ACOUSTICAL DESIGN FOR 21ST CENTURY LEARNING

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1 Introduction

The contemporary design of schools and buildings used for educational purposes has to not only consider the need of students and teachers but also reflect the world of business, retail and commerce in the rapidly changing 21st century world. The use of web-connected interactive, multimedia tools permits access to information and resources at fibre-optic speeds without the need for any of traditional learning media or instruction. At home, children and young adults have access to a wide variety of information from an array of online devices, which are enabling the quest for greater knowledge and control.

The contemporary role model works in an open-plan hi-tech office environment with a wireless connection to a mobile tablet device, communicating over social media using a 4G smart phones whilst drinking an almond milk americano misto from the in-house corporate barista. OK, so maybe this is not everyone's workplace, but in today's interconnected and technology driven world, a working environment does not need to be a physical location like a standard 10' by 15' office. It is more likely to be a shared or serviced open plan space with hot-desks but it can also be virtual, remote or, perhaps more succinctly, an online IP location somewhere on the web.

Educational experts believe a similar approach should be used for schools. The 21st century learning environment should enable and accommodate the learning needs of every individual learner while supporting the betterment of a group through positive relationships. 21st century learning should take place in the context of "promoting interaction and sense of community that enable formal and informal learning"[1]. To this end, 21st century architecture in schools or learning studios should allow for group, team and individual learning with a design flexibility that includes moveable furniture and walls that allow space to be re-configured.

Such flexibility in room-spaces can provide challenges in terms of the acoustic environment. The need for children to have a clear understanding of speech, whether from teachers or their contemporaries remains a critical requirement for any learning environment. Traditional classroom arrangements with a teacher providing instruction from the front of the room to children sat in rows is a relatively simple acoustic model – a single sound source located broadly one position transmitting instruction to receivers throughout the space. Providing the space contained sufficient reverberation control in terms of a fiberglass ceiling tile and perimeter walls that adequately isolated sound from entering the space the signal to noise ratio was sufficient for individual learning.

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In 21st century spaces, the sound transmission path from source to receiver is not so clearly defined as the primary source (i.e. teacher) is encouraged to move around the space and the receivers (i.e. students) may be in a large group, or small teams or may even be on the third floor atrium listening via the loudspeakers on a laptop. There simply is no "*simple*" model anymore.

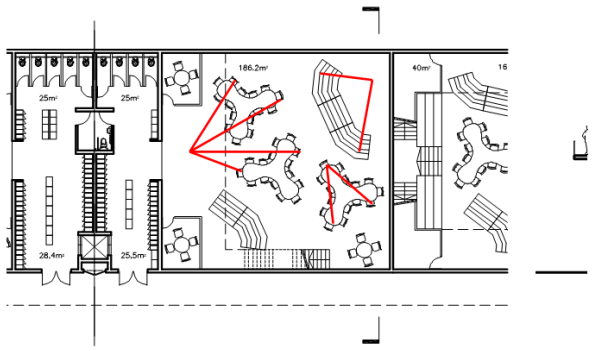

Figure 1: Potential source and receiver locations within a 21st century learning environment.

Furthermore, the sound source maybe a child or young adult with a distinct voice spectrum or an interactive MP3 file being played over the web for the benefit of a wider listening group. In these circumstances, the clarity of sound will inevitably be in a direct relationship to not only the amplitude but also the reverberant conditions and underlying sound levels in the space, which may be attributable to building services noise or noise ingress from exterior road traffic.

2 Design standards and speech intelligibility

Acoustic design standards for schools are typically defined by the School Board, with a general reliance on objective standards from good practice guides such as ANSI/ASA S12.60[2] and the ASHRAE Handbook[3]. Whilst these guidelines provide a wealth of guidance for the acoustic requirements of sound isolation, underlying background sound levels and reverberation in core-learning spaces little or no information is provided about speech intelligibility. Speech intelligibility is an important measure of the effectiveness or adequacy of a communication system in a noisy environment.

The UK Government Department for Education and Skills document Building Bulletin 93 (BB93) Acoustic Design of Schools: Performance Standards[4] provides design guidance for educational boards, architects and engineers involved in the design of both new and renovated school buildings. The guidance recognizes that open plan spaces require additional specification due to the complex acoustic conditions and provides specific recommendations for the speech intelligibility and privacy performance standards

during instructional group or critical activities and between workgroups. In some cases, supporting computational predictive acoustic modelling of the open plan space is required as part of the building code approval.

