ST. CECILA'S CONCERT HALL, EDINBURGH

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1 INTRODUCTION

St. Cecilia's Hall is located within the Edinburgh Old Town, UNESCO World Heritage Site, approximately 130m from The Royal Mile. The building houses Scotland's oldest purpose-built concert hall, the second oldest in the British Isles, after the Holywell Music Room in Oxford, as well as the University of Edinburgh's, Music Museum which displays one of the world's most outstanding collection of "early" musical instruments[1], including many harpsicords, some of which are playable. St Cecilia's is claimed to be the, "only venue in the world where it is possible to regularly hear 18th-century music being played on 18th-century instruments in an 18th-century setting"[2]. However, despite this, the concert hall appears virtually unknown among the acoustics community.

Commissioned by the Edinburgh Musical Society around 1760 as a private music performance room and designed by the celebrated Scottish architect Robert Mylne; whose architectural designs frequently incorporated the elliptical form, the concert hall's elliptical shape, with double domed roof and glass "cupola" is everything an acoustician designing a concert hall today would avoid.

St Cecilia's Hall, named after the patron saint of music has had a turbulent history since its opening night in 1763, not only influenced by the acoustics within the hall, where many alterations were made in the 20 years after opening but by dramatic physical and societal changes in the surrounding area of Edinburgh[3], many of which are still being tackled today. This, as well as major shifts in the architectural requirements for performance venues due to the new music being played, changes in audience composition and expectations and competition from new venues, all impacted on the economic viability of the project. The result being that the last concert at St. Cecilia's was held in 1798, just 35 years after opening. The intervening years saw the concert hall's elliptical shape torn down and the concert hall converted from Baptist church, to Masonic Hall, to School, to Dance Hall and finally in 1968 the reinstatement of its original shape, if not its original acoustic and a return to the use of the hall for music by its new owners, The University of Edinburgh.

In 2011 as part of the renovation of the venue by the University, New Acoustics had the pleasure of picking up where our former colleagues who worked on the project in the 1960s left off. With the aid of new research undertaken into the history of the building[4,5], as well as modern acoustic measurement and modelling techniques it was possible to more thoroughly investigate the impact of the acoustic changes made in the concert hall during its 35 years as a working venue as well as those proposed in the restoration. Auralisation of the venue enabled presentation of the sounds of the past and possible futures to the contemporary audience and other vital stakeholders. This led to a design for the acoustics which not only aims to provide an excellent space for the "early" music performances within the hall, suitable environmental noise reduction and acoustic design of the ventilation system but to also increase access to the historic instruments for performance, study and recording in a contemporaneous setting. In addition, and as a result of this, the overarching aim is to provide a functional modern and flexible space which, this time round, will remain economically viable for the foreseeable future; inspiring generations to come.

This paper provides an overview of this work, design constraints as well as reporting the post-occupancy feedback in the aim of encouraging future work and research at St. Cecilia's Hall.

2 HISTORY

The story of St. Cecilia's Hall is a very long but fascinating one. The summary provided here is only a snippet of the full history and we recommend that anyone with an interest in the acoustics of the building read the excellent works by Joe Rock[4] and Jane Blackie[3] as well as the Conservation Plan produced by Simpson & Brown Architects[5].

