early reflections. At the same time, binaural mechanisms appear to be limited in their ability to compensate for the spectral envelope perturbations that arises from these reflections and that give rise to coloration. The perceptual experiments described above indicate that early reflections, arriving with a spread of different interaural delays, will all be perceptually incorporated with the direct sound for the purpose of determining the sound's spectral envelope. However, early reflections do contain other information about the sound source. Indeed, without the reflected sound in rooms many sound sources would be completely inaudible. Coloration from these reflections might also provide information about the acoustic properties of the environment [12,13]. Thus, it makes some sense to incorporate non-spatial information from reflected sound [14].

A disadvantage of hearing coloration is that it arises from distorting effects on the sound's spectral envelope, but this envelope also carries information about the sound's source. For example, the source's resonances transmit information about the shape and size of the structures that produce them and impose characteristic envelopes upon the acoustic spectra of short segments of the auditory signals that arise. For this reason, descriptions of spectral envelopes, among other features, are widely held to be prerequisites of auditory identification. Thus, the distortion that gives rise to coloration might affect characteristics of musical instruments [15] as well as characteristics of vowel and consonant sounds in speech [16,17]. We have seen that this distortion is not overcome by binaural mechanisms, and that it is not overcome by mechanisms that bring about the perceptual integration of early reflections seen in the Haas effect.

Influences of Neighbouring Sounds

There do appear to be other kinds of perceptual mechanism that can compensate for distortions of the spectral envelope. These mechanisms appear to extract information about the distortion from neighbouring sounds in order to compensate for the distortion's effects on the spectral envelopes of subsequent and preceding sounds. The presence of such mechanisms could account for the apparent robustness of speech perception in the presence of the prominent spectral-envelope distortions that arise in everyday transmission channels such as telephone lines and reverberant rooms [18]. Much of the evidence

of these compensation mechanisms comes from experiments in which a test vowel is preceded by a filtered precursor-phrase, with the result that the test vowel is heard as one that has been filtered by the inverse of the precursor's filter [19].

Central Compensation Mechanisms

In the experiments with filtered precursor phrases, a small part of the effect on the test vowel was found to be similar to peripheral, adaptation-like phenomena, such as the negative auditory after-image [20,21]. However, effects with precursors that contained speech-like spectro-temporal variations were much larger than effects in control conditions where noise precursors were used. These noise precursors had time-stationary spectral characteristics, but their effects should have been much the same as those of speech precursors if peripheral mechanisms were the sole source of the compensation effects.

The bulk of the effect with speech precursors appears to arise from mechanisms that are more central than those responsible for effects with noise precursors. Comparing results from two sorts of experiment led to this conclusion. In one of these experiments the precursors were either presented to the same ear as the test sounds, or the test sounds were presented to the opposite ear. In the other sort of experiment sounds were presented binaurally. In one binaural condition precursors were given the same interaural delay as the test sound, so that they were heard to come from the same direction. In the other binaural condition precursors were given a different interaural delay to the test sounds, so that they were heard to come from a different direction. The results with noise precursors typified a peripheral mechanism. This is because their effects were abolished in different-ear conditions, but were uninfluenced by differences in interaural delay in the binaural conditions. However, effects with speech precursors seemed to typify a more central mechanism. This is because their effects were reduced, but not abolished, in the different-ear condition, while there was a similar reduction across binaural conditions when the interaural delays of the precursor and test sound were changed from same to different. Thus, it would seem that this central mechanism is 'smart', in that it reduces its compensation effects when direction differences indicate that the precursor and test sounds have arisen from different transmission channels.

Other results also indicate that a central mechanism is involved. They come from experiments where the identification of test sounds is influenced by the filtering of subsequent sounds when there are no precursors. For example, Watkins [22] found that an /It/ to /Et/ continuum of test sounds was influenced by filtering the /t/ and a subsequent phrase, 'is the next word'. The direction of this influence did indicate perceptual compensation for the effects of the filter, although this influence was much smaller than that of filtered precursors.

The Inverse-Filter Model

In the experiments that measure compensation, the effect on the test-sound is like the effect of applying the inverse of the filter that the neighbouring sounds are played through. Such 'inverse filtering' resembles techniques

used to remove transmission channel characteristics in voice recognition automata [23,24]. One way to get an appropriate frequency response for the inverse filter is to compute the whole signal's long-term average spectrum and then invert it. Watkins and Makin [25] used this method in a simulation of the perceptual compensation mechanism. They found that test sounds played through the simulation were perceptually altered in ways that resemble the alterations heard in test sounds played after filtered precursors. So it would seem that this sort of simulation has characteristics that are similar to those of the perceptual compensation mechanism.

A perceptual mechanism based on inverse filtering would provide the resistance to spectral-envelope distortion exhibited in speech perception, but such resistance is not necessarily achieved in this way. It might be that speech is perceptually coded in terms of features, such as peaks in the spectral envelope, and that these retain their essential properties better than others do over the range of ecologically likely conditions of distortion [26]. Peaks might plausibly function in this way because alterations to them have much larger effects on phonetic quality than alterations to other parts of the spectral envelope [27,28]. Furthermore, the frequency location of peaks is one of the major determinants of perceived similarity between sounds such as vowels [29]. However, simply extracting the features is not sufficient to overcome all distortions, as spurious features are likely to arise from the transmission channel [30]. Features imposed by the channel need somehow to be separated from those of the sound source. One basis for such a separation might be the presence or absence of similar features in neighbouring sounds. In experiments with precursors it may be that features of the filter that are present in both the precursor and the test sound come to be separated from other features in the test sound. Such a separation might come about in ways reminiscent of a perceptual grouping perhaps [31] or of the selective adaptation of auditory features [32].

Altering the spectral contrast of sounds can be used to test whether features in the spectral envelope are perceptually significant. Contrast is changed when a positive number, other than one, is used to multiply decibel values of the spectral envelope. This varies the difference in level between peaks and valleys, but features such as peaks stay at the same frequencies. If contrast-invariant features are more important than other parts of the spectral envelope, then contrast changes will have relatively little effect on perception.

Watkins and Makin [33] varied contrast to ask whether compensation for spectral envelope distortion involves the extraction of features that are contrast invariant. The experiments used a filtered precursor-phrase followed by a word containing a vowel test-sound which was drawn from a continuum between /apt/ and /ɔpt/. The contrast of the precursor's filters was altered by multiplying their frequency response by a positive number, other than one, while the contrast of test-sounds was altered by a similar multiplication that was applied to the spectral envelope. Compensation was measured when

the test-sound's contrast was the same or above that of the precursor's filter, as well as when the test sound's contrast was reduced to a value below the precursor's contrast. These manipulations should have little effect on compensation if it is only the contrast-invariant features that are involved.

However, it was found that these contrast manipulations had substantial effects on perceptual compensation for spectral-envelope distortion. The different contrasts gave rise to compensation that generally increased and decreased with the ratio of precursor contrast to test-sound contrast. This was the case as long as the precursor's contrast was not too high. The effects were generally larger than those to be expected from peripheral mechanisms and appeared to be caused by the more central, auditory mechanism that was responsible for compensation effects in earlier studies.

This pattern of results seems to rule out the possibility that the compensation mechanism involves feature extraction. Compensation for spectral-envelope distortion appears then to precede any extraction of features in the spectral envelope rather than to occur at a subsequent stage. Either of these arrangements could in principle avoid the influence of features that are added by distortion [34,30]. However, an advantage of a compensation mechanism that precedes feature extraction is that correction can be made for distortions of existing features, such as when a spectral-envelope peak is displaced to a different frequency. This can occur when the distortion does not introduce any new features, as happens when sounds are high-pass or low-pass filtered. Compensation can correct for this kind of distortion as it varies with contrast, so that its effects are appropriate for the degree of displacement of the original features.

Limitations of Perceptual Compensation

The perceptual compensation for coloration that comes from neighbouring sounds is limited when the distortion is too great, as we have seen. It will also be limited to time-stationary frequency response characteristics, so when these characteristics vary with time it would seem likely that intelligibility will suffer. There is some evidence that this is the case. For example van Dijkhuizen et al [35] played speech through a filter that changed the sound's overall spectral-tilt with a continuous oscillation between plus and minus 10 dB per octave. They measured intelligibility with the speech reception threshold, and found that it suffered as the rate of oscillation was increased. The threshold rose by up to 5 dB as the rate of oscillation was increased from 0.25 Hz up to 2 Hz. Another example comes from a study by Haggard et al [36] who attempted to alleviate the sensorineural hearing impairments of their listeners. They used a filter with a frequency response that varied between rising (+9 dB per octave) when the speech had a falling spectral slope, and flat. Speech that was filtered by this time-varying filter actually gave poorer intelligibility than the speech in two control conditions where the filter's frequency response was time-stationary and was either flat or rising.

There are 'everyday' situations in which the transmission channel between a source and the listener has a changing frequency response characteristic. These situations can arise when a microphone's frequency response varies with the direction of the sound source, giving 'microphone coloration' as the talker's position changes. This sort of time-varying coloration is therefore likely to impair intelligibility for users of a variety of electro-acoustic systems, including public address systems and hearing aids.

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NOISE ON THE NET – PART 2: AIRPORT AND AIRCRAFT NOISE

Matthew Ling MIOA

This is the second of a series of articles written with the aim of introducing you to some of the sources of information on noise and acoustics that are lurking around the Internet.

Several readers have contacted me since the first article was published; there was a lot of interest in sites concerning transport and transport noise. To address this, the current article lists some of the airport and aircraft noise sites. Some of these are government or 'official' Internet sites, but the larger proportion are pressure groups campaigning to reduce aircraft activities and noise.

As with all web sites, the views expressed reflect those of the organisation represented. The emotive nature of noise impact means that it is important to issue the caveat that information presented can be as much based upon opinion as it is on fact. However, there is value in these sites with many addressing non-noise issues, such as visual or social impacts, in addition to providing links to other aircraft noise sites.

The Airports

For a complete listing of airports then a site such as the Aviation UK site

www.aviation.uk.com/airports.html

is probably the best place to go. Information about noise at these airport sites is best obtained through their community relations pages, their environmental statement pages or from carrying out a general site search.

The BAA site

www.baa.co.uk and

www.heathrow.co.uk/BAAHome.htm

has links to airports including Heathrow, Gatwick, Stansted, Glasgow, Aberdeen, Edinburgh, Southampton. Searching the site yields the BAA Noise Management guide.

Bournemouth International Airport

www.bourneintairport.co.uk/bia_new/index2.html

East Midlands Airport

www.eastmidairport.co.uk/ema.html

Leeds Bradford International Airport

www.lbia.co.uk/

Manchester Airport

www.manairport.co.uk/

Their community relations page

www.manairport.co.uk/envirom/com_rela.html

gives details of the actions that are taken to address noise issues, such as utilising the Manchester Airport Noise and Track Monitoring System 'MANTIS' system and their noise compensation schemes.

