WIRE FREE WORK SPACES: THE SALTIRE CENTRE, GLASGOW CALEDONIAN UNIVERSITY

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1 INTRODUCTION

BDP was commissioned as framework architect, lighting designer and acoustic consultant by the University in 2002 for their five year campus redevelopment programme. The Saltire Centre was the largest single new-build project commissioned by the University and replaced the outmoded William Harley Library with a landmark building that is at the cutting edge of contemporary higher educational thinking.

The principle underlying the building concept is that learning begins with a conversation and great emphasis has been placed on social learning. Students are encouraged to learn from one another in a stimulating and appealing environment that ranges from formal and informal group areas, café spaces, incidental areas related to building circulation routes, through to silent 'monk cells'. The design includes a variety of individual and group learning spaces. It is an energy efficient building embracing highly sophisticated wireless and fibre based learning technology as well as an innovative storage solution for the collection of 350,000 volumes.

The £16m project was handed over in January 2006 and has since achieved a number of architectural design awards including a RIBA award in 2006.

2 BACKGROUND

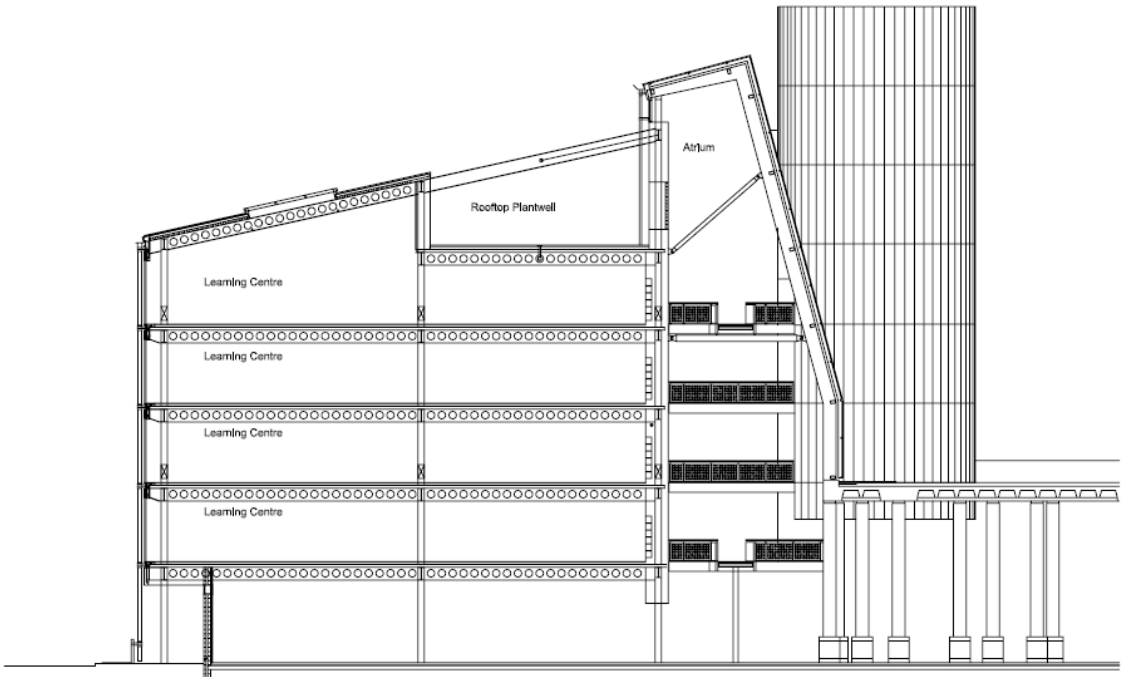
The Saltire Centre forms a link between two existing seven and eight storey teaching blocks. Circulation within the building is via a south facing atrium space that acts as an environmental buffer to the main learning accommodation housed to the north. Vertical circulation is by way of a perforated copper clad drum staircase. Bridge links spring from this drum, across the atrium space and through a six storey 'Resource Wall' that provides acoustic, thermal and fire separation between the 'noisy' circulation zones and more sensitive learning zones.