2.1 Heyday & Decline (1760-1801)

The Edinburgh Musical Society formed in the early 1700's and held private concerts for members (wealthy gentlemen and aristocrats) in the upper rooms of St Mary's Chapel, Niddry's Wynd, Edinburgh until 1752 when they began to raise funds for "a new room"[3]. Robert Mylne was chosen to design the building and in 1761 building works began on his elliptical shaped concert hall. Before the doors opened there were some negative comments from architectural rivals, *"… I saw the new Concert Room there, which has an ugly squat oister like look and will certainly murder the music totally"*[4] but the feedback on the acoustics following the opening of the hall in December 1763 seemed in the main positive, *"The hall… was an exact oval, having a concave elliptical ceiling, and was remarkable for the clear and perfect conveyance of sound without responding echoes"*[3]. However, it was not long before the acoustics of the oval started to cause a few problems and it was in only 1764 when the Musical Society met and discussed "raising the roof". From that day on a number of changes were made to improve the acoustics including: the regular hire of a carpet to cover the "great window", upholstering of the timber benches, shutters, screens, panelling and finally, around 1774, the raising of the roof and the squaring off of the south end of the oval. The Assembly Rooms, including a concert hall, were built in the "New Town" of Edinburgh in 1787 and this along with the construction of the "South bridge" for which some of St. Cecilia's Hall had to be demolished and the inexorable shift of the wealthy folk of Edinburgh to the North of the City, led to the end of St. Cecilia's as a concert hall with the last concert being held in 1798.

2.2 A Saint Silenced (1801-1958)

The hall was sold firstly to the Baptist Church and then to the Freemasons. During this period the oval shape of the hall was removed entirely. After a period as a school and being broken up into shops, pubs and warehouse the hall eventually became a Ballroom in 1933. In 1959, Miss Cairns the proprietor who had done some works to restore the building to a concert hall sold St. Cecilia's Hall to the University of Edinburgh who she believed would safeguard the building[3].

2.3 Restoration (1958 - 1968)

The University of Edinburgh required a building to house its expanding musical instrument collection including the Raymond Russell collection of early keyboard instruments and decided to purchase St. Cecilia's Hall. Ian Lindsay was the architect tasked with working alongside the Reid Professor of Music, Sidney Newman to provide the gallery space required for the instruments but also to revive the concert hall to provide "a live museum of music"[3]. The oval concert hall was reconstructed with an opening concert in June 1968. It was judged as an accurate representation of the original use of the building[5], although some elements of the original were not reproduced and others have commented that the alterations made by the Musical Society in the early years to "correct the acoustics", should have been in included in 1968. Although not documented in the historical records to date, we have information from a former colleague who worked at Sandy Brown Associates in the early 1970s that they were engaged as acousticians at St. Cecilia's Hall around 1971-72. Although the records of any testing or prediction calculations have long since been lost we are led to believe that this is when acoustic plaster (Audex) was installed into the double domes[6]. This may well have occurred after the retirement and subsequent sad death of Professor Newman, so whether he knew or approved of the measures we cannot confirm. However, for such action to have been taken we can be confident that someone was not happy with the 1968 acoustic and that the long reverberation time and possibly the focusing effects caused by the dome were to blame. From 1972 till the early 2000s the hall continued to be used for concerts and built up a very dedicated group of "friends" who helped to preserve the hall and retain it in active use. The building was listed in 1970.

2.4 "Let the Building Sing Again" (2003 - 2017)

In 2007 the University engaged Simpson and Brown Architects to undertake a detailed Conservation Study. This work was the start of the latest reincarnation of St. Cecilia's Hall cumulating in the restoration completed in 2017, bringing together under one roof the University of Edinburgh's musical instrument collection and providing a world class hall for the instruments to be played, studied and recorded. As Eilidh Henderson the project architect so succinctly put it when interviewed in 2017, the idea was to, "let the building sing again"[7].

3 FORM

The concert hall at St Cecilia's is often referred to as a "concert room"[3]. At the time it was built, in 1763, music was generally played in three major settings: churches, opera halls or private salons. The concert hall at St. Cecilia's was very much constructed in the form of a salon i.e. as a "room" for performances for, and by members of, the Musical Society and retains this intimate atmosphere today. Designed for small groups of players (typically 3–5 musicians), and with a volume of just less than 1000m^3 (after raising of the roof), it is questionable whether the hall should be categorised as, or even compared with, other chamber music halls such as those described in recent concert hall studies[8,9]. The most obvious comparison with St. Cecilia's is the Holywell Music Room in Oxford, built 15 years earlier, although it is more similar in volume and capacity (although not in shape) to The Wiener Saal of the Mozart Foundation in Salzburg at 1070m^3 with circa 200 seats which opened almost 150 years later[9].