The Government and 'Official' Sites

The Civil Aviation Authority (CAA)

www.nats.co.uk/

includes details about the National Air Traffic Services (NATS). Searching on this site can be very slow. However, it does have a comprehensive list of other aircraft related Internet sites

www.caa.co.uk/about/fr_body_links.html

An overview of NATS' noise work can be found in the Environmental Studies section

www.sdd.nats.co.uk/d/prj/0023/0023%2D1.htm

A nice feature of this site are the recordings of different Chapter 2 and 3 aircraft that can be downloaded!

The Department of Environment Transportation and Regions (DETR) aviation pages

www.aviation.detr.gov.uk/

are the starting point for reviewing government policy on aviation and aircraft noise. Pages here include noise contours and night time flying restrictions at the major UK airports.

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Federal Aviation Authority (FAA)

www.faa.gov/

This site has some information relating to Aircraft noise on it. Searching with 'noise' as a keyword is the best way to obtain documents such as their aviation noise abatement policy

aee.hq.faa.gov/Noise/Index1.html

Federal Interagency Committee on Aviation Noise (FICAN)

www.fican.org/

The Federal Interagency Committee on Aviation Noise (FICAN) was formed in 1993 to provide forums for debate over future research needs to better understand, predict and control the effects of aviation noise, and to encourage new technical development efforts in these areas. This site has an excellent bibliography of aircraft noise related studies carried out over the last decade or so.

International Air Transport Association (IATA)

www.iata.org/

Ministry of Defence (MOD)

www.mod.uk/

Little information on noise impact can be found, at present, on this site. Noise is alluded to in their low flying pages

www.mod.uk/policy/lowflying/index.htm

and also their conservation magazine *Sanctuary* found at

www.mod.uk/policy/conservation/sanctuary/27/regions1.htm

The Pressure Groups

Alliance of Residents Concerning O'Hare (ARCO)

www.nonoise.org/library/arco/arco.htm

Alliance of Residents Concerning O'Hare (ARCO) is an organisation comprising of residents that are affected by noise, pollution and safety concerns caused by O'Hare International Airport located in Chicago, Illinois. They have produced a number of newsletters that provide a good source of information on airport noise and environmental impacts.

Anti-MilNoise

www.kalama.com/~gadfly/milnoise.htm

This site brings together a number of resources on military noise.

Bentwaters Airbase Redevelopment, UK

members.xoom.com/bentwaters/

Noise is flagged up as an issue here on the redevelopment of a former US/RAF airbase in Suffolk, UK.

Citizens for the Abatement of Aircraft Noise (CAAN) – Washington/Dulles US

www.caan.org/

These pages concern developments at Washington National Airport and Dulles International Airport and identify opportunities where action might be taken. An innovative feature of this site is the ability to interactively check out the size of the noise footprint at the airport.

Citizens Aviation Watch (US-CAW)

www.nonoise.org/quietnet/us-caw/

A US organization comprised of local airport groups, environmental organisations and civic groups, cities and townships concerned about noise, environment, public health and other quality of life issues related to aviation

operations. US CAW is linked with established organisations in 26 countries throughout the world.

Citizens Concerned About Jet Noise (CCAJSN)

www.nonoise.org/groups/ccajsn/ccajsn.htm

The members of CCAJSN live and work in the community surrounding Oceana Naval Air Station and Fentress Field in Virginia Beach, Virginia. The goal of CCAJSN is to minimise noise from Navy jets and their impact on the local community while continuing to support the needs of the Naval Aviation Units.

Citizens Fed-Up with Aviation Noise – Seattle (CFAN)

www.accessone.com/rcag/cfanmiss.htm

The Citizens Fed-Up with Aviation Noise (CFAN) has the aim to improve the quality of life in the Seattle and Urban King County area by employing the most effective methods possible for minimising the impacts of aviation noise upon citizens. Its goals include (i) to restore and maintain the quiet in surrounding residential and natural areas, (ii) to reduce or eliminate all forms of pollution from the aviation industry including impacts upon the people as well as the air, land, and water of the region, (iii) to support the development of all reasonable alternatives for present and future transportation needs. The site also includes details of night-time noise restrictions at US Airports.

Coalition Against Runway 2 – Manchester UK

www.mfoe.u-net.com/car2/

The Coalition Against Runway 2 (CAR2) was formed to oppose proposals for a second runway at Manchester Airport. The site is based with the Manchester Friends of the Earth site that provides a useful resource, concerning all aspects of aircraft impact, including noise.

El Toro Airport

www.eltoroairport.org/

The Orange County Board of Supervisors intends to develop the former El Toro Marine Corps Air Station into a major commercial airport (El Toro International Airport) to compete with John Wayne Airport. A suit challenging the Environmental Impact Report (EIR) prepared by the county was filed by Taxpayers for Responsible Planning and the El Toro Reuse Planning Authority. On October 10 1997 the judge issued a tentative ruling requiring the county to redo the EIR. The development of the El Toro airport is opposed by a coalition of homeowner associations representing 100,000 residents, the Orange County Business Coalition, Project 99 (a citizens group), and various cities and school districts. This Web site has information on the impact of aircraft noise on property values and on children in school.

Heathrow Association for the Control of Aircraft Noise (HACAN) UK

www.hacan.org.uk/

HACAN claims to be the largest anti-aircraft noise organisation in the world. This site has copies of submissions used at the controversial Heathrow Terminal 5 Hearing. These include health aspects, measurement descriptors, and night time flights.

No More Noise!

www.wenet.net/~hpb/

No more noise is a coalition opposing expansion of air cargo traffic at Oakland International Airport. The Oakland International Airport has indicated that it plans to significantly increase its operations, principally by attracting more air cargo traffic. (Air cargo traffic is expected to quadruple in a dozen years if the airport is permitted to go ahead with its proposed development.) The airport is presently the 10th busiest in the US, while San Francisco International is only 20th.

The Environmental Organisation, Copenhagen, Denmark
hudson.idt.net/~beck/index-engelsk.htm

The Environmental Organisation is fighting to reduce the environmental pollution from Copenhagen Airport. The Environmental Organisation consists of more than 350 single members, other organisations and groups, representing in total more than 1200 people. There is also a useful list of Airport Pollution Fighters

hudson.idt.net/~beck/fighters.htm

– not just from a noise perspective.

Residents Opposed to Airport Racket (ROAR)

www.nonoise.org/groups/roar/core.htm

Residents Opposed to Airport Racket (ROAR) is a citizens' group fighting aviation noise from the Minneapolis/St Paul Metropolitan Airport. Founded in October of 1998, the group focuses upon improving the quality of life by seeking to reduce airport noise.

RCAA, Seattle US

www.accessone.com/rcaa/

The RCAA is a non-profit coalition of citizen groups and cities. RCAA believes that further expansion of Seattle-Tacoma International Airport (SEA) with a third parallel runway makes no sense, costs too much, and does too much damage to too many people. A host of good resources is provided on this site, with web links and bibliographies that provide an excellent point of reference.

Sane Aviation For Everyone (SAFE) – New York, US

pages.prodigy.com/NY/rockaway/safe.html

SAFE is a coalition of independent citizens groups and individuals in the New York City metropolitan area. SAFE is dedicated to stopping and reversing the environmental and health impacts of JFK, LaGuardia and Newark Airports and the 'fair sharing' of these impacts. The organisation was officially established on July 7, 1994 and recently joined Citizens Aviation Watch (USCAW), the US national noise coalition of anti-aircraft noise groups.

San Francisco Airport Noise Roundtable

www.smcroundtable.com/

The Airport/Community Roundtable was established in 1981 as a voluntary committee to address community noise impacts from aircraft operations at San Francisco International Airport.

South Metro Airport Action Council (SMAAC)

www.nonoise.org/groups/smaac/smaac.htm

The SMAAC are associated with the Minneapolis-St Paul airport and are committed to stabilising and preserving their residential areas through environmental and economic advocacy and monitoring.

Third Runway Protest Page, Sydney, Australia

www.ozemail.com.au/~darrylro/

Since September 1994 the residents of the Inner Western suburbs of Sydney have been exposed to aircraft noise caused by the opening of the third runway and closure of the east/west runway. These pages detail the campaign to convince the Government that the present complaints are serious and that the runway was prematurely opened. Highlighted are the standard concerns that the controlling authorities are taking responsibility and that the protests are falling on deaf ears.

The Right Price for Air Travel

www.milieudefensie.nl/airtravel/

'The Right Price for Air Travel' is a Friends of the Earth Europe campaign to reduce aviation's environmental impact. The campaign aims to unite environment and citizens groups all over Europe.

Union Francaise Contra La Nuisance d'Avions

www.ufcna.altern.com/ufcna

Other Information Sources

Airport Noise Report

www.airportnoisereport.com/

is a biweekly US based report on airport and aircraft noise issues.

AviationWatch is an Internet news service, launched by US-CAW on December 17, 1998 (the 95th anniversary of the Wright Brother's flight!). AviationWatch is a distributed via the ONEList service,

www.onelist.com

The list administrators are given as

Jack Saporito <jsaporito@aol.com> and

David Staudacher <quiet@igc.org>.

An AviationWatch archive is available to registered ONEList members. To become a registered member, click on the 'New member' button at

www.onelist.com

Boeing's Airport Noise Regulation Information

www.boeing.com/assocproducts/noise/airports.html

This site is extremely comprehensive in meeting its aims of tracking and reporting airport noise restrictions and government noise regulations specifically for airline customers.

League for Hard of Hearing (LHH)

www.lhh.org/noise/airport.htm

gives guidance on airport and aircraft noise, and includes a number of good resources.

The Noise Pollution Clearing House has a section entirely devoted to aircraft noise

www.nonoise.org/quietnet/us-caw/us-caw.htm

The site usefully provides a copy of the FAA document *Aviation Noise Effects* which is a wide ranging report covering noise indices to health effects of aircraft noise.

And finally...If you know of sites that have passed me by, then let me know at lingm@bre.co.uk and I'll feature them at a later date.

Matthew Ling MIOA is Senior Researcher with the Acoustics Centre, BRE, Watford

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AUDITORIA: THE LEGACY OF THE 20TH CENTURY AND BEYOND 2000

Thistle Manchester Hotel, Manchester, 22-24 October 1999

Meetings on auditorium acoustics linked to recent British projects have proved a great success for the Institute, attracting an impressive international audience. The latest meeting in Manchester was linked to the Bridgewater Hall that opened in 1996 and the Lowry (Centre), due to open next year. Previous meetings were, with the auditoria concerned: Birmingham Symphony Hall (1992), Glyndebourne Opera House (1995) and the Belfast Waterfront Hall (1997). Sixty-three delegates attended this meeting from nine countries including the United States and New Zealand.

Attending a performance is a necessary component of these meetings. We kicked off on the Thursday evening with a concert in the Bridgewater Hall by the Hallé Orchestra in slightly ragged form. The concert programme was a centennial repeat of the first concert given by their then new conductor, Hans Richter, on 19 October 1899. This was solid Germanic stuff with Beethoven, Liszt, Brahms and Wagner.