3 Acoustical design to improve speech intelligibility

As a starting point, the acoustician should seek to minimize the variables under their direct control. The potential for intrusive sounds can be reduced, but not necessarily eliminated, by the provision of large amounts of acoustic absorption within the space. Acoustically absorbent surfaces should be maximized with the use of not only highly efficient ceiling and wall treatments but also soft furnishings and carpeted floors. The use of "soundclouds" or acoustically absorbent wall panels can offer potentially delineated areas within the space that have low reverberant conditions ideal for individual learning.

The underlying background sound level should be low, although not unduly quiet, and more importantly constant and steady in nature. The over-reliance on mechanical services to provide background sound should be avoided and consideration should be given to the use of white or colored noise systems in open plan areas as the potential acoustics benefits are well-merited.

Finally, the use of operable screens or moveable furniture should be utilized to provide barriers to sound transmission paths within the open plan areas. Acoustic glass wall dividers and operable walls are capable of achieving levels of sound isolation commensurate with the objective standards outlined within the best practice guidelines. However, in areas that are recognized as noise generating (e.g. music practice rooms or drama spaces) extra provisions would be necessary to achieve higher sound isolation.

The use of moveable raked bench seating not only provides opportunistic physical barriers but also increases the potential for sound absorption within the space. Moveable furniture allows schools to not only orientate spaces as they require but also enables short-lines of sight between teachers and students, which increases the speech intelligibility within the workgroups.

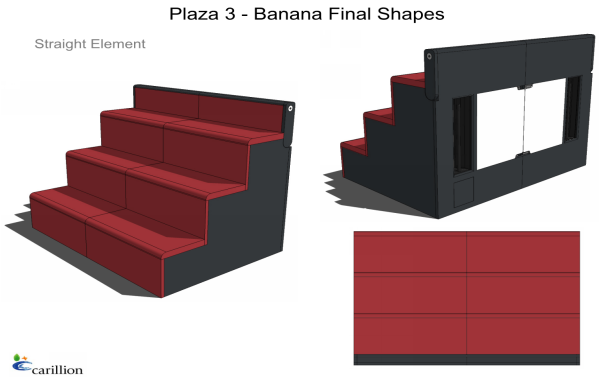

Figure 2: An example of fabric covered raked mobile seating (*courtesy of Carillion UK plc*.)

4 Conclusion

Overall, while 21st century learning presents considerable challenges to the acoustician, securing appropriate acoustic conditions for group, team and individual learning that also includes design flexibility is fully achievable with adequate planning and the inclusion of measures that increase sound absorption, reduce noise intrusion and promote clear, short-lines of sight for improved levels of speech intelligibility.

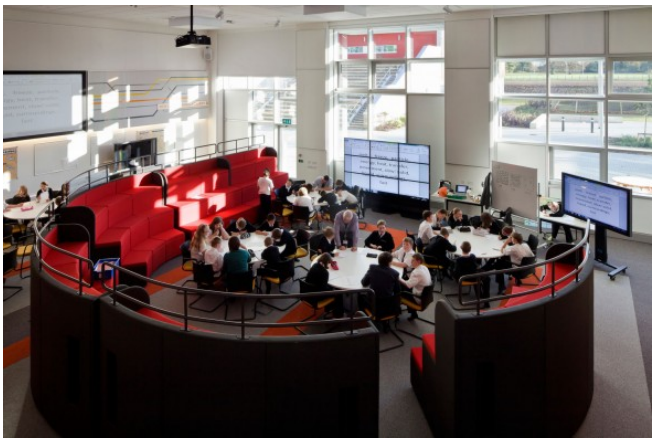

Figure 3: An example of a 21st century learning environment.

References

1 Cornell, P. (2002). "The Impact of Change in Teaching and Learning on Furniture and the Environment." In Chism, N. & Bickford, D. (2002). The Importance of Physical Space in Creating Supportive Learning Environments. New Directions for Teaching and Learning. No. 92, Winter 2002. San Francisco: Jossey Bass

2 ANSI/ASA S12.60-2010/Part 1, American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools

3 ASHRAE Handbook. Heating, ventilating, and air-condition systems and applications

4 Building Bulletin 93 Acoustic design of schools: performance standards, December 2014 UK Department of Education & Education Funding Agency