The oval plan shape of the hall and elliptical double domed ceiling can be seen in the detailed drawings undertaken before reconstruction of the hall in the 1960s, shown in Figure 1 (unfortunately no drawings from the original design have been found to date). By the middle of the 17th century knowledge of the acoustical effects of curved spaces had been spreading and by 1792, 30 years after the opening of St Cecila's, the use of elliptical floor plans explicitly to enhance the low sound levels at the back rows of theatres was being recommmend[10]. Despite the obvious acoustic issues arising from use of concave surfaces, they were commonly used in concert halls into the 19th century[11], possibly most famously in the Royal Albert Hall which opened 100 years later, and can still be found in designs today[9].

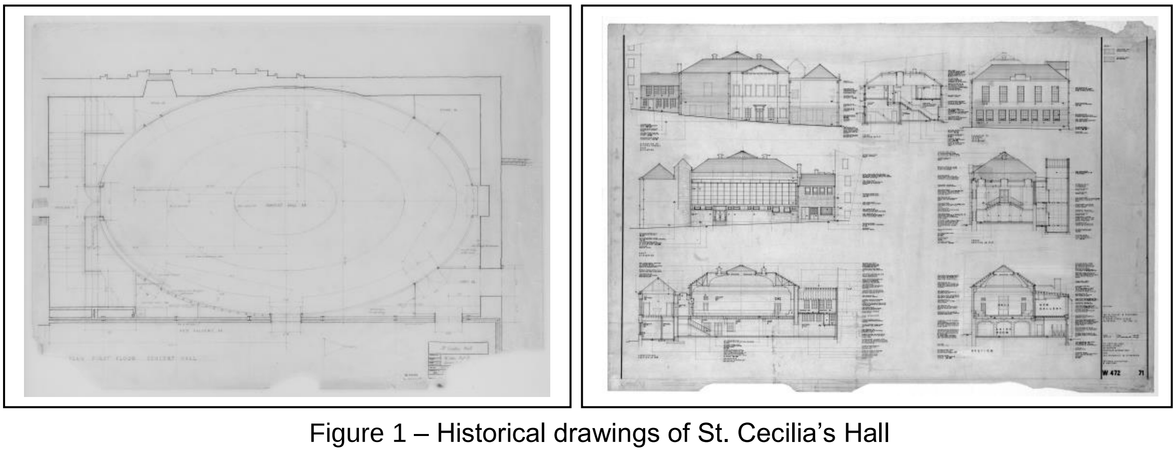

Figure 1 – Historical drawings of St. Cecilia's Hall

In the original 1760s design of St. Cecilia's, seating was provided by way of five tiers of fixed benches lining the circumference of the hall along to the stage area at the north end. The bench seat height ranged from 0.46m at the front to 0.97m to the rear. The timber benches were un-upholstered, meaning those with "a delicate constitution" found it necessary to bring along their own cushions for comfort[4]. This contrasts with modern concert halls which are often designed to include well upholstered seating[8], providing similar acoustics when the hall is either full or empty. The listening experience in the 1763 hall will have changed significantly between high and low occupation as the reverberation time and reflection effects will have noticeably varied, however, this effect will have lessened slightly in 1767 when the benches were moderately upholstered. The 1968 reconstruction of the hall also included moderate upholstery on the single tier bench located around the perimeter of the room, with removable lightweight seating (this was plastic in 2013) on the flat floor at the center of the hall providing a capacity of 244 and a volume of 4m^3/seat, noticeably lower than other small chamber music halls[9]. The dimensions of the hall (length 18m, width 11m) provided excellent sightlines, resulting in strong direct sound paths. Unfortunately, the exact seating capacity of the original 1763 hall is undocumented, although historically a capacity of 500 has been documented[12] this seems optimistically high, as there is no evidence that the middle section of the hall between the raked seats was utilised for seating.