The meeting proper ran from Friday morning to Sunday lunchtime. Somewhat by mistake, the meeting had acquired a historical element in its title, which was addressed in the first session. Mike Barron in his introduction listed what he felt were eight key concert halls of the century from an acoustical standpoint: Boston Symphony Hall, Massachusetts (1900), Salle Pleyel, Paris (1927), Royal Festival Hall, London (1951), Philharmonic Hall, New York (1962), the Berlin Philharmonie (1963), De Doelen Concert Hall, Rotterdam (1966), Christchurch Town Hall, New Zealand (1972) and Birmingham Symphony Hall (1991). Not that all these were successes – the New York Philharmonic was actually demolished because of its disappointing acoustics. A major conflict in the design of concert halls has been whether to place greater reliance on precedent or science.

The first paper by Pamela Clements of Jaffe Holden Scarbrough Acoustics (Connecticut) took us back a further 30 years to the Musikvereinssaal, Vienna, which opened in 1870. This hall has acquired almost mythical status for its sound, to the extent that several close copies exist like the Seiji Ozawa Hall at Tanglewood, Lenox, Massachusetts (1994). Pamela had gained access to a treasure-trove of drawings at the Vienna Bau Polizei (Building Police) and together with an extensive study of the literature she has managed to piece together the building's little-known history. A substantial renovation of the hall was undertaken in 1911, whose most radical component was the movement of the caryatids, the columns in the form of female figures which supported the front of the balcony, to a position against the side walls.

Pamela stressed the importance of this hall not only for acousticians but also for the development of classical music: Brahms, Bruckner, Mahler and Richard Strauss all knew this hall intimately and had first performances of their work there, surely influenced by its acoustic quality. (An article based on her presentation appears at page 5 of this issue).

Anne Minors' paper was pertinently titled *Twentieth century music spaces – to look at or listen in? The struggle of the aural over the visual*. We were given an encyclopaedic history of the century's concert halls from her perspective as a theatre consultant. This contained the marvellous anecdote by Abner about the surround hall in Berlin, the Philharmonie, that the logic of the design 'leads us to trumpets, with four bells pointing to all quarters of the compass and to singers with mouths in the back as well as the front of their heads. Alternatively, I suppose it leads us to people, like Stockhausen, whose music breaks out like a civil disturbance all over the place'. One of Anne's conclusions was that a really successful hall combines both good acoustic quality and visual (architectural) interest, but very few halls succeed in both areas.

Paul Scarbrough, also of Jaffe Holden Scarbrough, took up the development of the concert hall since 1950, relating developments to either the precedent from the previous century, the shoebox hall, or the revolutionary surround design found in the Berlin Philharmonie. His own firm had been responsible for a major surround hall, the Boettcher Concert Hall in Denver (1978). Of particular interest was his account of what happened in the early 1980s, when four halls designed by Bolt, Beranek and Newman (BBN) for San Francisco, Baltimore, Toronto and Melbourne, Australia, were all opened. The poor reception of each of these halls led clients to turn to the precedent with a good reputation from the past, the shoebox hall. But a big disadvantage of the shoebox hall is its formality, with audience and orchestra facing one another. The more intimate possibilities of the surround design are now again beginning to be explored.

After this auspicious start and coffee, we heard from Tor Halmrast (Statsbygg, Norway) on the problem of colouration on concert hall stages. He suggested that the critical delay period was 5-20 ms, which gives a boxy quality to the sound. From classical music, we turned to Javanese Gamelan music which has traditionally been performed outside but is now being played within buildings. Joko Sarwono of Salford University has been investigating the preferred delay of a single reflection for Gamelan music, finding interesting differences between the results of Indonesian and non-Indonesian subjects.



Orchestral concert at Bridgewater Hall, Manchester

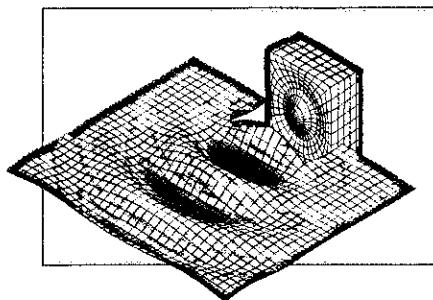
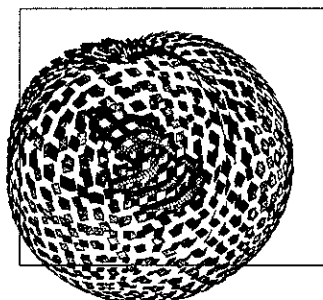
George Dodd of Auckland University, New Zealand, discussed an on-going survey of listening habits he has been conducting over a decade with respondents from both France and New Zealand. Among his results was an indication that New Zealanders were less cerebral in their tastes than the French, a trait which he thought might well have a bearing on their then current success in the Rugby World Cup (oh!). George deftly navigated us through the various issues his survey had touched on. His conclusions were that a large majority of people prefer live music but that only a small proportion of their exposure to music occurs at live performances. His results provided evidence that listeners to live music were strongly attracted by two-way communication between performers and listeners.

Russell Richardson of South Bank University told us about results of questionnaire surveys with normal concert goers at four British halls. They were able to survey four very similar Rachmaninov concerts by the Philharmonia Orchestra. Getting a good rate of return is the first problem, 17% is a typical response. One surprising

statistic was that in three halls over 75% of respondents owned a CD of one of the pieces played. Results on the acoustic characteristics of the halls are proving more difficult to extract.

After a wholesome lunch, Ian Drumm of Salford University explained an adaptive beam tracing algorithm for computer modelling of rooms. A broad triangular beam is radiated from the source which subdivides into smaller beams when it hits more than one boundary surface. Good agreement between measured and predicted objective characteristics have been achieved in a small auditorium, even though the computer model currently ignores diffraction effects. Simon Kahn (Bits & Pieces) also discussed computer modelling programs. Many commercial programs treat reflections as either purely specular, purely diffuse or a combination of the two. Errors can be significant when as is usually the case diffraction at edges is ignored and when there are curved surfaces in the space being modelled.

The paper by Xavier Meynial from Le Mans University in France was titled *Active reflectors for room acoustics*.

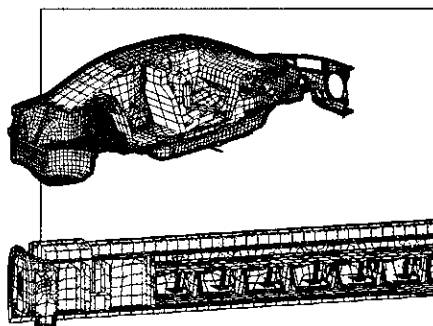
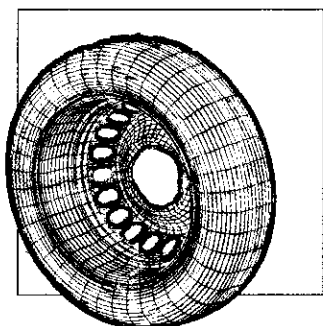


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Xavier has been investigating feedback systems for a 4 x 4 loudspeaker array. A double feedback scheme (placing the transducer in an impedance bridge and employing a microphone close to the transducer) looks the most promising option but further improvements could be achieved by transducers specially optimised for the purpose.

The four final contributions of the day concerned acoustic consultancy on actual auditoria. Catherine Semidor from Bordeaux described the proposed conversion of a chapel at the University of Science in Bordeaux into a lecture room and recital space. Radical changes are proposed with screens and side balconies closing off the transepts, the introduction of an overhead reflector and considerable absorption. Henrik Möller of Akukon Oy in Helsinki discussed two medium-size concert halls for the Helsinki Conservatory of Music and for the city of Pori. Both look interesting designs; each has a high proportion of surfaces rendered acoustically diffusing and cross-sections to promote early lateral reflections.

Joan Faria of Arup Acoustics told us about the renovation of the Royal Exchange Theatre in Manchester completed at the end of 1998. The main theatre is a steel and glass module providing theatre-in-the-round with 684 seats; it opened originally in 1976. The major change has been to remove louvered windows and replace them by opening roof doors to allow either good isolation from or coupling with the surrounding Victorian building. A flexible Studio Theatre has now been added to the complex. Also in the Manchester area is to be the Lowry in Salford, containing an art gallery to display paintings by L S Lowry, a 1730 seat Lyric Theatre and a 466 seat Adaptable Theatre. Ian Knowles of Sandy Brown Associates described this major lottery-funded project due to open on 28 April 2000, which we were able to visit on the next day.

On the Saturday morning, we made our way for a visit to the Bridgewater Hall. This 2400 seat hall was built to replace the Free Trade Hall as a home for the Hallé Orchestra as well as providing public performing space for the BBC Philharmonic Orchestra and Manchester Camerata. Competing with riggers setting up for the evening show, Nick Thompson of RHWL (Architects) described the development of the design. The building was seen as a key element in the regeneration of the city of Manchester, and indeed the centre line of the auditorium points towards the city centre.

The auditorium design was very much a joint development between architect and acousticians, Arup Acoustics. Its form is a hybrid between a parallel-sided shoebox at the stage end and a vineyard-type arrangement at the rear. Unusual in new halls is the inclusion of a large organ behind the choir seating. The gross dimensions of Bridgewater Hall are not very dissimilar to those of Birmingham Symphony Hall, each having a very high ceiling. In Bridgewater Hall an exposed roof structure limits the apparent visual height.

The complete auditorium is mounted on springs to exclude train vibration; steel springs mounted in damping liquid were used. The whole support system can be

clearly admired in a remarkably clean undercroft.

From a building which has been very well maintained since its opening three years ago, we were taken by bus to the Lowry (Centre) site in the old docklands of Salford. Kitted out in hard hats and bright yellow waistcoats, we were taken round by Sandy Brown Associates and able to see, in places through scaffolding, the large main auditorium and adaptable theatre. This will be a very interesting major venue; one hopes it will manage to attract sufficient audience.

Invigorated by the bracing air at Salford Quays, delegates settled down to an attractive programme of papers in the afternoon sessions.

John O'Keefe of Aercoustics in Toronto kicked off by describing his work on the influence of height to width ratio and side wall boxes on room acoustics measurements. On the basis of computer and scale model experiments he concluded that the ratio of Early Decay Time to Reverberation Time is affected by the height to width ratio of the room, the amount of acoustical absorption in the room and the presence of balconies and side wall boxes. He is applying these results to the refurbishment of the Queen Elizabeth Theatre in Vancouver.

Jerry Hyde of JRH Acoustics in St Helena, California addressed the issue of Sound Strength in concert halls by considering acoustical measurements and computer modelling. He proposed that the early sound field has a significant effect on the total Sound Strength and this is not properly accounted for in classical theory or Barron's revised theory. He suggests that the prediction model for Sound Strength should be refined by adding a 'room geometry' term.

Raphaëlle Bermond from The University of Salford presented a paper on the effects of diffusion on early reflected energy on orchestra platforms which she co-authored with Bill Davies. She is using a tenth scale model for the investigation and has found that the characteristics of the model sound source are critical for obtaining accurate acoustic responses at various locations on the stage.

Mike Barron of the University of Bath presented a thought-provoking paper on spatial impression and envelopment in concert halls. He confirmed that there are at least two spatial effects, source broadening and listener envelopment, and hinted that there may be more. Design considerations for source broadening are well understood whereas those for envelopment are less clear – many questions still remain to be answered.

