From noise control to sound design: the class room as a soundscape project
by Juergen Bauer, Tramore, Ireland

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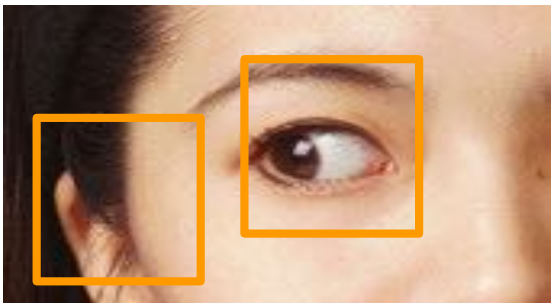
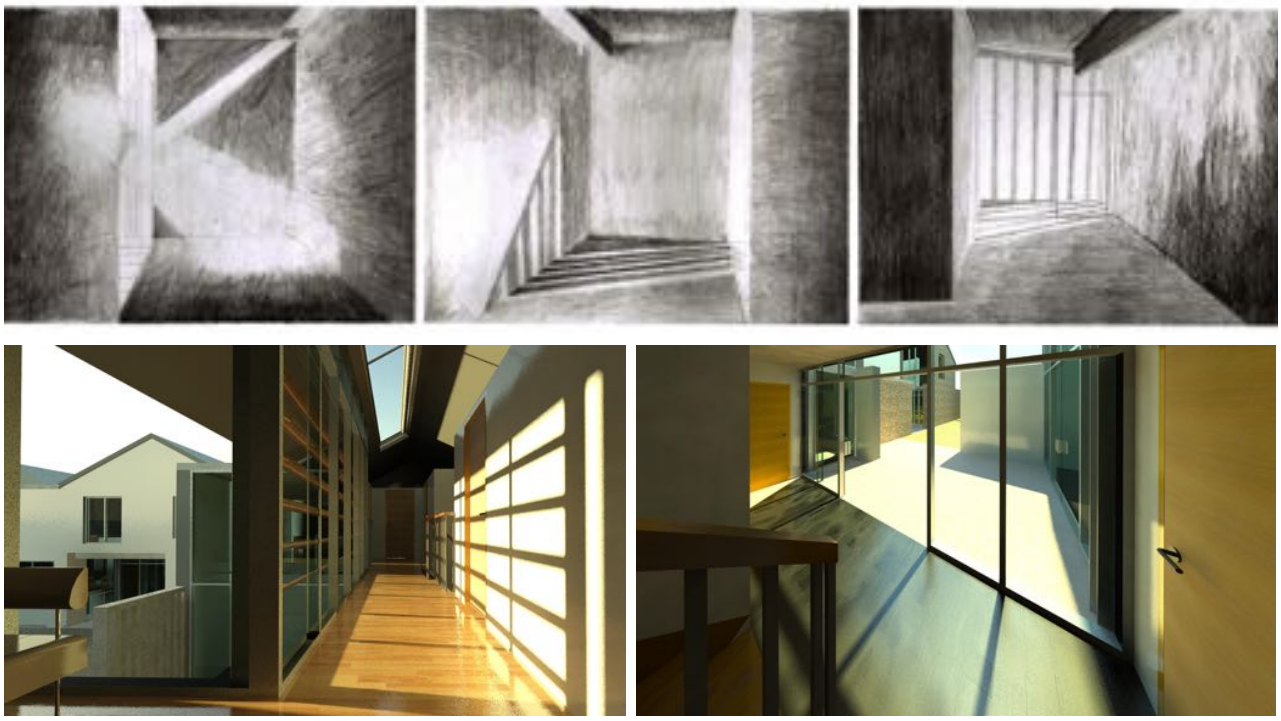
Abstract

As part of an overall campus building project, the Department of Architecture in Waterford Institute of Technology in Ireland moved to provisional premises in autumn 2011. The premises was a former warehouse, dating from 1875 and is located in the city centre. While this building is a fine example of historic industrial architecture which was previously used successfully as a museum, as a school venue it is “acoustically seen” as inappropriate. The studios are halls rather than rooms and have an approx. height of 5 meters; two classes share one unit and are subdivided by screens, with lectures and tutorials needing to be scheduled at different times in order to avoid (acoustic) clashes. Most surfaces are hard, and in some cases, the class units are even exposed to open galleries and circulation areas.
How can this noise problem be transformed into a soundscape project? How can the current situation be used to develop sound as a design tool that informs an awareness of sound phenomena, that strengthens an understanding of sound propagation and that instills a confidence to design using this information?
This paper investigates different methods that could be used to introduce sound as a design tool in early architectural education and summarizes the learning outcomes derived from using the class room as a sound design lab.