The contemporary method of reverberation time measurement developed by Sabine was not in existence at the time of the original 1763 design or in 1764 when the Musical Society started to discuss making alterations to the acoustics of the hall including raising the roof and squaring the southern end, however models of the hall as it would have been (oval in plan, with raised roof but without pilasters or additional panels) predict the mid-frequency reverberation time would likely have been around 1.6 to 1.7 seconds unoccupied. The reverberation time of the 1968 reconstruction of the hall is likely to have been similar when it opened, however circa 1972 "Audex" acoustic treatment, a sprayed "vermiculite" with cement binder ("all the rage in the early 1970s"[6]) was applied to the full extent of the double-dome ceiling reducing the mid-frequency reverberation time to 1.3 seconds unoccupied (as measured in 2013). Although this treatment results in an unfaithful replication of the original design, the resulting reverberation time is in line with that recommended for concert halls of similar volume to that of St Cecilia's Hall (circa 1000m^3)[11].

Despite the "improvement" in the reverberation time of the hall by the application of the Audex, the lack of absorption at low level meant that the flutter and whispering gallery effects remained. While the 1972 incarnation of the hall lends itself well to the 18th century instruments (early string instruments such as violins, cellos and harpsichords, wooden flutes, double reed instruments and clarinets were often quieter than their modern day counterparts[13]), filling the hall with sound, the focusing effect of the domes and strong reflections from the curved walls make for a predictably variable listening experience depending on seating position.

Other oval shaped concert halls such as the 1788 Felix Meritis in Amsterdam, "renowned for its acoustics"[5], and the 1781 Leipzig Erstes Gewandhaus, "regarded as exemplary"[14], were built with diffusion on the curved walls by way of windows, doors and other structural features, similar to that seen in the earlier "salon". Unlike these halls, the walls in St Cecilia's are entirely smooth (although the 1763 hall did include an "enriched cornice" which was not reinstated in 1968). The introduction from 1764 of acoustic adjustments to compensate for these smooth surfaces and resulting acoustic effects, included carpet, matting, pilasters and panelling (see Section 2) providing a more diffuse field in the space and a more even sound.

Despite this lack of diffusion, the acoustics of the 1972 hall were greatly liked by listeners, many of whom returned to the same seating position time after time, even in areas known to experience odd listening environments. Whilst aspects such as viewing angle (having to turn your head or not), comfort and proximity to the performers all impact seating choices, conversations with patrons of the hall indicate that a familiar listening experience plays a significant part in the seating choice of frequent visitors. Such is the importance of familiarity that significant changes to the acoustic of the hall were strongly discouraged during the latest refurbishment project. The Class A listed status of St Cecilia's is dated 1970 and includes the 1960s reproduction of the hall but not the original 1763 design meaning that the installation of "original alterations" made shortly after opening by the Musical Society could not be adopted in 2017, although inclusion of variable (removable) diffusion was something supported by many stakeholders.

4 PRE-WORKS ACOUSTIC STUDY

An objective acoustic survey was undertaken prior to any alterations being made to inform the acoustic design, provide baseline figures for calibration of acoustics modelling and to provide a record of the historic 1968/1972 reconstruction of the concert hall. In addition, subjective commentary was gathered. Concerts were attended and interviews with a wide range of stakeholders conducted.

4.1 Room Acoustics

The reverberation time was measured in the concert hall both with and without the loose plastic seating (arranged in “lecture” style facing the front of the room). There is very little difference between the two measurements as shown in Figure 2. Both have an average reverberation time, of 1.3s and a mid-frequency reverberation time, T_{mf} of 1.4s. The reverberation time in the 1972 hall therefore varies considerably with the number of people present, providing a very different acoustic during rehearsal, practice and recording scenarios from that found during concerts. This effect would have been markedly more noticeable in the 1763 and 1968 halls where no absorption was included, although the 1764 hall had more diffusion than 1968.