Following tea, Peter Henson of Bickerdike Allen Partners gave an account of the design of the IMAX cinema at Waterloo in London which he described as an acoustic challenge! This was perhaps an understatement as the site was in the centre of one of London's busiest roundabouts, close to an elevated railway, with two tube tunnels below and Heathrow bound aircraft above. Nevertheless, the stringent acoustic criterion of inaudibility of external noise inside the auditorium was met.

Paul Scarbrough of Jaffe Holden Scarbrough Acoustics (Connecticut) described a new approach to multi-purpose hall design. Based on many years of develop-

ment of concert shells, the approach involves installing a specially shaped shell in the stagehouse which provides the right acoustic conditions for orchestral performances in a multi-purpose facility.

Rob Harris of Arup Acoustics gave an account of the acoustics of the redeveloped Royal Opera House, Covent Garden which will reopen in December 1999. As well as describing the refurbishment of the main auditorium, he outlined the acoustic design of the new 420 seat studio theatre and presented results of objective and subjective measurements. Opera rehearsal rooms, ballet studios and music practice rooms were also illustrated and Rob concluded that measurements and listening tests were encouraging and in line with the overall perceived success of the project.

The paper by Larry Kirkegaard of Kirkegaard Associates from near Chicago was titled *The art (and science) of concert hall design*. We were treated to an extended account of both his survey of concert stages as well as his recent consultancy work in the Liverpool Philharmonic Hall, the Glasgow Royal Concert Hall and Barbican Concert Halls in London. He also showed us slides of two recent new halls: the Seiji Ozawa at Tanglewood, Massachusetts and the new hall at Kuala Lumpur.

Following the banqueting and related festivities of Saturday night, Sunday morning dawned for many (but not all!) in the cold light of the overhead projector with a double bill from Trevor Cox of the University of Salford. In his first paper, Trevor described two methods for measuring a diffusion coefficient both of which have

advantages and disadvantages and both of which are likely to form the basis of standards in the near future. He went on to describe new techniques for designing, shaping and optimising diffusers which combine both acoustic and visual requirements.

Rendell Torres from Chalmers University presented a paper on the audibility of diffusion in auditoria which was co-authored with Mendel Kleiner and Bent-Inge Dalenback. Using a panel of listeners responding to auralisation from a computer model, they were able to demonstrate that changes in frequency coloration are consistently heard with changes with diffusion and concluded that diffusion must be modelled in a frequency dependent manner.

Bridget Shield from South Bank University, who worked in collaboration with R Canham, described the results of noise surveys of orchestral musicians at the Barbican Concert Hall. They concluded that many players are exposed to noise levels known to cause a risk to hearing with brass players being most at risk.

Rob Metkemeijer from Peutz Associates in the Netherlands gave an account of auralisation techniques using binaural impulse responses from scale models. His work was based around the 1:12 scale model of The Royal Albert Hall with a view to demonstrating the effect of alterations that have been proposed. He illustrated his talk with a fascinating series of 'auralisations' of the Hall under various conditions.

Raf Orlowski of Arup Acoustics spoke about the recently opened Milton Keynes Theatre. He wasn't sure

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Milton Keynes Theatre – the acoustics can be varied by a moveable ceiling

whether to leave the introduction to Angela (a TV presenter), but she had the disadvantage of being on video at the mercy of a hand control. The theatre is a multi-purpose space with two levels of balcony and a capacity of 1400. The novel feature is a moveable ceiling which can move over a height change of 10 m; at its lowest position it closes off the upper balcony seating. A reverberation time change of between 1.0 seconds to 1.5 seconds has been measured.

Tor Halmrast presented an intriguing account of a theatre designed inside a stone quarry which boasts very good acoustics for the spoken voice. He made measurements using a simple directional source to examine impulse responses and pointed out that measuring conventional room acoustic parameters with an omnidirectional source would not have shown up the high quality of the sound.

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Last but not least, Albert Yaying Xu from Paris discussed domes and echoes in classical opera houses with particular reference to his work at Opera-Comique in Paris. He pointed out that acoustic treatment of the dome is very tricky because of the need to preserve its heritage intact. In the case of the Opera-Comique which has a very large orchestra pit, he has come up with the novel idea of moving the position of the sound source (the orchestra) to reduce the effect of focusing.

Poets were also at work; the Acousticians' Rap first saw the light of evening after the conference banquet:

*The raw shock of a good hall
is carbon based not silicon slick.*

*But with a transparent stage
we have a warm hug, not a Heimlich.*

*The pot end of the rainbow,
not edgy, harsh or scraping,*

*But more like tearing paper
than smeared sound, or geometric shaping.*

*Scattering surfaces, yes, but ensure
that they talk to each other*

*At the high strings cross-roads,
but measurements – why bother?*

Raf Orlowski FIOA & Mike Barron MIOA

Has Noise at Work Worked?

On 13 October, the recently reformed Industrial Noise Group held its inaugural symposium to review the benefits of 10 years of the Noise at Work Regulations.

Forty-six delegates gathered at the Chamberlain Hotel in Birmingham and were presented with a broad spectrum of views from the Health and Safety Executive and from industrial, legal and health practitioners' perspectives.

Dr Peter Graham, Head of the Health Directorate at the Health and Safety Executive gave the keynote address. He reviewed the circumstances leading to the creation of the Noise at Work Regulations and went on to talk about their implementation, enforcement and impact on industry in the UK. He suggested that the level of detailed knowledge of the Regulations could usually be scaled by the size of the company involved, being generally poorest in the smaller companies.

Recent statistical surveys undertaken by the HSE, details of which were subsequently presented by Trevor Benn of the HSE Statistical Unit, showed that the average cost of the Regulations to industry was approximately £35 per employee. These surveys also indicated that there are currently almost 1.3 million workers in the UK who are exposed to high levels of noise, exceeding the first action level, and that of these, 10% were likely to suffer significant long term hearing problems.

Iain McAlastair, a solicitor with Davies Wallis Foyster and specialising in Personal Injury Litigation, later presented supporting anecdotal evidence for the increase in awareness by employees of the NAWR's, and he high-

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lighted the modest levels of compensation allowed for under current DSS legislation. Currently, a 50 dB reduction in hearing had to be demonstrated in the 1 kHz, 2 kHz and 4 kHz octave bands, to achieve the full disability pension, and usually, legal costs significantly outweighed any eventual claim settlement fee.

Dr Graham said that the HSE have no current plans to revise the regulations themselves, but that they do propose to revise the guidance on the required knowledge and training of the appointed Noise Competent Person. This issue was further addressed by David Bull, who presented an overview of the Institute's training scheme for work-based competency, emphasising the practical hands-on approach adopted for this training. This approach was enthusiastically recommended by several of the delegates who had received their initial introduction to acoustics through David's course.

As part of the *Good Health is Good Business* initiative, renewed emphasis was to be placed by the HSE upon the correct selection and use of hearing protection systems. Dr Graham also announced two research proposals that the HSE were aiming to launch shortly, one to evaluate the effectiveness of the NAW Regulations, the other to investigate hearing loss and tinnitus.

Rosie Hayes of Hear and There subsequently re-emphasised the need for the correct selection and use of hearing protection devices, when she presented the results of practical experiments undertaken by herself, and of similar research undertaken in both the US and Germany. This work demonstrated the real world levels of attenuation and protection provided by various popular hearing protection devices and compared these measurements with the stated manufacturers performance as measured in a laboratory. Rosie went on to highlight the rapid absorption of the equivalent daily noise dose achieved by someone removing their hearing protection for even short periods. Finally, she raised whether there was a need to review how the protection data is presented and how a hearing protection device is selected, to allow both comfort and communication at the same time as achieving maximum protection.

Dr Graham completed his review by stressing the HSE's long term aim of further reductions of the levels of noise in industry. He expressed the hope of seeing noise reduction at source by the continued development of quieter machinery and the extension of robotic or remote technology for those processes where noise generation was unavoidable.

Joe Saxton of the Royal National Institute for the Deaf questioned the apparent success of the Regulations and wondered if the improvements seen had been because of the decline of the heavy engineering industry, which had been seen traditionally as a major source of hearing disablement. The RNID are now very concerned for employees working in call centres who are using headsets for long periods, particularly with the volume level turned up high to overcome background noise problems in many adapted rather than purpose built buildings. Joe also raised the need for employee 'baselineing', suggesting that employees' hearing should be

tested before they join a company, so that any claim or assessment of hearing damage can be attributed to an employment period and a specific employer.

Simon Kahn of Bits & Pieces expanded upon the difficulties associated with this, where particularly in his experience, musicians tended to be part-time members of a number of orchestras, and where much time was spent practising. Discussion also revolved around an employer having no control over how the period of 'not working' was spent. The problems of the 'noise' created being the 'end product', and the difficulty claimed by many musicians of not being able to use hearing protection in such circumstances, because of the colouration effects of different levels of attenuation at different frequencies.

Tom Chambers of Hazlewood Foods presented an employer's view of the Regulations, stressing the duties made upon both employers and employees and how these were discharged by a large industrial company. Tom highlighted how Hazlewood had progressively improved its performance in this area by learning from practical experience, and several of those learning experiences were refreshingly presented.

Dr Deepak Prasher of University College London, brought events to a close by looking at the side effects, particularly the non-auditory effects, of hearing disability, or as he pointed out the politically correct phrase is now 'hearing activity limitation'.

These side effects tend to start with sleep disturbance, leading to a lack of attention, increased levels of annoyance, increased stress levels and stress reactions which can all lead to cardio-vascular problems. Each of these has ramifications for both the sufferer and for their immediate family and colleagues. Deepak went on to say that recent advances in medical and acoustic research are enabling hearing performance to be measured very accurately by inserting a tiny microphone and a noise source into the ear canal and measuring the reflected sound. It is hoped that these measurements will allow the susceptibility of a subject to hearing damage to be determined. A disturbing result of these measurements would appear to be that damage is being sustained at lower noise doses than previously thought. Much interest is anticipated when this work is published.

A visit to a substantial leisure development, which is to house an eight screen cinema above a night club, and be surrounded by a number of theme bars and restaurants, with this whole development fronting onto a major road and with a multi-storey car park behind, followed. Phillip Dunbavin of Phillip Dunbavin Associates was responsible for the acoustic design of the development and is supervising the construction to ensure that the client's stringent noise requirements are met. This provided a fascinating end to an interesting and enjoyable day.

And the answer to the question? The consensus view was that things have definitely improved in the ten years since the Noise at Work Regulations were first enacted. How much of the improvement is due to the regulations is open to much discussion. Hopefully the research work planned by the HSE will eventually tell us more definitely!

