TEACHING ACOUSTICS IN ARCHITECTURAL PROGRAMS IN CANADA

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1 Introduction

This paper aims to reflect, based on experience of the author, on the way in which acoustics is taught to Canadian architectural students. A few years ago, the author faced the challenge to innovate the III-year undergraduate acoustics course at Ryerson University. The goals of this course, named "Light/Sound in Architecture" (ASC521), are "*to develop a basic understanding of lighting and sound, and to become familiar with the primary modes of characterizing and quantifying light and sound in engineering terms. Basic design concepts and techniques used to manipulate and control sound and light in buildings will be explored*."

The process of updating the teaching approach and the contents of this course started with the analysis of other similar courses offered in Canada. Currently, there are 11 university schools of architecture which have been granted CACB Accreditation in Architecture. Based on the information available on the websites of these programs, the analysis showed that while the Architectural Science program at Ryerson University, as well as some other institutions, included into a single course the contents of lighting and acoustics, many programs ignore the subject of acoustics in a specific manner (Table 1). The common reason behind this decision is the lack of a faculty member with an expertise in acoustics or the other competitive requests to get the accreditation of their programs, which do not leave space for a dedicated course about acoustics.

This situation is probably known and no surprising; in fact, a NSERC CREATE application was submitted a couple of years ago with the title "Training Program for Acoustical Synthesis in High Performance Buildings and Communities" to increase to attention towards architectural acoustics in Canadian universities (unfortunately, it was not funded).

2 Acoustics at Ryerson architectural school

In order to understand some of the characteristics and constrains of the course ASC 521, it is useful to point that this course consists of 12 lectures offered once a week for 3 hours each. ASC 521 dedicates six classes to acoustics (and six to lighting), a surely short time to deliver its content properly and deeply. In fact, through the course ASC521, students should become familiar with basic laws of sound propagation in rooms, as well as the design criteria and analysis procedures for the acoustic design of performance spaces. Typically the course is taught in large classrooms (theaters) given the over 100 students attending it.

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Table 1: Acoustic courses in Canadian architectural schools

School	Program Name	Acoustics course
University of British Columbia	Masters of Architecture more courses in Mechanical and Civil Engineering	ARCH 531 - Architectural Technology II MECH 405 - Acoustics and Noise Control MECH 505 - Industrial and Environmental Acoustics and Vibration MECH 584 - Advanced Engineering Acoustics PHYS 318 Acoustics
University of Waterloo	Bachelor of Architectural Studies	ARCH 272 - Interior Environments: Acoustics and Lighting
Universite de Montreal	Bachelor of Science in Architecture	ARC 5317 - Lighting Engineering and Applied Acoustics
Carleton University	Bachelor of Architecture	*ARCN 3003 - Theatre Production*
Dalhousie University	Master of Architecture	ARCH 5208 - Acoustics
McGill University	Master of Architecture	ARCH 555 - Environmental Acoustics
Athabasca University	*Post-Baccalaureate Diploma in Architecture*	ARCH 526 - Architectural Design: Acoustics

One of the elements that emerged in teaching this course is the somehow limited attention of students who believe that in an architectural program, the no-studio courses would deserve less attention than design courses. In the case of subjects such as acoustics, which is perceived as an engineering discipline with strong bases into physics, students also consider the course far from the architectural profession. As a result, new pedagogical approaches were introduced to enhance students' participation.

The course has been traditionally based on describing room acoustics using photos and graphs, while a visit to a notable performance space allowed students to give the spatial sense of a room, but often it failed at providing the experience of listening the different acoustic attributes of a space. It was believed that the possibility to compare different sound spaces using auralizations would have allowed students to get better experiences.

Some novelties were hence introduced in ASC 521 over the last few years: students had to visit and describe both architecturally and acoustically a performance space, then a room acoustic simulation was run during a lecture in class to show some of the challenges of the acousticians' profession [1], and finally, sound level measurements were done.