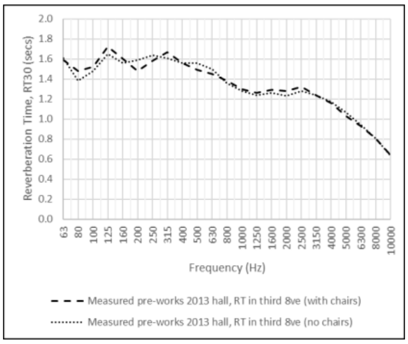

Figure 2 – 1972 Hall Reverberation Time as measured in 2013

As discussed in Section 3, the reverberation time in the 1972 hall corresponds with the volume of the hall and is suitable for the types of early music played[11], although some interviewed felt that the visual impression of the space did not correspond to the acoustic. Comments included that the sound is unbalanced and that the strong reflections and whispering gallery effect are almost superimposed on the average reverberation. This effect can be seen in the reflectograms produced in the Odeon baseline modelling.

Despite this, the room is much liked by musicians for recitals and other small music performances, with mixed commentary regarding difficultly hearing instruments across the stage platform. The issue of the unoccupied acoustic being so different to that in the occupied space was raised with comments regarding the balance of instruments being “wrong” when the space was unoccupied and the room having “a much warmer sound with an audience”. Some commented that a “dryer and evener” sound would be preferable, in particular for recording.

It was noted that many of the regular audience at St. Cecilia’s are highly supportive of the venue often attending concerts, and that their preference is for the perimeter seating (front half of the venue) where the whispering gallery along the curved outer walls is strong, perhaps due to familiarity or a preference for a certain side of the directional instruments such as harpsicords. Other listeners tended to prefer to sit at the focal point of the roof ellipse at the rear of the hall where the sound strength was highest across all instruments.

Speech intelligibility in the hall is very poor, particularly with a lively speaker, with problems similar to that reported in the Times newspaper during the opening speech by the Prince of Wales at the

Albert Hall in 1871. Measurements of STI at St. Cecilia's were not undertaken at the pre-works stage but it was noted that when the speaker turns their head whilst speaking they set off a whole array of long reflections in the horizontal plane around the room. Singing or speaking is best done on the centre line with little movement as this provides the best balanced feedback to the speaker or singer and the least confused signals to the audience members thereby increasing speech intelligibility.

4.2 Environmental & Services Noise

Noise from road traffic, intrusive sounds (sirens, horns, revelers outside etc) as well as birds on the roof and rain noise were all reported audible and as "too high" in the hall by those interviewed. Ambient noise measurements, L_{Aeq} undertaken in the hall from 5pm-9am (logged every 5 minutes) with the hall ventilation system switched off ranged from 25-43dB with emergent/intrusive noise levels, $L_{Amax(fast)}$ ranging from 28.9-59.9dB, the majority exceeding 40dB. Low frequency noise (described by users of the space as "rumble") and vibration is also audible, noted as a problem for those recording in the venue, transmitted through groundborne paths from commercial vehicles on Cowgate as well as occasionally (and at much higher levels) from Niddry Street itself.

No measurements of the ventilation system in the concert hall were undertaken in 2013 as it was clear that noise levels were unacceptable with the system being switched off during performances. Measurements undertaken by Sandy Brown Associates in 2011[15] ranged from NR24 – NR41dB (L_{90}) depending on the combination of equipment in use.

4.3 Internal Sound Insulation

Internal sound insulation between the concert hall and surrounding areas in the building was not adequate for simultaneous use of the spaces during performance with figures of D_w 45dB recorded between the hall and the rehearsal/teaching rooms below and D_w 23dB for the door to the foyer.