Jon Richards AMIOA ♦

MEETING NOTICE

One-Day Meeting

(Organised by the Building Acoustics Group)

THE ACOUSTIC DESIGN OF CINEMAS AND LARGE LEISURE COMPLEXES

Wednesday 19 January 2000

National Film Theatre, London

Programme

- 11.00 Registration & coffee
- 11.30 The IMAX Cinema, Waterloo, London - an acoustic challenge!
Peter Henson & J G Charles, Bickerdike Allen Partners
- 12.00 A power-flow approach to the assessment of base-isolated buildings
James P Talbot, Cambridge University Engineering Dept
- 12.30 Lunch
- 1.30 Lightweight cinema wall design
Jonathon Cherry, British Gypsum
- 2.00 The acoustic design of the Spouters Corner Multiplex
Charles Bladon, Hann Tucker Associates
- 2.30 Cinema design: the Silencer of the Lambs or The Nightmare on Elm Street?
Alan Saunders, Alan Saunders Associates
- 3.00 Tea
- 3.30 Some experiences with resilient ties in dry wall constructions
Ian Thompson, Arup Acoustics, Cambridge
- 4.00 A discussion of measured sound insulation values for a variety of auditorium wall constructions
Robert Adnitt, Cole Jarman Associates

A tour of the IMAX Cinema has been arranged for 9.30am. This tour is limited to 20 delegates. Please indicate below if you wish to attend, places will be allocated to the first registrations received.

Cinema Acoustics - Wednesday 19 January 2000

Name:

Organisation:

Address:

Tel:

Fax:

email:

Please register me as a delegate. I enclose a cheque/ credit card details/ purchase order number for the delegate fee. ☐ Members £95 + VAT £111.63 ☐ Non-Members £125 + VAT £146.88

☐ I wish to attend the IMAX Cinema tour

I cannot attend the meeting. Please send me a copy of the proceedings ☐ £20.00 Members ☐ £25.00 Non Members

Institute of Acoustics, 77A St Peter's Street, St Albans, Herts AL1 3BN
Tel 01727 848195 Fax 01727 850553 email ioa@ioa.org.uk Registered Charity No 267026

MEETING NOTICE

One-Day Meeting

(Organised by the Electroacoustics and Speech Groups)

SPEECH INTELLIGIBILITY

Thursday 17 February 2000

Church House Conference Centre, London

Programme

- 09.00 Registration and coffee
- 10.00 Overview of speech intelligibility • *Peter Barnett, AMS Acoustics*
- 10.30 Coloration and speech perception • *Antony J Watkins, Reading University*
- 11.00 Coffee
- 11.30 Intelligibility vs. quality in objective speech quality assessment • *Mike Hollier, BT Labs*
- 12.00 Speech intelligibility – an audiological perspective • *David Canning, City University*
- 12.30 Modelling confusions in aircraft call-signs • *Stephen Cox, University of East Anglia*
- 1.00 Lunch
- 2.00 Speech intelligibility in classrooms • *Sharon Airey, Heriot Watt University*
- 2.30 Speech intelligibility in arena and stadia • *Rajesh Patel, Arup Acoustics*
- 3.00 Tea
- 3.30 Objective speech intelligibility testing of sound systems • *Peter Mapp, Peter Mapp Acoustics*
- 4.00 Subjective speech intelligibility in practice • *Helen Goddard, AMS Acoustics*
- 4.30 Proposals for a revised subjective speech intelligibility testing method • *Peter Barnett, AMS Acoustics*
- 5.00 Close of meeting

Technical Programme:

Electroacoustics Group, Peter Barnett & Speech & Hearing Group, Stephen Cox

Speech Intelligibility - Thursday 17 February 2000

Name:

Organisation:

Address:

Tel:

Fax:

email:

Please register me as a delegate. I enclose a cheque/ credit card details/ purchase order number for the delegate fee.

☐ Members £95 + VAT £111.63 ☐ Non-Members £125 + VAT £146.88

I cannot attend the meeting. Please send me a copy of the proceedings ☐ £20.00 Members

☐ £25.00 Non-Members

Institute of Acoustics, 77A St Peter's Street, St Albans, Herts AL1 3BN
Tel 01727 848195 Fax 01727 850553 email ioa@ioa.org.uk Registered Charity No 267026

MEMBERSHIP

The following were elected to the grades shown at the Council meeting on 14 October 1999

Fellow

Ainslie, M A
Leighton, T G

Member

Anakwue, P M
Curson, T A
Dupere, I D J
Ellicott, G C
Fogarty, B
Gosling, S J
Hall, J A
Hanley, P
Harris, G J
Hill, H J
Hooker, S D
Jefferson, K M
Kellett, P
Ku, C Y
Law, R
Lockwood, E S
Lynch, T N
McManus, B
Monk, S A
Ng, K W
Peckham, M R
Philpison, P J
Phillips, S M
Sendall, P
Stanworth, I K
Wastell, K
White, A
Wildfire, C E

Associate Member

Allen, C D
Andrews, J
Arnold, M
Ashe, C
Atkinson, D J
Barker, G E
Basnett, A
Boaden, D J
Bokor, S
Cain, A T
Cannings, S M
Canwell, P
Carley, P G
Colburn, S
Cope, A P
Cushing, A M
Dangerfield, N
Davies, K T
Davison, P J
Dommatt, S H
Donnelly, E J
East, S J
Flynn, G W
Francis, K I
Furey, B F
Gayler, K J
Geoghegan, J
Gill, A M
Glen, R L
Gould, A J
Hale, D J
Hale, R A J

Hill, M G
Jackson, P
John, A S
Jones, S D
Kelly, M G
King, R A
Lauezzari, M C
Lee, D M
Letley, S P
Magee, B
Mangan, K T P
McKeown, E P
Meers, S D
Michon, A
Miller, G S
Money, L E
Morrissey, H S
Nakiwala-Muwonge, S
Needham, E
Ng, W T
Norman, L K
Norris, H
O'Brien, G
O'Kelly, G
O'Shea, D
Parkes, P
Pearce, R N
Pennington, S J
Pilliner, N J
Plaice, G A
Pollard, A
Quint, G A
Ridpath, J

Rimington, A F
Scullion, K M
Shellard, N T
Shields, P J
Smith, R
Smith, R G
Songer, H J
Stephenson, S J
Stevenson, G P
Storey, R C D
Taylor, J S
Thomas, S P
Thompson, H S
Thrower, M
Wallbank, I J
Waters, S A
Weatherhogg, K
Williams, F
Willmott, T
Wilson, P J
Woolnough, L
Worth, K D
Wyatt, A J

Associate

Kennedy, J W C
Parker, G

Student

Chittock, C J
McCordick, A
Van Buuren, G L

The following were elected to the grades shown at the Council meeting on 25 November 1999

Member

Curd, T
Day, C
Dewen, T
Gibbs, T J
Hughes, G
Kang, J
Marsh, D W

Phillips, B
Reid, F M C
Silva, E

Associate Member

Evenden, E
Griffiths, K F
Groves, C

Hornby, G
Lawson, S J
Lee, A S Y
McDaid, R
Richardson, M J
Timmins, G J
Trew, D C
Vepers, A D

Waites, E L

Student

Koundouras, M
Skinner, C J

For reasons of space the Institute Diary 2000 has been moved to the back page of this issue of the Bulletin.

EDUCATION

Certificate of Competence in Environmental Noise Measurement

The following were successful in the October 1999 examination

Bell College Brown, A J	Marshall, R J Orchard, N Rowlands, D K	Staples, J	Shuttleworth, S K Summers, T J	NESCOT Adderson, K J Dnakoya, M D Griffiths, D T Heppell, J M McGawley, S J Newham, K J Weald, R P
Birmingham Bourne, G D Lavender, M Lo Presti, C Payne, J M Wilkes, D J Williams, S J	Sanders, R K Colchester Boyles, S J Harris, R Hayes, J E Heath, T D Maddock, P Manchester, L J	Derby Harrison, S James, A T Lloyd, S G Smith, L J	Liverpool Allison, J D Hanlon, S Horne, M J Kells, R A Moorby, A E Moncada, A Salisbury, C S Webb, J E	Newcastle Harris, R W Patterson, C M Smith, A J
Bristol Crooks, A R Cwiero, P	Murfitt, J Peters, J	Leeds Baddeley, K Croasdale, M Hodson, I D Morrison, J S Nicholson, S L		

Certificate of Competence in Workplace Noise Assessment

The following were successful in the October 1999 examination

Bristol Martin, C J Richardson, D G Sherwood, E A G	EEF Sheffield Barraclough, M Beard, T Bennett, D Boyd, K M Hemmings, S Wilde, M	Newcastle Briggs, R N Charlton, A K Glorstad, B Hansen, A Henderson, F Oliver, P W Ringstad, H P Runge, P J	Strathclyde Allan, G S Hutchinson, C Jackson, R Macgillivray, L McFarlane, P McKinlay, D K Wilson, S A Yates, A
			Ulster Healy, T O'Donoghue, S P Owens, M G Roche, C Ryan, T Stack, E

INSTITUTE REGISTER 1999/2000

Advertisements Errata

Due to an administrative error, in the Institute Register 1999/2000, the telephone number for Dynamic Structures & Systems Ltd was printed incorrectly in their advertisement for 'RAYNOISE, the program for geometrical acoustics in architecture, industrial and environmental applications'. The correct number is 0114 282 3141.

The address and telephone numbers published in the advertisement on page 14 for Acoustic GRG Products are incorrect and should read: Acoustic GRG Products, RPG Diffusers, Lower Wall Road, West Hythe, Kent CT21 4NN Tel: 01303 230944 Fax: 01303 230961. Any inconvenience is regretted.

ENGINEERING COUNCIL QUARTERLY

ARTICLE – OCTOBER 1999

Malcolm Shirley

Until now I have studiously managed to avoid the millennium fever that is sweeping the country – especially the most virulent 'new millennium, new beginning' strain of the disease! Somehow though, I now find myself succumbing and beginning to warm to such sentiments. Not so much because of the millennium itself, but because, at last, the Engineering Council has completed the comprehensive Activity Review that has dominated its attentions during 1999 and genuinely appears to be on the threshold of a new age.

I am well aware that similar optimistic claims have been made before, both by and for the Council. This time, though, I think there are sound reasons for believing it is the real thing and not just another false dawn. After a lengthy period of introspection, we are finally in a position to start looking outwards and getting on with the job we were set up to do – promoting and regulating the engineering profession effectively.

At the end of September, the Engineering Council Senate was presented with plans for a radical change in direction when it received the *Activity Review Implementation Report*. The Report is the result of a year-long profession-wide evaluation of the Council's core activities, aimed at assessing how the Council can better represent the interests of its various stakeholders principally individual engineers, Institutions and engineering industry. Allied to the existing strategy document *Engineering 2005*, it maps out the way forward for the Council and the profession into the next century.

The main thrust of the Report is that the Council should seek to pass on mature, well-established tasks to other organisations that are equally well or better equipped to run them successfully. This will create resource 'headroom' that the Council can then use to take on new tasks, ideally time-limited and cost neutral – that it believes will help move the profession forward more quickly and more effectively. It will also allow us to tailor our activities better, in order to benefit more directly the 280,000 professional engineers and technicians on our national register.

So how will the recommendations of the Report translate into action? Well, we are already working on one of them – a major new campaign, to be launched next year, aimed at promoting the benefits to companies of employing registered engineers and Institution members. This should benefit professional engineers directly by raising awareness of their value to employers and, ultimately, providing them with enhanced career opportunities, prospects and status. The 'end game' aim is to persuade employers to insist on Institution membership and registered status when recruiting engineer employ-

ees. We recognise fully the size of this task but believe that it is achievable.

