Predicting noise behaviour in building acoustics – a case study example

By Paul Absolon and Dr Max de Salis

Background

Launched in 2000, Moneypenny leads the UK telephone answering service and outsourced switchboard market, looking after more calls for more businesses than any other company of its kind.

With a purpose-built development on the cards in its home town of Wrexham, Wales, Moneypenny had a 10-acre plot with which to design a new office space which could house up to 1,000 employees.

However, unlike many traditional office projects of this nature; Moneypenny approached the building design in a unique way. The £15 million headquarters' top line brief was to create a development which would literally "put a smile on people's faces".

While the wider landscape was to include innovative features such as a tree house and a village pub for staff, the main three storey office had to satisfy the "work hard, play hard" mantra of the business – and at the same time deliver an environment which fostered team work, collaboration and interaction. To help achieve this, founder Ed Reeves was clear on one thing: the office had to be open plan yet feel welcoming, homely and inspiring.

Given the nature of the telephone and switchboard operations, this presented an unprecedented design challenge from an acoustic perspective. How could such a fluid space be achieved in a high density, high call volume environment, where call quality was crucial to business performance and customer service?

To address this challenge, the client appointed PDA Ltd as acoustic consultants on the project at concept stage – before the footprint or external design had been produced.

Defining specification

Unlike traditional commercial building projects, the acoustic performance of the space at Moneypenny was not to be determined solely by traditional objective standards or guidelines. Moreover, the employer requirements regarding the acoustic environment were initially subjective in that it was imperative to limit perception of different conversations between adjacent individuals to an absolute minimum.

The starting point to define the target sound levels for the new offices therefore looked to the company's existing premises for an initial benchmark.

The existing rented offices used by the client were of a standard open plan office type with standard suspended ceilings of reasonably low ceiling height fitted with acoustically absorbent tiles. In addition the space had traditional individual window lights of limited coverage. This space had been made to work acceptably for the client using acoustic screens, various absorbent wall hangings and background masking noise. However, the vision for the work spaces in the new development was to present a significantly more challenging acoustic environment due to the following factors:

- Feature significant proportion of floor to ceiling glazing and high ceilings with non-continuous baffle / raft type ceiling to allow heat transfer and ventilation to the slab above.
- Minimise the use of screens to retain / improve visual connection between individuals as well as between the individuals and their surrounding environment.

Based on the design vision, it was agreed that the practical goal should be to ensure that the new space retained and / or improved on the acoustic environment and levels of privacy that were exhibited in the existing premises. Seeking to define objective target performance criteria for the new space, PDA adopted the following methodology.

Modelling

PDA modelled both the existing space and the proposed new space in CATT acoustic 3D ray tracing software for comparison.

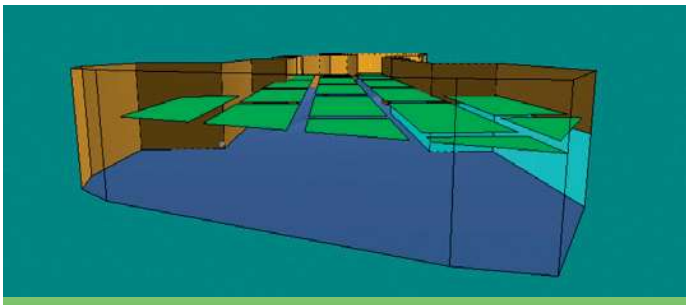

Figure: Screenshot showing Simplified CATT Model of Raft Ceilings in the Proposed Space (Unfurnished)

The ability to model diffraction around screens in CATT was very useful in this instance, as it allowed PDA to show the effect of the raft ceilings and the effect of increasing and decreasing height and density of screening. Subsequently the models were able to predict the room acoustic properties of the space and also the noise transfer between work stations.

Using the said models the layouts and treatments could then be tweaked to show that the speech noise transfer between individuals in the proposed space would be reduced compared to the previous space in spite of the challenges presented by the proposals.

Auralising

The vocal sound transfer between the PAs in the existing and the new environment were further "auralised" using a limited audio simulation to approximate the combined vocal effect of a number of people taking enquiries around a single "control" person. This meant that the predicted change in "Soundscape" from the existing to the proposed environment could be subjectively assessed, as could the effect of adding different levels of masking noise.

Testing

With respect to commissioning of the space it was determined that a simple measure of the mid-frequency reverberation time T_{mf} (average of 500 Hz, 1 kHz and 2kHz) results would be the most simple and practical way of measuring the acoustic environment. The predicted T_{mf} for the modelled PA floor was 0.75 seconds and as such a criterion of $T_{mf} \leq 0.8$ was chosen as the test criterion value.

As part of the conceptualisation process, PDA modelled circa 40 scenarios and conducted circa 20 simulations.

Acoustic treatment

Following the acoustic modelling at concept stage, PDA followed the project through to building design and played an active role as part of the design team. At this point, the importance of 'real world' acoustics became prominent and required the acoustic consultants to interface with architects AEW and the contractors to provide guidance on how the interior environment could be acoustically treated to achieve the agreed specification. Moreover, any acoustic product applied in the new space had to provide a highly aesthetic finish.

As such, the design team agreed on the use of absorptive ceiling and wall treatments as per the specification from PDA. The main challenges facing the design and manufacture of the acoustic treatment were as follows:

- Treatments needed to follow the curvature of the building
- Different fabric facings were required throughout the building to avoid monotony
- Wall treatments had to withstand impact

- Ceiling treatments had to be demountable to allow service access behind the rafts.

The precise performance and practical requirements of the specification greatly limited the choice of acoustic treatments which could be used. After putting the details out to tender, CMS Danskin Acoustics was appointed as the product partner on the project, with a brief to design and manufacture its SuperPhon range of absorptive panels.

From design to manufacture

Working closely with the AEW and PDA, CMS Danskin Acoustics undertook a bespoke design process which balanced aesthetics with installation practicalities.

SuperPhon panels at 40mm thick were manufactured in a range of sizes. Installed direct to the skirting, the SuperPhon High Impact was installed up to a height of 1.8m to protect the acoustic performance in the event of an impact from passing traffic. The maximum height at which the panels were installed was 9m, with the average height being to 3.5m.

CMS Danskin Acoustics cut the radii to the panels and supplied them ready to install on-site. In doing so, this removed the need for cutting on-site and improved the accuracy of manufacture. Both CMS Danskin Acoustics and PDA provided site supervision to protect the integrity of the acoustic treatment design.

Two thousand five hundred wall panels were installed over the two operational storeys of the new building, with a total contract value of £200,000. From an aesthetic perspective, CMS Danskin Acoustics delivered a highly varied range of finishes and colours, from funky and bright patterns through to highly creative gooseberry fruit prints.

For the raft panels, approximately 1,500 rafts were hung from adjustable wires. The most common size was 3000mm x 1200mm but some were manufactured with radii corners to accurately follow the building profile.

The new Moneypenny HQ

Building commissioning

Following the installation of the panels, and ahead of the building becoming operational, PDA undertook pre-commissioning testing in the unfurnished open plan spaces to ISO 3382-2:2012 requirements.

The measured T_{mf} for the two tested floors at the end of the project were 0.68 and 0.72 seconds respectively, therefore showing compliance with the required criterion and reasonable agreement with the modelling.

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