5 DESIGN

5.1 Room Acoustics

As part of the refurbishment project a 3D computer model of the hall was constructed to not only test the effect of changes on the acoustics of the hall but to also demonstrate to stakeholders the predicted effect on the listening experience from these measures through auralisation. The 3D model shown in Figure 3, created in room acoustic prediction and simulation software Odeon Auditorium 12, was calibrated using the reverberation time measurements carried out in 2013.

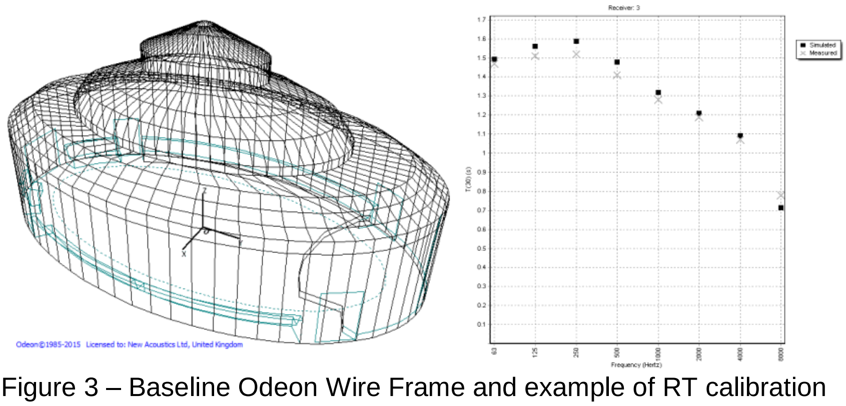

Figure 3 – Baseline Odeon Wire Frame and example of RT calibration

Throughout the consultation sessions with stakeholders, a number of different seating and treatment options were trialled using the computer model, all of which were based around removal of the 1972 “Audex” (or “porridge” as it was “affectionally” termed[7]). The reintroduction of tiered upholstered perimeter seating, which was tabled by the university as far back as 2007, was also confirmed with two tiers added to the design. There was some discussion about possible re-instatement of pilasters. In addition, the idea for variable acoustics such as removable diffusion (such as framed pictures) as well as removable absorption (removable seating absorption) was also suggested. Whilst these ideas gained the support of musicians and academics as well as those interested in recording in the hall, the added cost and reluctance from the authorities dealing with the historic listing of the building meant that they could not be included in the design going forward.

With this in mind, the following treatment options were modelled: painted plaster ceiling (returning the hall to its 1968 design), modern acoustic plaster on the outer/lower dome only and modern acoustic plaster in the inner/upper dome only. Each treatment option was modelled with and without the addition of upholstered removable seating filling the floor area in the center of the hall.

In order to more easily convey the impact of these treatment options to the stakeholders, auralisations of each option (in “quiet” conditions) were generated using the predicted impulse response of the room. Using an excerpt of a soprano singing, the response of the hall with each treatment option was played back to stakeholders in group sessions using a good quality two-channel playback system as headphone presentation was impractical for the numbers of people present.

Feedback from the consultation sessions fed into the final design, which included: replacement of the “Audex” with modern acoustic plaster on the inner/upper dome only, with the outer dome/ ceiling mostly returned to painted plaster and a lowered seating capacity, of 200 resulting in a larger volume per seat of 4.89m^3, comparable with other smaller chamber music halls[9]. Additionally, user concerns about flutter echo above the stage (between the hard stage surface and the soon to be reflecting painted plaster on the flat ceiling area directly above) resulted in the adoption of a small recessed area of acoustic plaster incorporating stage lighting.

5.2 Environmental and Services Noise

The main source of emergent noise (airborne) entering the concert hall was via the single glazed cupola and ventilation outlets in the roof, airborne noise also entering the building via the roof itself. The low frequency noise enters the building via structural paths.