We are also acting on the Report's recommendation that we should continue to work ever more closely with the Institutions to secure maximum benefits for our respective customers – members and registrants. Our collaborative work on implementing the third edition of *Standards and Routes to Registration (SARTOR)*, is a good example of this. Developed and agreed by the profession for the profession, SARTOR is the engine for maintaining and raising standards and of ensuring that the profession produces engineers who match precisely the needs of industry. Employers are demanding professional engineers and technicians with a broad range of different skills – some with advanced theoretical and analytical skills and others with more practical, applications-oriented skills. The implementation of the new SARTOR will, over time, ensure that the profession meets this demand.

Adopting the recommendations of the Activity Review Report and re-focussing our activities in the way it proposes reflects the Council's commitment to being more flexible and proactive in responding to its customer needs – and I am pleased to say that registrants are already reaping the benefits. Greater efficiency and some staff rationalisation has already given us net cost savings of more than £100,000 per year, allowing us to freeze registration fees for the year 2000. There will undoubtedly be further savings to come as we implement fully the recommendations of the Activity Review.

I believe we have reached an important milestone. We now have a vision for the engineering profession that has been created by the whole profession and seeks to foster the best interests of all within it. After more than a year of consultation, the Activity Review Report is now being implemented and *Engineering 2005* will be ready for launch as planned on 1 January 2000. The shared vision of the way forward, created and owned by the Engineering Council and its partner engineering Institutions, provides a platform to inspire and direct the longer-term future of the profession.

We are understandably very excited by our plans for the future and want to involve all registrants in them. So we are using the latest technology to communicate on a direct but cost-effective basis with registrants through a new, interactive web site at www.engineering2005.org.

The site presents an imaginative and entertaining visual interpretation of the Strategy, *Engineering 2005*, and will bring registrants bang up to date with what is being proposed. Because it is interactive, it will also allow them to comment on the Strategy and will give each and every

one of them the opportunity to make their voice heard. The site has been running since 7 October and will remain open until December, after which all comments received will be reviewed and, where appropriate, fed into the final draft of the Strategy before it goes to Senate for endorsement at its December meeting.

Behind all the hype, there is no doubt that the year 2000 really does represent a landmark for the world. It is a time to look back, certainly; but, more importantly, it is a time to look forward. I am confident that all the hard work done by the Engineering Council and its partner Institutions during the final year of this millennium – and the firm foundations laid – puts us in excellent shape to look forward with confidence to the next.

Malcolm Shirley is Director General of the Engineering Council

New Chartered Engineers

Howard Gwatkin

Howard's interest in acoustics was sparked by a final year module during his Mechanical Engineering degree at Hatfield Polytechnic in 1980. His career in the subject took off when he joined the consultancy firm Bickerdike Allen Partners in 1985.

At BAP, Howard concentrated on acoustics relating to buildings. In 1986, he completed his MSc with a thesis on the directionality of impulse sources in relation to their use in assessing conditions on auditorium platforms.

Howard took up the challenge of an overseas post with Arup Acoustics Hong Kong in 1994, and worked primarily on the construction phase of the Chek Lap Kok airport, and the new mass transit rail link to the airport.

Moving on to 1997, the Gwatkin family now live in Sydney, where Howard works for RFA Acoustic Design on a number of large building projects, including airport terminals, landmark office and hotel/apartment blocks and major sporting venues currently under construction for the year 2000.

Paul Malpas

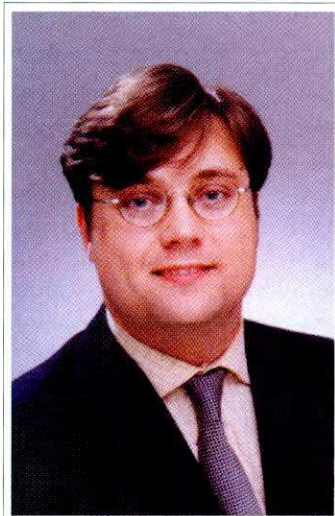
Paul graduated from the University of Salford's Department of Applied Acoustics in 1990 with a BEng in Electroacoustics. He was motivated to the course by his interests in physics, music and the aural environment rather than by any specific career intentions. A developing interest in architectural space and an interim year placement at WS Atkins focussed Paul on acoustical consultancy.

After graduation, he joined Arup Acoustics in the Lon-

don office as an Assistant Acoustic Consultant. The first five years were spent gaining a foundation in architectural engineering and acoustical design, while developing an expertise in computer and scale modelling.

Later, as an Acoustic Consultant, Paul used his electro-acoustic foundation to manage the design, specification and commissioning of a number of public address, sound reinforcement and audio-visual installations. As part of the line-wide acoustic consultancy teams for the Jubilee Line Extension in London and for the Lantau & Airport Line in Hong Kong, Paul developed particular experience in achieving speech intelligibility in transportation buildings.

His time at Arup Acoustics has included a secondment to Arup Communications and to Arup Acoustics offices in Hong Kong, Los Angeles and, currently, New York, where he is working on the installation phase of the public address at the new International Arrivals Terminal, JFK Airport and on the contract documentation of audio-visual systems for the Lamont-Doherty Earth Observatory.



Tommy N F Wan

Tommy was educated in Hong Kong Polytechnic with the discipline of mechanical engineering and finished the Associateship course in 1981. He was also awarded the Associateship in Noise & Vibration Control in 1984 by the same Polytechnic. His acoustic knowledge was further enhanced and acknowledged by the award of Master of Science (MSc) in Acoustics, Vibration & Noise Control from Heriot-Watt University in 1987 and Council of the Institute of Acoustics Prize for the top student on the MSc course in the academic year 1986/87.

After graduation he worked in Westco Air-conditioning Ltd for two years and Ryoden Electric Engineering Ltd for four years to acquire the solid foundation of mechanical ventilation and the building services knowledge. After leaving Ryoden in 1988, he joined Industrial Acoustics Co (HK) Ltd as a senior acoustic engineer. He was then promoted to Technical Manager in 1990 and to Vice President in 1995. Tommy has been a corporate member of IOA for more than 14 years.



STANDING COMMITTEES OF THE INSTITUTE

The Engineering Division Committee

Composition and Role

The Engineering Division was established twelve years ago, under the Chairmanship of former President Professor Peter Lord, with responsibility for the registration of members of the Institute as Chartered Engineers (CEng), in conjunction with the Institution of Mechanical Engineers (IMechE). This initiative was taken by Council as a service for those IOA members working in acoustical engineering who wished to become Chartered Engineers. The multidisciplinary nature of the Institute has always been seen as one of its strengths, with many members holding dual membership with organisations such as IoP, CIEH and RIBA.

The work of the Division is overseen by the Engineering Division Committee, with the administration of the registration procedures delegated to its Registration Sub-Committee.

The Chair of the Division, currently Professor Bob White, has a seat on Council under the Articles of Association of the Institute.

The terms of reference of the Committee are to promote engineering within the Institute and to advise Council on all engineering matters, to put forward members for registration with the Engineering Council and to act as a forum for co-ordinating the activities of IOA of particular interest to engineering.

Since the Division's inception, IOA members have been able to gain Chartered Engineer status via an affiliation with the IMechE. In 1995, the Institute was granted authority to register members in the grade of Incorporated Engineer (IEng) directly.

The Committee comprises not less than eight members, each of whom must be CEng or IEng. The President has an ex-officio seat. A member of IMechE sits on the Committee by invitation and also sits on the Registration Sub-Committee which organises the interviews of candidates for CEng and IEng. An Engineering Council Representative (EngCRep) also sits on the Committee. EngCReps are volunteer members of the thirty-seven nominated bodies who support the sharing of good practice by serving on the membership/registration committees of other institutions.

The work of the Division has been supported by a part-time officer in the Institute, Dennis Playle, CEng MIEE, who joined IOA in 1995 and assisted many members in gaining registration, including our first IEngs. Dennis retired in 1998, since when former President and Chairman of the Division Professor Peter Wheeler has been providing advice and support for the work of the Division, in registration interviews and, importantly, preparing for the quinquennial Engineering Council audit.

As a routine procedure, all new and upgrade mem-

bers' files are now reviewed by the Division and those members who may qualify for registration are contacted and offered advice on gaining CEng/IEng through the Institute.

Since the Division's inception, more than 100 IOA members have gained registration as CEng or IEng and a further 110 younger members have gained interim registration, pending their full registration after a further period of responsible experience in acoustical engineering employment. In total, more than five hundred IOA members hold full or interim registration as CEng or IEng, including those registered through other bodies such as IEE, ICE or RAeS.

Who Does the Work?

So much for the formalities and statistics. Like so many of the Institute's activities, the development of the Engineering Division has depended on the tireless efforts of a small group of individuals. Peter Lord established the Division and personally organised the interviews for engineers throughout the first five years. Since the beginning, Frank Shaw, of the IMechE Membership Committee, has acted as the IMechE representative for all of

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the Division's work, including all of the CEng interviews. Until the Institute moved into Agriculture House in 1993, Frank also hosted CEng interviews at the Sir Henry Royce Memorial Foundation, of which he is Chairman, near Towcester.

At the Institute's Twenty-Fifth Anniversary Conference this year, Ian Campbell, as President, formally acknowledged Frank's work for IOA with the gift of a camera. Frank, now in his eighty-sixth year, continues to serve IOA, although he says that he finds the climb from the branch line station at the bottom of Holywell Hill to the new headquarters somewhat more onerous than the comparatively gentle walk up to Agriculture House!

Our EngCREP, Mervyn Leach, of the Nuclear Engineers, has given the Institute valuable guidance and support over the past two years, providing advice on the development of procedures and processes for registration and other Engineering Council requirements.

The current members of the Engineering Division Committee are Richard Bines, Keith Broughton, Alex Burd, Alan Cummings, John Edwards, Colin English, Frank Irving, Ken Ratcliffe and Sue Tindal. Several of these members have given a considerable amount of their time to serve on the 100 plus CEng/IEng interviews held since 1987.

Sue Tindal has served on the Senate of the Engineering Council and the Institute is now represented on Senate by Peter Hills of the Institute of Engineering Designers.

The Committee is keen to recruit additional members willing to serve as assessors for CEng and IEng interviews and further information can be obtained from the Institute office.

Recent Developments

The IOA was visited by the Engineering Council audit panel in June and was granted a renewal of operation as a Nominated Body of the Engineering Council. However, there is more work to be done in developing new procedures for the implementation of SARTOR 3.

The third edition of SARTOR – *Standards and Routes to Registration* – was published in 1997. It is known throughout engineering departments in academia for requiring aspiring CEng candidates entering University after 1998 to take a four-year engineering degree rather than a three-year BEng (although a three-year degree with a top-up year is also accepted). IEng candidates are required to have taken a three-year course (or HND plus a one-year matching section), instead of the previous two-year HND.