The building comprises five floors of 'learning accommodation' (Levels 00 to 04), an open-plan area on Level 00 and a central stair tower. These are all connected via the Atrium space. Main access to the building is on Level 01, which opens out into a mezzanine level within the 'courtyard' space on Level 00.

Floors 01 to 04 contain open-plan learning spaces each with a floor-plate of approximately 1,600m^2. Levels 01 to 03 of the Learning Centre are based on the same floor-plate design. Level 04 has the same plan as Levels 01-03 below, but differs in section as it is on the top floor, which is double height at its highest point.

The open-plan area on Level 00 is the main area of social activity, and contains facilities such as the Learning Café and exhibition areas. The Level 00 Study Space takes the form of mostly group/noisy study space, due to the lively public nature of the floor. It was anticipated that this area would have a very noisy environment due to its open-plan design and the circulation of students around the building.

Figure 1: Section of Saltire Centre



3 ACOUSTIC DESIGN

Due to the many and flexible methods of learning the building needed to cater for, the open plan nature of the floor-plates and sheer size of the areas involved, a number of acoustic design issues arose.

The main issues included;

- Reverberation – large floor areas and hence volume, along with the use of acoustically hard surfaces resulted in the potential for very high reverberation times.
- Requirement to provide an environment suitable for various types of study within an open-plan space (i.e. individual study, group study, resource spaces).
- Control of activity noise from atrium space to learning spaces.
- Building services noise.

4 REVERBERATION

A significant acoustic issue raised early on was the need to control reverberation in all spaces. The Saltire Centre has a volume of approximately 35,000m^3, with each of the Learning Spaces being approximately 4,100m^3. This, coupled with the use of exposed concrete soffits for thermal mass, meant that without the introduction of significant acoustic absorption, reverberation times would be too high to provide a suitable acoustic environment for learning.

ODEON modeling was undertaken to assist in recommendations regarding quantities/location of acoustic treatment for the following areas:

- Typical floor-plate in learning space

- Level 04 'Silent Space'
- Atrium and Level 00 space

The acoustic design criteria were based on guidance provided by Building Bulletin 93 'Acoustic Design in Schools' (BB93). Whilst not specifically relevant to further and higher education establishments, this represented the most suitable guidance available for acceptable acoustic standards in such buildings.

Table 1: Summary of BB93 mid-frequency reverberation times for rooms which are finished but unoccupied and unfurnished

Type of Room	T_{mf} *(seconds)*
Open-plan: Teaching areas	< 0.8
Open-plan: Resource areas	< 1.0
Study room (individual study, withdrawal, remedial work, teacher preparation)	< 0.8
Libraries	< 1.0
Atria, circulation space used by pupils	< 1.5

Target T_{mf} criteria of 0.8 – 1 seconds for the Learning Spaces and <1.5 seconds for the Level 00 and Atrium spaces was used.

4.1 Levels 01 - 03

The aim was to provide an acoustic environment similar to that acceptable for open-plan offices, in order to;

- Improve privacy (i.e. to ensure sound is localised and does not carry far).
- Reduce activity noise levels.
- Improve speech intelligibility to ensure voices do not need to be raised.

Levels 01 – 03 of the Learning Centre are based on the same floor-plate design and contain similar learning, study and resource spaces. Access to the atrium is through portals in the 'Resource Wall' along the southern side of the room. Bookshelves line the Resource Wall, and on the opposite side of the room is a translucent glazed wall. The floor underside is made up of exposed concrete soffit and steel beams. The floor finish was thin, office-grade carpet. The only furniture included in the modelling was bookshelves, compact shelving and the printer pods which serve to enclose and absorb sound from printing and photocopying facilities.

Without any acoustic absorption, the modelling predicted T_{mf} values approaching 2 seconds throughout the space. This was deemed unacceptable for a learning/study environment. Due to the many limitations related to potential locations for acoustic absorption, the only practical place to include absorption was to suspend it from the soffit.

Holes formed in the exposed steel beams served the function of carrying services at high levels and the arrangement of lighting strips was designed around this. Any acoustic absorption needed to integrate into this design. A series of lightweight suspended panels within the 'bays' formed by the lighting and services running perpendicular to the exposed beamwork were proposed. The size and suspension height of the panels was determined so as not to obstruct airflow paths, to allow percolation of air out of the displacement ducts and to allow the flow of 'purge' air over the underside of the slab at night.