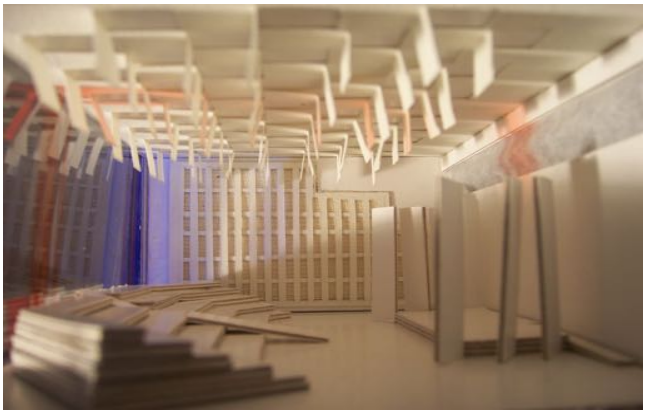
The Audiovisual Design Workshop

In recent years, we have been exploring the question of how a basic understanding of acoustics and sound could be introduced in early architectural design education. We believe that architecture is a multi-faceted profession, with a strong emphasis on environmental issues and that good architectural design will always contribute to the user's wellbeing.
During the first term of the second year, our students are introduced to daylight as a design tool; they explore light and shadow, light reflection, diffusion and absorption in their projects.



2nd year student projects -
Michael O'Donovan: Cast Shadow Studies
Andy Kiely: Sunlight Studies

During the second term of the second year, our students are exposed to some hearing experiences, using audio samples and as a result, are stimulated and introduced to another design tool: sound.



2nd year student projects -
Rachel Farrell: Lecture Hall

The question focused on during the second term is: how is your design project – not only – going to look like but how is it going to sound?
This is more a provocation to reflect on sound in architecture rather than a scientific approach to acoustics, but the response of our students has shown that the idea of the "audiovisual design workshop" actually is an exciting approach to design education.

The way we introduce sound to the students is actually very simple:
Firstly, we show them short scenes from famous movies. However rather than showing the visual version, we merely play the soundtrack of each scene. The students are asked to listen carefully to the soundtrack and then to imagine the space which might relate to the sound. (I need to clarify that the films are from the sixties and earlier, a time with which most of our young students would not be familiar.) We then encourage them to describe their observations and to imagine the space from where the sound came. (After the discussion, we re-show the films again - this time with images.)

Orson Welles in: The Third Man, UK 1949 (Directed by Carol Reed)
Paul Newman in: The Torn Curtain, USA 1966 (Directed by Alfred Hitchcock)

Secondly, we expose the students to some audio samples for speech and music with reverberation times between 0.5 and 5.0 seconds. We take these samples from the websites of several specialist acoustic manufacturers. Again, the students are asked to describe the sound and then to imagine the space, or the volume of the space according to each sample.

The learning outcome of this hearing experience can be summarized as follows:

1. Training Students to Describe Sound

After some short and basic audio samples, our students are very capable of describing their listening experiences and of identifying differences between them: they are able to distinguish between sound qualities using attributes such as soft, hard, warm, cold, dry, boomy etc., and most importantly clear versus blurry.

On this basis, they can easily be introduced to two parameters of how to describe sound: speech intelligibility and reverberation time, clear versus blurry, hard versus soft, consonants versus vowels, and all this is as a result of hearing experience, rather than scientific definition.