The Engineering Council has also called for better educational intake standards for engineering degrees and it is envisaged that there will be a growth of new degree programmes aimed at IEng candidates, with a decline in the number of 'CEng' courses. Many engineering departments in the middle-ranking universities will see considerable change in their academic provision over the next few years as a result and it would seem that some closures are inevitable.

So how will SARTOR 3 affect IOA members seeking

registration as CEng or IEng?

In addition to the headline four-year degree news, SARTOR 3 also introduces requirements for enhanced professional review interviews for CEng/IEng candidates.

The new Professional Review Interview (PRI) procedures require that candidates demonstrate their professional development achievements against defined competencies in the areas of

- a) the acquisition and application of new engineering knowledge,
- b) the analysis and solution of engineering problems,
- c) technical, commercial and managerial leadership,
- d) communications and interpersonal skills and
- e) commitment to codes of professional conduct, health and safety and the environment.

All thirty-seven engineering institutions are implementing these new procedures in their interviews. This should lead to more structured interviews, with a clearly defined baseline criterion for levels of achievement for candidates. Our current CEng/IEng candidates have been provided with guidance for the preparation of their reports and Professor Wheeler is assisting them by reviewing their draft reports. Interviewers will need to be trained in these new procedures and this also is in hand.

Agreement has also been reached with IMechE for a simplified system of presenting early-career engineering training or experience in lieu of formal training for assessment.

Members seeking CEng registration who have already completed their engineering degrees are not required to meet the new 'four-year' SARTOR 3 rules, but they should obtain interim registration (Stage 1) now, in order to facilitate their future application for CEng. Similarly, candidates seeking IEng registration are urged to make their interim registration at this time, if possible.

The Engineering Council has also asked the Institute to consider whether it might have a role in the registration of Engineering Technicians (EngTech). EngTech candidates are expected, under SARTOR 3, to have a Higher National Certificate, Advanced GNVQ or similar qualification. It may be that our Certificate of Competence courses could serve as specialist training elements for candidates wishing to gain registration as EngTech in acoustical engineering.

Any member interested in EngTech registration, or who is aware of colleagues in their organisation who may be interested, is asked to contact the Institute office for further information.

An important factor in the evolution of SARTOR 3 is the shift within many of the engineering institutions (IMechE and IEE for example) in their CPD requirements from 'hours logged' to 'outcomes', based upon personal development needs identified by an individual, against the competencies criteria of SARTOR 3. It seems eminently sensible to ask engineer members to assess their personal development needs in the context of these competencies, and to address them, through a self development action plan. This is an area for our new Professional Development Committee.

The Engineering Council has recently completed a review of strategy involving a considerable slimming down of work on 'non-core' activities. There has been widespread acceptance of the generality of proposals by the institutions, which had been developed under the auspices of a joint Engineering Council/institutions working group. However, two proposals caused concern to many of the smaller institutions – a plan to charge for licensing and a proposal to change the electoral colleges for Senate. Both the Chairman of the Engineering Council and the Chief Executive were quick to express their view that the smaller and newer bodies were important to the development of the profession as they were often in emerging areas of engineering and at the forefront of new technologies. Although acoustics as a science was known to the Greeks, recent developments such as active noise and vibration control, auralisation in concert hall design and voice recognition may be said to place acoustical engineering among the leaders in new technologies.

Peter Wheeler FIOA

Any IOA member seeking further information about the work of the Division or wishing to pursue CEng/IEng registration is invited to contact the office (email: engineering.div@ioa.org.uk)

Membership Committee

Report of a Code of Conduct Case

Summary

In the summer of 1997, a complaint of a failure by a member to abide by the Institute's Code of Conduct was received and notified to the Membership Committee. That Committee formulated special procedures to handle this case, because the complaint related to the conduct of an Honorary Officer in the course of carrying out duties on behalf of the Institute. These procedures were approved by Council on 2 October 1997, following which an Investigating Tribunal comprising three senior members of the Institute was convened under the jurisdiction of the Membership Committee.

The Investigating Tribunal received the statements of case and defence from the parties concerned, and gave due consideration to the allegations which had been made. The Tribunal duly reported its findings and recommendations to the Membership Committee, which would assume the role of a Disciplinary Panel in the event that any aspect of the complaint were to be upheld.

The Tribunal concluded that the complainant's case had not been upheld and that his professional reputation had not been damaged either by the procedures followed or as a result of the totality of the actions of the Institute of Acoustics in this matter.

The Membership Committee recommended that Council should accept the Tribunal's findings, which Council did on 4 March 1999.

Further Recommendations Made by the Investigating Tribunal

Whilst being satisfied in this particular case that the spe-

cial procedures had enabled the complainant's specific allegations to be properly handled, the Tribunal recommended that a review should be undertaken of the process of handling complaints and grievances received by the Institute. This review should extend to cover the Institute's own actions as a body corporate and those of its officers, employees and voluntary servants.

Council has instructed the Membership Committee to prepare proposals for extending the scope of the Institute's Code of Conduct, in accordance with the Tribunal's recommendations.

On Behalf of Council

A J Jones FIOA, Honorary Secretary

Education Committee

New Course Announced

Certificate Course in the Management of Occupational Exposure to Hand Arm Vibration

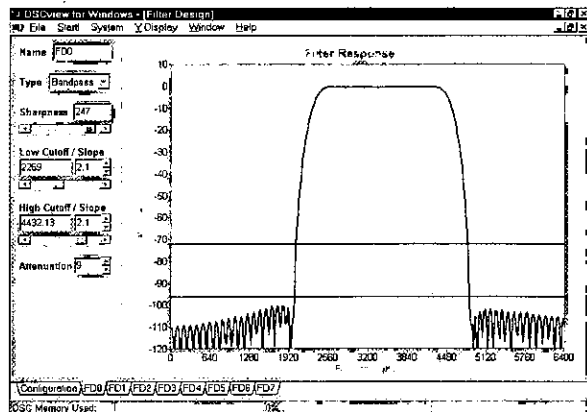
Last June the Measurement group of the IOA organised a very well attended one-day meeting on Hand Arm Vibration. The high level of interest in the meeting is a reflection of the increasing attention being given to the risk and health hazards of Hand Arm Vibration as the result of a major awareness campaign by the HSE in the UK and the imminent introduction of the Physical Agents Directive by the EU. At that meeting I made a brief appeal for interested practitioners in Hand Arm Vibration to help the Education Committee form a working party with a view to developing a short course in the management of Hand Arm Vibration. Following this appeal there were a significant number of offers of help and on the strength of this interest, a meeting was held at Leeds Metropolitan University on 8 September 1999.

This meeting was very positive in its support for a short course and the discussions led to the following conclusions:

1. The course should be five days.
2. The course should include theory, legislation and practical HAV measurement.
3. The course should be aimed at those likely to be responsible for enacting HAV management in the workplace.
4. An outline syllabus was discussed and agreed, following some minor restructuring.
5. The course should be assessed (written and practical examinations).
6. The course should be offered as soon as possible. The first suitable examination date that fits in with the other Institute short courses is 19 May 2000.
7. Any centre wishing to run the course would be required to demonstrate that the practical measurement within the course would be taught by experienced practitioners of HAV measurement. This was considered very important if the delivery of the practical content of the course is to be credible.

The meeting did not think it was necessary for the

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The iDSC 1816 board from Microstar Laboratories combines brick-wall anti-aliasing filters on each of 8 simultaneous analog inputs with 16-bit data acquisition all on one board at a throughput of 1.2M samples per second. It comes with DSCview included and drivers for DASyLab, LabVIEW, and HP VEE, as well as for Windows (NT, 98, 95) programming. With DSCview software on your PC, you can customize the filter characteristics for each channel, and download them to the iDSC board. Download DSCview from our Web site and check it out.

iDSC 1816: Data Acquisition, Spectral Analysis, and Aliasing

- 8 simultaneous inputs
- 16-bit resolution
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- Independent programmable filters
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- Sample rates up to 153.6k S/s per channel; 1.2M S/s per board
- PCI interface (log to disk at 1.2M S/s)

Data acquisition digitizes an analog signal by sampling it at discrete times, several times in each cycle, to produce a stream of numbers. Spectral analysis does the math on

these numbers, mostly using the fast Fourier transform, that breaks out the frequency components of the signal. And **aliasing** — high-frequency results folded into otherwise accurate data — **corrupts the results**.

The iDSC 1816 board takes out all aliasing from data acquisition. Guaranteed. Using the latest **analog** and **digital** components and proprietary algorithms, it implements onboard brick-wall filters. And that **makes spectral analysis reliable**.

Microstar Laboratories has produced a unique new board for the PCI bus. And it has applied its trademark on-board intelligence to make the board a must-have product for anyone doing serious data acquisition. The filters in the iDSC 1816 have variable cutoff frequencies — up to 61.44 kHz — and linear phase response. Each channel can have a different filter. And the board **requires no programming**.

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DAP 5200a: Real-time board for measurement and control of Noise and Vibration

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The new DAP 5200a/526 brings many more real-time data acquisition and control applications within the scope of Windows systems. Its onboard 300MHz processor increases the real-time processing power of the top end of the DAP line by a factor of

more than four. Real-time processing functions include smoothing, filtering, FFT, PID control, and responding to alarm conditions; the DAP 5200a also can scan high-speed data for trigger events in real time to capture pre-trigger as well as post-trigger data.

When real time means response in milliseconds, the message-driven, event-polling Windows user interface cannot work in real time. So, in that case, neither can programs running under Windows. For real-time performance from systems with a Windows user interface, work around this Windows limitation by using the on-board intelligence of a DAP directed by associated PC software from Microstar Laboratories.

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IOA to write its own text for the course. Individual centres would develop their own resources for teaching the programme but co-operation between centres would be encouraged.

It was thought that many of the traditional centres for IOA courses would look to bring in outside assistance for part of the programme so if you have expertise in the practical monitoring and management of Hand Arm Vibration and would like to be involved in the teaching of the short course, please let the Institute know and we will act as matchmakers in bringing educationalists and practitioners together.

The same applies to educational centres, if you would like to run the course but lack expertise in some areas then please get in contact and we will try to help.

In addition to promoting the course through the IOA Bulletin, we are announcing the new course in all the major Health and Safety Journals and are looking at other means of marketing the course.

If we are to stick to the planned date of May for the first presentation of the course, we need to have applications from interested centres by 31 January. This will allow the Advisory Board to vet and accredit centres in February which should give centres time to recruit and to prepare for the course in the following May.

If you are interested, what you should do next?

- Teaching Centres: request an application pack from the IOA office.
- Experienced HAV practitioners: let the office have your details and they will put you in contact with teaching centres.
- If you are interested in taking the course: let the Institute office have your details and they will pass on the information to accredited centres.

Outline of the Course

Title

Institute of Acoustics Certificate Course in the Management of Occupational Exposure to Hand Arm Vibration.

Aims

The aims of the course are two-fold: to enable course delegates to appreciate the nature of Hand Arm Vibration (HAV) hazards in the workplace and the need to protect employees from hand-arm vibration syndrome (HAVS); and to enable them to advise and assist employers to meet their legal duties regarding HAV, under relevant health and safety law in accordance with current guidance from the Health and Safety Executive.