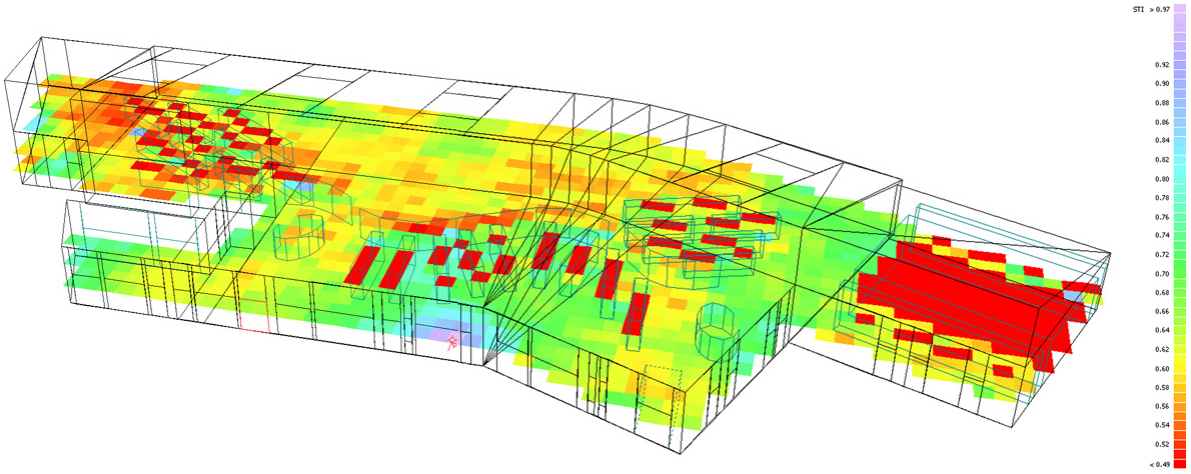
A total of 950m^2 of acoustic absorption in the form of suspended panels was included in the model, which predicted a reduced T_{mf} of approximately 1 second; acceptable for a learning environment.

4.2 Level 04 – 'Silent Space'

Level 04 shares the same floor plate as Levels 01 – 03, but has a different roof profile, which is double height at its highest. Instead of a concrete soffit, Level 04 has a perforated metal roof soffit underside with skylights. This level also has the additional requirement of being a 'silent space' where quiet study areas are provided.

The lack of low-level ceiling space meant that there was less potential for absorptive material to be added to the soffit. However, additional acoustic absorption was required to compensate for the increase in volume and to reduce activity noise to suitable levels for a 'silent space'. A similar area of absorption to that included in Levels 01-03 was proposed. The modelling predicted T_{mf} values of approximately 1.3 seconds without acoustic absorption and 0.9 seconds with acoustic absorption across the spaces.

Figure 2: ODEON Modelling Output



4.3 Atrium Space and Level 00

The open-plan area on Level 00 is the main area of social activity, and contains facilities such as the Learning Café and exhibition areas. The Level 00 study spaces are mainly group/noisy study spaces due to the lively, public nature of the floor. There is also the possibility of occasional small scale events being held.

There were limited possibilities to introduce absorption into the Level 00 spaces due to the need for exposed soffits and the acoustically hard floor surface required for practical reasons (high levels of foot traffic). Suspended absorptive panels below the concrete waffle slab were considered not visually acceptable by the Architect and spraying the waffle slabs with an acoustic treatment would impair thermal mass performance. To reduce reverberation within the Atrium space, perforated timber panels with absorptive backing were recommended for at least 25% of the atrium wall at high level.

Localised areas of acoustic absorption were also included in terms of 'floating fabric clouds' in the Level 00 space. The area of this absorption type was relatively small compared to the volume of space and therefore the overall effect on reverberation was limited, but localised benefits were

anticipated. In addition, inflatable 'pods' were included within the space to provide contained areas with some element of perceived acoustic privacy.