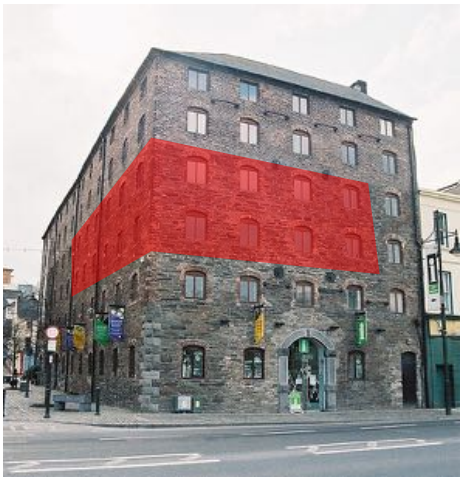
2. Fine Tuning the Ear in Architectural Training

As young designers, the students use their listening experience to imagine the space (and specifically its size) belonging to the sound they are hearing. As a result of the exercise, it is apparent that our students are innately able to envisage space by means of audio samples.

This of course is not really new; surely everybody can instinctively guess where a certain sound is coming from: inside or outside, a huge space like a cathedral, or a smaller space like a canteen. However, we believe using sound samples allows the hearing sense to be refined and it allows the student to re-think the quality of the space. As a result, we find this exercise to be an exciting contribution to the training of architects and to raising of an audiovisual awareness.
Being taught to see or fine tuning the eye is an expected outcome of architectural education. We suggest that fine tuning the ear should also be included in the training.

3. Linking Awareness of Sound to how Sound Travels

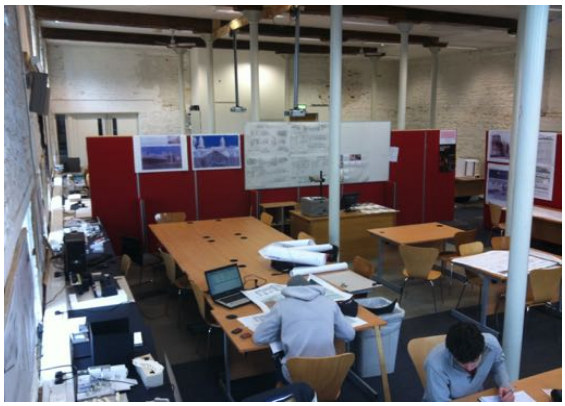
How could we continue from here? How could we develop from raising the awareness about sound to a better understanding of how sound travels? The opportunity came more or less over night.



The Granary in Waterford, Ireland,
Class room area focused here is indicated in red.

The perfect Case Study

As part of an overall campus building project in Waterford Institute of Technology in Ireland, the Department of Architecture moved to provisional premises in autumn 2011, in a city centre former warehouse, dating from 1875. We had been based in prefabricated units before: thus, we were lucky to be housed in considerably improved premises. However, while the new location is a fine example of historic industrial architecture, which was previously used successfully as a museum, as a school venue it is “acoustically seen” as difficult to deal with. The studios are halls rather than rooms and have an approx. height of 5 meters; at least two classes share one unit and are subdivided by screens, with lectures and tutorials needing to be scheduled at different times, in order to avoid (acoustic) clashes. Most surfaces are hard, and in some cases, the class units are even exposed to open galleries and circulation areas.



Granary class rooms on 2nd floor: screens subdividing class units and circulation area