Objectives

After completing the course, delegates should be able to:

- explain the requirements of current legislation;
- identify situations where HAV hazards exist and assess the risk;
- discuss basic techniques for control of vibration exposure and identify areas where vibration reduction is required;
- assess the effectiveness of vibration control measures;
- evaluate the daily vibration exposures of employees from information about measured vibration

More than meets the ear . . .

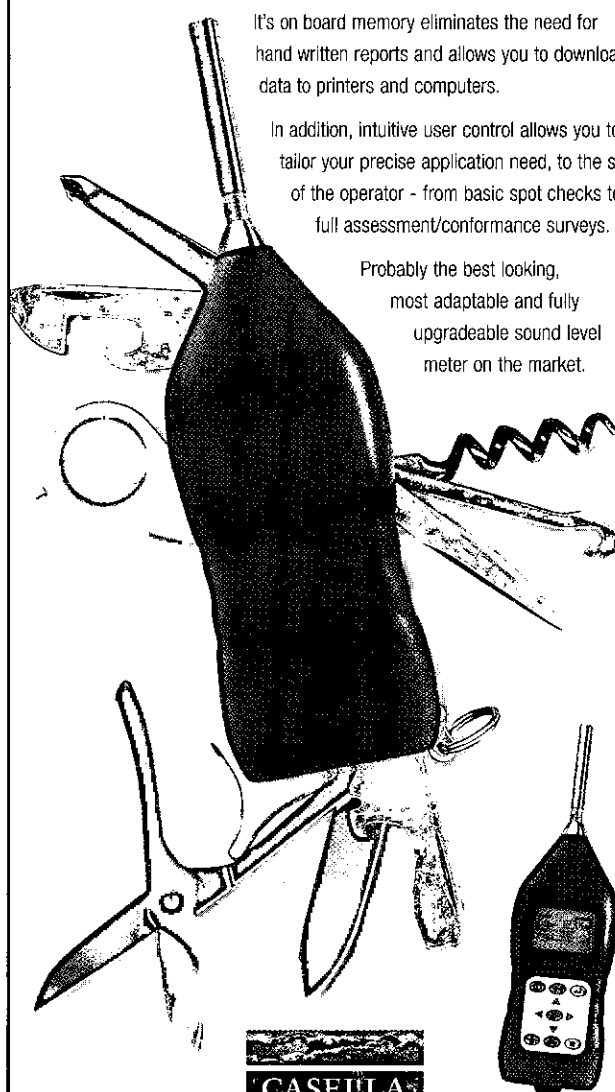
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This fully upgradeable ergonomic sound level meter, offers you complete choice and flexibility in both Type 1 and Type 2 variants which can be adapted to your own specific requirements. The choice of manual or automatic operation, and broadband or frequency analysis is available.

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Invest in a Sound future

magnitudes and work patterns; and explain the uses and limitations of personal protective equipment.

Syllabus

1. Basics of Vibration

Introduction to vibration
Continuous vibration and shock
Time averaging, rms, peak and peak-to-peak indices
Acceleration, velocity and displacement
Frequency and frequency weighting
Calculation of daily exposure

2. Health effects of HAV

Hand-arm vibration syndrome
Vascular component:
vibration induced white finger (VWF)
dose-effect relationship in standards, A(8)
Neurological component
Musculoskeletal component
Carpal tunnel syndrome
Requirements for reporting disease (RIDDOR 95)

3. Effects upon business

Lost time
Insurance premiums
Claims
Redeployment and retraining
Productivity

4. Legal Duties

Employers' duties
assessment of risk
control of exposure
selection of equipment
maintenance of equipment
information, instruction and training for employees
consultation with employees
selection and assessment of PPE
health surveillance
reporting occupational diseases.
Duties of Machinery manufacturers and suppliers.
Relevant H&S regulations
The Management of Health & Safety at Work Regulations 1992
The Provision and Use of Work Equipment Regulations 1998
The Personal Protective Equipment at Work Regulations 1992
The Workplace (Health, Safety & Welfare) Regulations 1992
The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995
The Safety Representatives and Safety Committees Regulations 1977
The Supply of Machinery (Safety) Regulations 1992 as amended by the Supply of Machinery (Safety) (Amendment) Regulations 1994

Proposed EU Physical Agents (Vibration) Directive

5. A Vibration Exposure Management Programme

Identification of hazard
Assessment of risk
Control Monitoring
Management of affected workers

Costs and benefits

5.1 Exposure Assessment

Evaluation of exposure and assessment of risk
Dose-response relationship for VWF
Determining vibration magnitudes:
manufacturers' guidance and emission data
use of vibration information
limitations of information (accuracy and applicability)
measurement of vibration
Determining exposure patterns and durations
Determining daily vibration exposure

5.2 Measurement of Vibration Magnitudes

The current standards (ISO 5349:1986, BS 6842:1987) and draft revisions (ISO/DIS 5349-1:1999 and ISO/DIS 5349-2:1999)
Instrumentation:

instruments available and standards for their specification (eg. ISO 8041)
transducers (mounting methods, single and triaxial arrangements, effect of mass, etc
sources of measurement artefact: d.c shifts, overloads, transducer movement, etc
use of mechanical filters
calibration

Sampling of activities for measurement

The limitations of accuracy, repeatability and applicability of measured vibration magnitudes

5.3 Control of Risk

Reducing vibration exposure
selection of process
selection and maintenance of tools and equipment
equipment modifications
reduction of exposure duration
Reducing risk by other means
blood circulation
PPE
grip and push forces
information and instructions to employees about risks
training in correct operations and risk control

5.4 Monitoring the effectiveness of a control programme

Regular review of risk assessments
Regular review of management actions and control measures
Health surveillance
management of health surveillance programme
questionnaires
clinical interview and medical examinations
objective testing
Management of affected workers
Mike Fillery FIOA, Chairman, Education Committee

EAA Symposium Architectural Acoustics

Madrid, 16–20 October 2000

Information at
<http://www.ia.csic.es/sea/index.html>

NOISE AND VIBRATION HSE SPECIALIST INSPECTORS

VACANCIES IN LEEDS AND EDINBURGH

Noise and Vibration Specialist Inspectors of the Health and Safety Executive (HSE) work from offices in Edinburgh, Leeds, Manchester, Birmingham, Cardiff, Luton, East Grinstead and at Bootle, Merseyside.

The job: You will assess the risk to health arising from occupational exposure to Noise, Hand-arm Vibration and Whole-body Vibration and advise on the adequacy of measures to prevent injury.

You will achieve this by inspecting industrial workplaces and reporting your opinion on factors such as the level of risk, the potential to reduce risk by engineering or management measures, and how the conditions you find compare with minimum legal requirements and HSE guidance. Your reports will guide decisions on enforcement action and you may be called upon to assist courts as expert witness.

There are opportunities to assist in the preparation of HSE guidance, development of European and International standards, and commissioning of research. You will be expected to liaise and consult widely with colleagues, industry, professional bodies and institutions across the world.

Qualifications and attributes: You will have a relevant degree or equivalent and the experience and technical competence sufficient to obtain Chartership or full membership of an appropriate professional body. However, personal qualities are as important as your technical ability. You must be able to defuse conflict, negotiate successfully, display sound judgement in a pressured environment, be able to work as a member of a team and adopt an influential and persuasive approach in order to achieve your objectives. You must also have a full driving licence valid in the UK.

Interested? Ring 0151 951 3366 for an application pack.

Completed applications must be submitted by 21 January 2000.



INVESTOR IN PEOPLE

HSE is committed to equality of opportunity. We aim to reflect the diversity of the community we protect and therefore particularly encourage applications from minority ethnic groups and women as they are under-represented amongst our Inspectors.



Health & Safety
Executive

Reducing Risks - Protecting People

www.open.gov.uk/hse/hsehome.htm

Citation

1999 Rayleigh Medal

Dr George C Maling, Jr

George Maling began his undergraduate studies at Bowdoin College in Brunswick, Maine, transferring to the Massachusetts Institute of Technology with a major in electrical engineering. In 1954 he received an AB degree in Physics from Bowdoin, as well as both BS and MS degrees in Electrical Engineering from MIT. Following this, George spent some time in industry researching noise radiated by fans and blowers and then two years in the US Army working on radar systems. He returned to MIT and received the professional degree of Electrical Engineer in 1958. He became one of Uno Ingard's doctoral students, and his PhD in Physics was awarded in 1963 for a study of acoustic wave propagation and instabilities in inhomogeneous media. He also worked on several other projects with Professor Ingard ranging from atmospheric acoustics and flow noise to heat-maintained oscillations and measurements of temperature fluctuations in shock waves. George's wave propagation studies, particularly in respect of atmospheric turbulence, made early and important contributions to the understanding of sound propagation outdoors.

After leaving MIT, George established his own consulting firm which was involved with several projects with International Business Machines Corporation. From 1965 to 1992 Dr Maling worked directly for IBM as a full-time noise control specialist where he was responsible for noise control of computers and business equipment, techniques for determining noise emission, and standards. Since his first published paper in 1955, in which he presented a new approach to determining the noise output of small centrifugal fans, George's special research interest has been the noise generation of air-moving devices. For example, a test apparatus he designed and built in the early 1960s to expedite the acoustical testing of small air-moving devices has since become an industry, national and international standard. Indeed, George's research on discrete frequency sources has been the mainstay of the development of several national and international standards for sound power level measurements of various types of sound source under different conditions. Dr Maling is recognized worldwide as an authority on the measurement and control of the noise emitted by air-moving devices, and his fundamental contributions have significantly advanced the understanding of the mechanisms of sound power generation by noise sources.

Dr Maling also has had a significant influence in the field of digital signal processing, having recognized the importance of the Fast Fourier Transform when it was rediscovered by Cooley and Tukey in 1965. George worked intensively during the following decade to bring the FFT algorithm into widespread use for many applications involving acoustical measurements and noise control.



George is a member of the (US) National Academy of Engineering and a Fellow of several Professional Societies, including the Institute of Electrical and Electronics Engineers, the Acoustical Society of America, the American Association for the Advancement of Science, and the Audio Engineering Society. He has served the Acoustical Society of America on their Medals and Awards Committee, their Executive Council, and as Associate Editor of JASA. He was a founder of the Institute of Noise Control Engineering of the USA in 1971, having held several posts including President and is currently the Managing Director. George also founded the INCE/USA newsletter Noise/News and now serves as Managing Editor of the respected quarterly news magazine Noise/News International. This is published by INCE/USA and International-INCE which was formed in 1974. He is President of the INCE Foundation, a Director of the Noise Control Foundation and a Vice President of I-INCE.

Dr Maling's key contributions to research and the development of noise control engineering as an important acoustical subject in its own right, are reflected in his some 80 scientific papers, technical articles and proceedings, the several patents to his name and the many honours he has received. Among the latter, he was awarded the Silver Medal of the Acoustical Society of America in 1992.

The Institute of Acoustics is delighted to award the Rayleigh Medal in 1999 to Dr George C Maling Jr for his outstanding contributions to acoustics, in particular for his leadership in advancing and disseminating the discipline of noise control engineering.