



**ICA 2013 Montreal  
Montreal, Canada  
2 - 7 June 2013**

**Noise**

**Session 2pNSb: Soundscape and its Application**

---

**2pNSb6. The practical SoundLab for architects: sound parameters as a design tool**

**Juergen Bauer\***

**\*Corresponding author's address: Department of Architecture, Waterford Institute of Technology, Ireland., Waterford, 00000, County Waterford, Ireland, [jbauer@wit.ie](mailto:jbauer@wit.ie)**

The experience gained from exploring the subject of Acoustics with architectural students in Waterford Institute of Technology (Ireland) suggests that a studio situation can be exploited and used as a case study for young designers to become familiar with basic sound phenomena. From phase 1 of previous research, the student "audiovisual design workshop" concluded that class rooms, that perform poorly acoustically, can help to strengthen the students' understanding of the sonic environment, in a way that the students were exposed day after day to high reverberation, low speech intelligibility, and the "Lombard" effect in their own studio. However, becoming aware of poor acoustics necessitates a creative follow-up: how to design and create good acoustics, or how to develop the environment as a "soundscape"? Consequently, phase 2 of our audiovisual design workshop introduced the practical sound lab: our students were required to design and to build acoustic panels for their own studio environment. These "prototypes" would be analyzed as part of an Acoustic Laboratory, with specialist advise.

---

Published by the Acoustical Society of America through the American Institute of Physics

## Introduction

The experience gained from exploring the subject of Acoustics with undergraduate architectural students in Waterford Institute of Technology (Ireland) suggests that a studio situation can be exploited and used as a case study for young designers to become familiar with basic sound phenomena.

From phase 1 of previous research, the student “audiovisual design workshop” concluded that class rooms, that perform poorly acoustically, can help to strengthen the students' understanding of the sonic environment, in a way that the students were exposed day after day to high reverberation, low speech intelligibility, and the “Lombard” effect in their own studio.

However, becoming aware of poor acoustics necessitates a creative follow-up: how to design and create good acoustics, or how to develop the environment as a “soundscape”?

Consequently, phase 2 of the audiovisual design workshop introduced the practical sound lab: the students were required to design and to build acoustic panels for their own studio environment. These “prototypes” would be analyzed as part of an Acoustic Laboratory, with specialist advice.

## The Audiovisual Design Approach in 4 Steps

In the proposed audiovisual design approach, the following topics have been identified and issued:

### *1. The Experience of Room Acoustics*

The generic training in architectural education that aims to describe the visual perception of space, as precisely as possible, is expanded and applied to aural perception.

Without any prior introduction to the theory of acoustics, students are introduced to music and speech audio samples that are simulated with different reverberation times and can be retrieved from the web. The concept of reverberation time and speech intelligibility is new to most students and this listening experience offers them a first criterium as to how to discuss the quality of the sound around them i.e. their class room environment in their own words.

The initial discussion focuses on the distinction between “clear” and “blurry” and it encourages students to verbalize what they are hearing. In this way, step 1, “Experience”, puts “perception versus physics” (Grueneisen, 2003) and prioritizes subjective parameters such as loudness, pitch and timbre in relation to objective ones, such as level, frequency and spectrum (Hoover, 1991/2007).

Finally the discussion on “clear versus blurry” would conclude with the explicit introduction of the terms “reverberation” and “speech intelligibility”. With reference to these key terms, it has proved very helpful to emphasize the similarities between reflection and absorption both in relation to both light and to sound. (Day-)light is interpreted, in this case, as a visible design tool and sound as an invisible one.

### *2. Case Studies of Room Acoustics*

The aim of the audiovisual design approach is not just to apply acknowledged standards and recommendations of good class room acoustics; the students are encouraged to become enthused to explore and develop design concepts that have been informed by both visual and by aural considerations.

Simple simulations for class room acoustics, provided by industries, are used to explore the impact of materials and surfaces on the reverberation time and speech intelligibility. However, step 2, “Case Studies”, aims to explore acoustics in a way not as a means of optimization, but as a tool to create atmosphere.

Analyzing international case studies, that are visually and aurally appealing to the students, are a key to emphasize the potential of sound in architecture. This analysis can be in the form of a visit to a building, or by research that is supported by multimedia documents.

What is a significant acoustical case study in architecture for undergraduate students?

It is presumably one that is challenging the acoustic expectations according to its spatial performance. For example, most people would expect a large building, such as a church or a big hall to have rather a blurry sound or atmosphere, yet there are examples that surprisingly are not the case: The public library building in Seattle (designed

by OMA Architects and completed in 2004) is such a significant case study: even though hundreds of users utilize the building and flow through a sequence of multi-storey-high open spaces, like in a city within a city, the sound that one experiences, as soon as one enters the building, is that of amazing intimacy. This is even more astonishing as one is faced, on entering the building with large amounts of concrete and glass surfaces throughout the huge interior volume. It is believed that a case study like this awakens the curiosity of the audiovisual exploration of architecture and highlights its potential.