A Ryerson Learning Teaching and Education Fund grant allowed to develop new ways for teaching acoustics. The project epitomized the ambition of Ryerson University

towards applied learning while constantly innovating its offerings in blended learning environments through creating immersive virtual acoustic experiences. In fact, while a great deal of emphasis is placed upon the visualization of space during the design, yet the acoustics of a space is often poorly considered by architects. Based on the architectural data provided by the students (Fig. 1), the author aimed at creating a repository for collecting and sharing acoustic data about performing spaces, such as impulse responses and auralization. This intent aimed to enable students to explore room acoustics beyond class hours and to create a new way to experience a room by allowing to listen to auralizations done in different halls. Since the intent is that this large data source will grow in the following years, it was decided to collect all the data into two open-source e-books which to showcase the acoustics of main Canadian performing spaces (Fig. 2). Once the impulse response collection and the auralizations will be completed done, it will be possible to conduct a virtual trip in many Canadian performance halls.

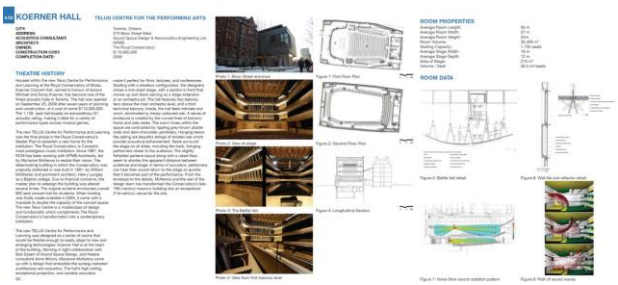

Figure 1: Example of the concert halls description in the e-book.

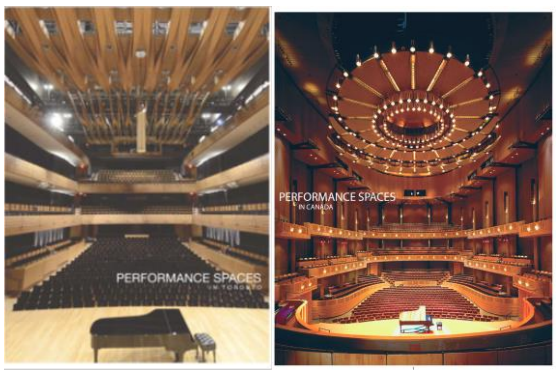

Figure 2: Covers of the e-books including 70 performing halls.

The intended e-books will also offer the possibility to listen to different sounds in the same space, allowing to understand the importance of performing a given music in a space with a particular acoustics, being more experiential leaning that the technical validation of sound formulas.

Another important novelty in ASC 521 was represented by the introduction of the use of smartphones into the teaching delivering. Smartphones have evolved into powerful computing machines with exceptional capabilities and many built-in sensors. Meanwhile, smartphone developers now offer many sound measurement applications (apps). This allowed to base two course assignments on measurements done in real life environments with dedicated apps. Recent studies have compared and examined available sound recording apps for smartphones, and have found that some apps, such as SoundMeter give good results [2]. Without doubting that accurate sound measurements would need to be conducted using professional sensors, but for the sake of practicality (given the over 100 students attending ASC521), students were asked to use their smartphones for assignments such as: "*in pairs, after having downloaded on your smartphones at least two apps each, conduct measurements of different urban sound environments (with different average sound pressure levels), and discuss the sound level results of the different apps*." Students could hence figure out common sound pressure levels but also inconsistencies of their devices as they became aware of the limits of these apps and of the importance of detailing reporting and professional writing (Fig. 3).

Figure 3: Samples of the submitted assignment with app measures.

3 Educational opportunities and challenges

Many questions raised from the first experiences about introducing new educational approaches in acoustic teaching. First of all, about the possibility for smartphone apps to replace a professional measuring devices and about how much these apps should be included in our teaching. The results proved that sound pressure level measurements were poorly detected with smartphones. Comparing different apps on the same or on different smartphones resulted in significant fluctuations of the measured values. This means that smartphone apps are not very reliable, although they represent a resource for enhancing students' participation and engagement beyond class hours. The limits of the app force to rethink their values in order to build a more scientifically valid exercise.

Finally, the e-books that have been created still include few rooms, and hopefully with the support and donation of Canadian acousticians, more impulse responses will be collected in the future.

References

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[2] C.A. Kardous and P.B. Shaw. Evaluation of smartphone sound measurement applications. *J Acoust Soc Amer*, 135(4):186-92, 2014