The early design was therefore to include a secondary glazed rooflight above the existing cupola and to line out the underside of the roof trusses with dense plasterboard. Removal of all the redundant building services openings through the roof was a priority. As structural alterations were not possible to reduce low frequency noise, the idea of the area outside St. Cecilia’s becoming pedestrianised was also discussed with the Local Authorities.

In the end, the historic fabric of the building and its inherent weaknesses as well as very restricted access and space in the roof between the upper side of the dome and underside of the roof truss limited what could be achieved, resulting in a double glazed cupola replacing the single glazed unit, rather than the secondary structure. Slating boards (sarking) and the roof slates were fully replaced but the underside of trusses could not be lined out. The building services penetrations through the hall roof were removed and made good during the re-roofing process. Unfortunately, this plan for pedestrinisation was not viable in the short term, so improvement in groundborne vibration would be limited.

The existing ventilation and air conditioning system serving St. Cecilia’s was decrepit and not fit for purpose with units distributed locally in storage around the concert hall and in the concert hall roof cavity. Air was supplied to the hall at high level through four large grilles mounted in the wall. Air was extracted from the hall at ceiling level with outlets located in the roof directly above.

The design of the new ventilation and conditioning system is centred around keeping all plant and any outlets/inlets to the environment away from the roof space to lower noise breakout from the plant into the hall and increase sound insulation from inside to outside the building. The new plantroom is located internally on the second floor of the new building adjacent to the hall and with the large ducts (required to keep velocities low) routed between the two buildings, entering the hall above the new door lobby. Supply air is fed to plenums formed beneath the seats and extract ducts are routed through the very tight ceiling cavity to the back of slots cut into the ceiling below the cupola. The noise ratings required were NR25 for concert performance and NR20 for recording (ideally the noise limit for recordings would have been lower but this was not possible given the space restrictions). NR25 can only be achieved by use of a purge system so that the heat and fresh air can be changed rapidly during intervals in the concerts.

5.3 Sound Insulation

Internal sound insulation was to be improved as far as possible within the limits of the historic fabric of the building.

6 POST-WORKS ACOUSTIC STUDY

Following the renovation works a repeat set of objective measurements were undertaken. Informal feedback from stakeholders was also gathered following the opening night concert.

6.1 Room Acoustics

The reverberation time and STI (speech transmission index) were measured in the unoccupied concert hall with the new absorbing loose seating in place (in “lecture style” facing the front) and ventilation system set to performance mode.

The average reverberation time measured is 1.14s and the mid-frequency T_{mf} 1.23s which correspond well with the predictions of 1.0-1.2s. The measured reverberation time in 3rd octave bands is shown in Figure 4 alongside the predicted reverberation time from the Odeon and Excel (Sabine-Eyring) models. The reverberation time has reduced across most frequencies from the 1972 hall (as measured in 2013), although this is most pronounced below 400Hz due to the absorption provided by the new raked seating podium. The “no loose chairs” configuration has not been measured but prediction is that the average reverberation time will be 1.33s and mid-frequency T_{mf} 1.29s. Measurements were made in accordance with ISO 3382-1:2009 using 10 measurement positions and 2 source positions.

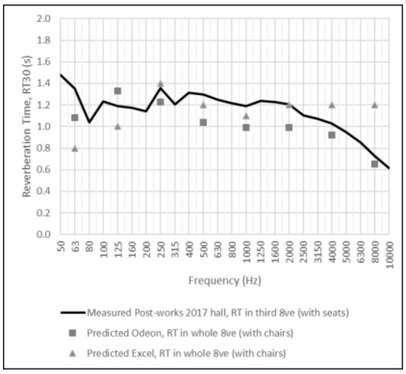

Figure 4 – 2017 Hall Reverberation Time (with lightly upholstered loose chairs)

The speech transmission index was measured across 22 seating positions (seats in lecture theatre layout) using a single speaker location on the stage at the front of the hall. Results show that across the hall the STI is fair to good (0.5-0.7) with the vast majority of positions measuring around 0.6.