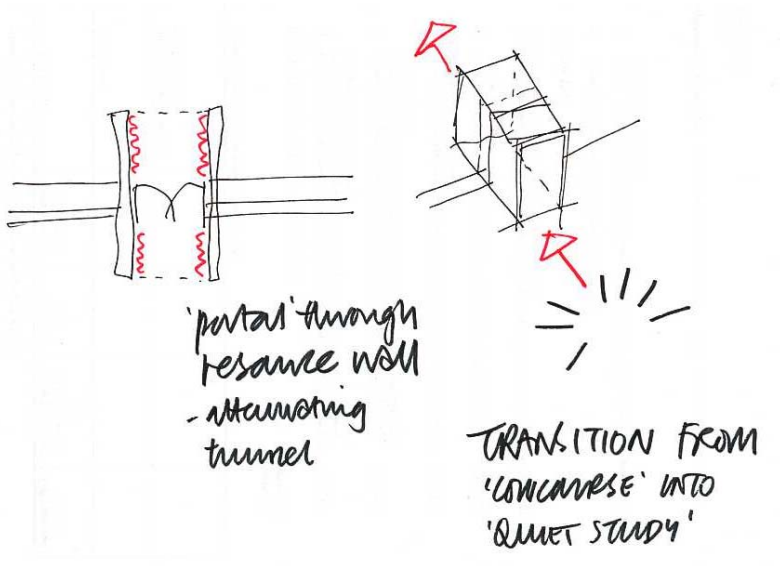
The modelling exercise predicted T_{mf} values in excess of 4 seconds with bare finishes, reducing to 2.7 seconds when acoustic absorption and furnishings were included.

Figure 3: Saltire Centre, Level 00 Space

5 ACOUSTIC PORTALS

Although the construction of the Resource Wall provides sound insulation between the Atrium and the Learning Spaces, there was concern that noise would intrude into the Learning Spaces via the door entrances. Multiple doorsets and lobbies were considered too restrictive on easy movement of students. A portal construction was recommended in the form of an 'attenuating tunnel'. The tunnel arrangement incorporated a single set of double doors and absorptive material (perforated timber and plasterboard) as the internal lining. The recommended dimensions of the tunnel were at least 2.5m length with an internal size of 2.5m x 2.5m.

Figure 4: Acoustic Portal Concept



6 BUILDING SERVICES

Mechanical ventilation is provided to all areas via centralised systems located in the main plant room at Level 05. Fresh air intakes to plant are taken from the Northern elevation of the building at Level 05 and foul air discharged at high level via roof level louvred plenums.

An AHU provides conditioned air to Level 00 and 01 areas via low level displacement diffusers. Extract air rises into the atrium where it mixes with extract air from other areas before returning to the plantroom via high level grilles in the atrium. Two general supply and extract AHUs provide tempered air to general open plan learning accommodation; extract air is rejected into the Atrium before returning to the plantroom via high level grills.

NR criteria for building services noise were set for each area ranging between NR35 - NR45. AHUs were double skinned to minimise noise breakout and attenuators were included to achieve the internal and external noise criteria. Additional acoustic attenuation was required to the air transfer path between the Atrium and Learning Spaces so as not to exceed the NR criteria and also to minimise activity noise break-in. Acoustic absorption was included in the Atrium at high level opposite plant room louvres to control noise break out by minimising reflections.

7 CHARACTERISTICS

Ambient and mechanical services noise levels were systematically checked, keeping to ANC methodology. Mechanical services noise levels were generally within the design criteria of NR 35 for learning spaces and NR40 for the atrium space. Indoor ambient noise levels were also within the design targets. The commissioning measurements indicated a reverberation time of below the target value of 1 second in the Learning Centres (Levels 01-04), and were very consistent throughout the spaces. Reverberation times (T_{mf}) of 2.3 seconds to 2.6 seconds were measured in the Atrium/Level 00 spaces. Although the measured T_{mf} was in excess of the design target, it was within expectations as predicted by the modelling exercises. The higher reverberation time was accepted as suitable for a space with such a large volume and ultimately contributed to the lively and vibrant atmosphere specified for this space. The Client is actually enthusiastic about the activity noise contrast between the Level 00 concourse space and the Learning Levels.