### *3. Remedial Elements in Room Acoustics*

The class room environment that is used as a living SoundLab has a current reverberation time of more than 1.0 seconds. This provides the basis for a practical exercise for interior design ideas that would contribute to sound absorption. Step 3, “Elements” identifies the principles of frictional, flexural and resonant absorbers; however, the practical exercise currently focusses on frictional/porous absorbers.

It is important to clarify that the main task here is not to produce standard acoustic panels, but to design interior space by architectural means, that is also sound-smart. The exercise aims to conclude that the way a building or a room sounds is part of an initial considered designed plan.

The practical approach of building some absorption panels “sounds” rather simple, but it is the most crucial step of the audiovisual design approach: the intuition of the design idea has to incorporate some scientific principles from the very beginning. No absorption panel can be detailed cleverly without the designer knowing about the concept of speed, frequency and wavelength of sound. It is worth mentioning that this task is challenging for both design students and design instructors. The danger of overloading with theory is a fine balance for designers who are expected to be free to develop new ideas, and it is debatable how much theory can encourage, or block an idea.

The Building Bulletin 93 “Acoustic Design of Schools”, issued by the UK department of education and skills (Shield, B., Hopkins, C., 2004), and the ASA-publications on class room acoustics have been very helpful guidance documents for the preparation of the student project. Both documents are currently being fully reviewed and are expected to be relaunched soon (Shield, Canetta, 2012), (Woolworth, Phinney, 2012).

### *4. Analysis Tools for Room Acoustics*

Step 4, “Analysis” is a review and a re-evaluation of the design. “Analysis tools” are understood to examine ideas. The results are discussed on two levels: by calculation and/or simulation of the reverberation time in the class room environment before and after the installment of the absorption panels, and by comparison and discussion of all samples with the support of an Acoustic Consultant.

While the first three steps, “experience, case studies and elements” are supposed to provide the grounds for appropriate design decisions with regard to sound, the fourth step, “analysis”, aims at fine-tuning these decisions. It is crucial that these analysis tools are easy to use by the designer. It is argued here, and with particular respect to the preliminary design process, that high-end mobile phone applications can be preferable to complex and training intense auralization software. More sophisticated software packages will greatly inform the audiovisual design process, but seem to be more applicable for architectural training at a higher educational level.

## **Conclusion**

The practical soundlab for architects implements aural awareness into a design process that is commonly led by the visual senses. It addresses the interdependency between the aural and the visual perception; it refers to the current soundscape research (Schulte-Fortkamp, 2012). Furthermore, like in the soundscape approach, the sonic environment is interpreted as a sound resource, rather than noise that needs to be eliminated. Designers can contribute to this approach, as they are trained not only to perceive and to observe the environment as it exists, but also to imagine and to plan the environment the way it could, or should be.

The combination of experiencing sound in an every-day-environment, like in a class room setting and studying the acoustic atmosphere of provoking case studies that are beyond expectation, will allow design students to model the built environment with both their eyes and their ears.

The feedback from previous undergraduate students on the audiovisual design approach has shown that designers are actually well aware that the “intuition and metaphysical power of the arts” need the “fresh blood of science” (Wilson, 1998). The students develop an appreciation for sound as soon as they are introduced to it three-dimensionally. Therefore, the next step of the audiovisual design approach, as a developing project, will focus on the

relationship between sound and space geometry. It will be exciting to learn more about architectural forms and how they respond acoustically.

## REFERENCES

- Grueneisen, P. (2003), *Soundspace – Architecture for sound and vision* (Birkhauser, Basel Boston Berlin), Chap 3, p. 53.
- Hoover, K.A. (1991/2007), *An appreciation of acoustics* (Seminar/Textbook at ASA-Meeting Salt Lake City, June 2007), Chap. 4. Sound indoors pp 4.3., Chap. 7. Hearing and Psychoacoustics, pp 7.7.
- Shield, B., Canetta, R. (2012) *Impact and revision of UK legislation on school acoustics* (Proceedings of the 164<sup>th</sup> Meeting of the Acoustical Society of America) The Journal of the Acoustical Society of America, volume 132, No. 3, Pt. 2 of 2, p. 2045
- Shield, B., Hopkins, C. , Editors. (2004) *Building Bulletin 93 – Acoustic Design of Schools* (The Stationery Office, London), Introduction, Section 1: Specification of acoustic performance, Section 4: The design of rooms for speech, p. 9, p. 14, pp. 53.
- Schulte-Fortkamp, B. (2012) *Laermminderung in der Stadtplanung*, in: Boehme, C., Kliemke, C., Reimann, B. , Suess, W. Handbuch Stadtplanung und Gesundheit,(Huber, Bern) p. 156.
- Wilson, E. O. (1998) *Consilience: the unity of knowledge:* in: Grueneisen, P. (2003), *Soundspace – Architecture for sound and vision* (Birkhauser, Basel Boston Berlin), Chap 2, p. 18.
- Woolworth, D., Phinney, P. (2012) *Creation of an architect's companion booklet for ANSI 12.60 American National Classroom Acoustics Standard* (Proceedings of the 164<sup>th</sup> Meeting of the Acoustical Society of America) The Journal of the Acoustical Society of America, volume 132, No. 3, Pt. 2 of 2, p. 2046.