Feedback from the stakeholders present at the opening concert night, many of whom had already been in the venue to hear earlier test performances was in the main very positive, with many praising the perceived improvement in speech intelligibility and noting this had been achieved without detrimental effect on the acoustic for music. Although positive responses are to be expected from any changes to a concert hall as noted by Bradley in his 1990 paper[16], there was some less favorable feedback from two attendees who considered the reverberation time following the 2017 refurbishment too short, one of whom noted that he personally preferred the Reid Concert Hall.

6.2 Environmental and Services Noise

Repeat ambient noise (including air conditioning noise) measurements in the hall from 5pm-9am (logged in 5 minute periods) were undertaken in 2017. The average noise level (L_{eq}) in the hall is now dominated by building services noise and so direct comparison with the 2013 survey data is not valid for the lowest noise levels. However, taking this into account the average noise level (L_{Aeq}) range from 31-37dB is an improvement of 6dB. Analysis of the reduction in emergent/intrusive noise (measured as L_{Amax}) shows a more than 5dB average reduction, with the frequency of exceedances of >40dBA being reduced to a fifth of that in 2013 (exceedances >40dB $L_{Amax,5mins(fast)}$ reduced from 121 to 25 between 5pm-9am). This correlates with subjective comments from regular audience members that the intrusive environmental noise sources, such as sirens etc were, "much less distracting than before". No improvement in low frequency noise from groundborne sources was possible.

Ventilation/Conditioning noise in the hall has been measured in the hall for each of the ventilation modes included in the design. The noise level for "performance" mode was NR25 but no reduction was seen for the "recording" mode and it is understood further balancing of the system was to be undertaken.

6.3 Internal Sound Insulation

The sound insulation between the concert hall and education, rehearsal and museum spaces below has increased to D_w 52-56dB in line with expectations. The sound insulation of the historic concert hall doors into the original foyer stairs has increased from D_w23dB to D_w29dB, with some snagging works expected to increase this further.

7 LIMITATIONS

As well as the limitations discussed previously (load bearing restrictions of the historic fabric, roof and side walls and limited roof cavity space etc.) one of the key employer's design requirements was for tiered seating around the perimeter of the hall. Whilst this provided a good solution for improvement of the ventilation strategy, another key design requirement, the addition of a large area of low frequency absorption (hollow wooden podiums) results in an unwanted reduction of the low frequency reverberation time reducing some of the warmth in the listening experience. The listed status of the hall to the 1968 design meant that reinstatement of the wall pilasters, panelling and enhanced cornice installed for diffusion in the original hall of the 1700s was not possible. Ironically, had the receipts and details of the original hall been available in the 1960s, and fuller reconstruction of the hall carried out in 1968, such additions may have been included in the 2017 refurbishment and acoustic benefits to the room gained.

8 CONCLUSION / FURTHER WORK

Through the latest refurbishment project, the turbulent and intriguing history and design of St Cecilia's Hall has re-emerged. The oldest purpose-built concert hall in Scotland, it came into being during a time of rapid change in musical requirements as the quieter musical instruments of the Baroque period were giving way to their louder Classical counterparts with halls increasing in volume and seating capacity. Halls of similar, although increasing, sizes and shapes were being built to great success on the continent although it is not known if these architects ever knew of, let alone, visited St Cecilia's and its status as a music venue dwindled into obscurity. Since its acquisition by the University of Edinburgh, great efforts have been made to return the hall to the prominence it once had, with this latest work aiming to "let the hall sing again"[7].

It was not possible for the authors to procure the equipment necessary to measure more detailed acoustic parameters (such as Clarity, Definition and Strength etc.) in time for submission of this paper, however future research and measurements of the hall are encouraged as it is felt that the design (let alone the history) of the hall should be brought to the attention of the wider acoustics community.

9 ACKNOWLDEGMENTS

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