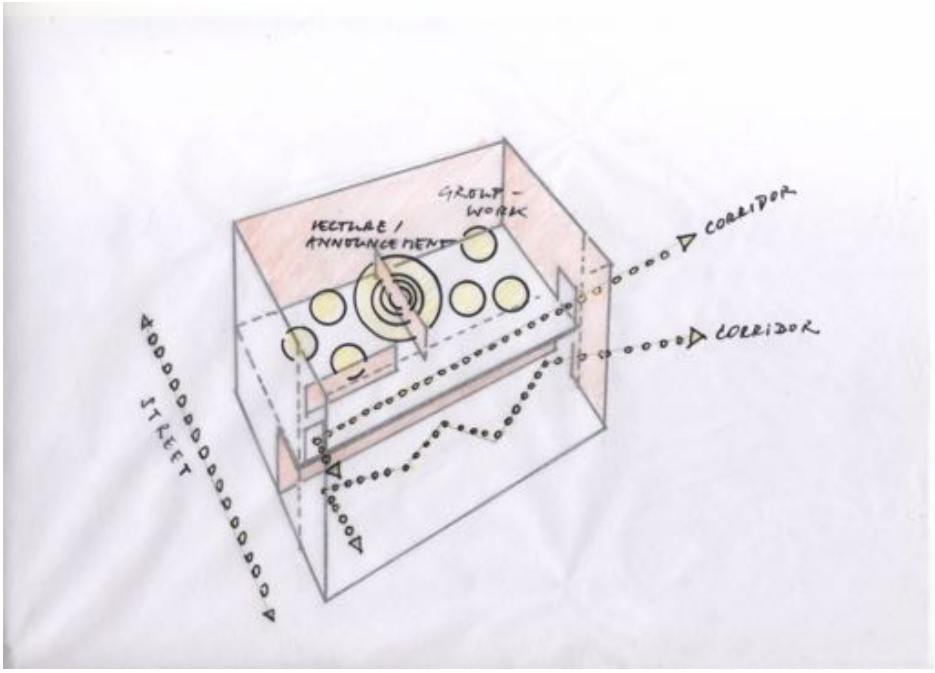

Granary class rooms on 2nd floor: gallery and window display

It is surely fair to say that this is quite a unique, but not necessarily a sophisticated learning environment, so further investigation was necessary.We did a survey of all surface areas and applied materials in the class rooms and on this basis, we consulted Ecophon UK, who kindly did a rough calculation of the reverberation time for us.

Reverberation time RT
(by courtesy of Ecophon UK, Calculation based on student survey of surface areas)
Surface Area 917 m²
Volume 1135 m³
Tmf (Current Situation) = 1.277 sec

Those who are familiar with this issue will not be surprised: the reverberation time in our class room environment is more than 1.2 seconds. The recommended reverberation time for class rooms, according to British Building Bulletin 93, should be 0.4 seconds, taking into account the special needs of hearing impaired students: 0.8 seconds would be considered acceptable (BB93, 2004). 1.2 seconds reverberation time would be almost perfect for an operetta or a musical theatre (Grueneisen, 2003). For educational premises, any reverberation time longer than 1.0 seconds surely falls into the category of “health damaging”.

Open plan school layouts, whether they be in purpose-built, or applied premises are facing at least one huge problem: the perception of one sound (usually wanted) being affected by the presence of another sound (usually unwanted), or in other words auditory masking.
In our case it is even more complex. The following quick sketch highlights the cluster of sound events, from an architectural perspective:



The two class room areas are mainly used for group work or discussions in small teams.
In both areas there are announcements and informal lectures; the classes in the two areas are scheduled at different times, but having said this, spontaneous meetings and debates tend to take place simultaneously. The whole class room area opens up to a corridor zone with circulation of students and staff on two levels. There is also sound emission from the nearby street with four traffic lanes.

As can be seen, this is a perfect case study for experiencing (unwanted) sound, and there is no doubt that in an acoustic environment such as this one, our students have become intensely aware of unwanted sound.
This case study is, therefore, certainly a live case study. We did not analyse it with an external "cold" eye, or ear, as we have first-hand experience of this space.
We could also say: we have been suffering from this long time experiment.

What can be summarized from our exploration?
I would like to point out two dimensions of our experience, which would include both students and staff:

1. The discovery of sound

For a designer, it is exciting to find out more about sound propagation by listening, i.e. by practical experience. Our 2nd year students obviously enjoyed our audio adventure and our in-house case study. The students now talk about the "amazing bouncing of the sound from the wall" or "how much materials affect the acoustics of a room" and as a result appear to have taken home an

appreciation for sound.

Discovery is the fun part of dealing with sound. However, the sound needs to be analysed

2. The identification of sound components

The analysis of sound starts with identifying different sound events (or components) that might happen at a location at the same time. This can be done in a very simple way: e.g. with a quick sketch as shown before.

Different sound events need different treatments, or architecturally speaking: an architect who has identified more (sound) clues will make the cleverer (sound) design decisions.

The proper analysis of sound depends on professional expertise and an early cooperation between an acoustician and a designer should be seen as an enjoyable experience that leads to greater understanding.

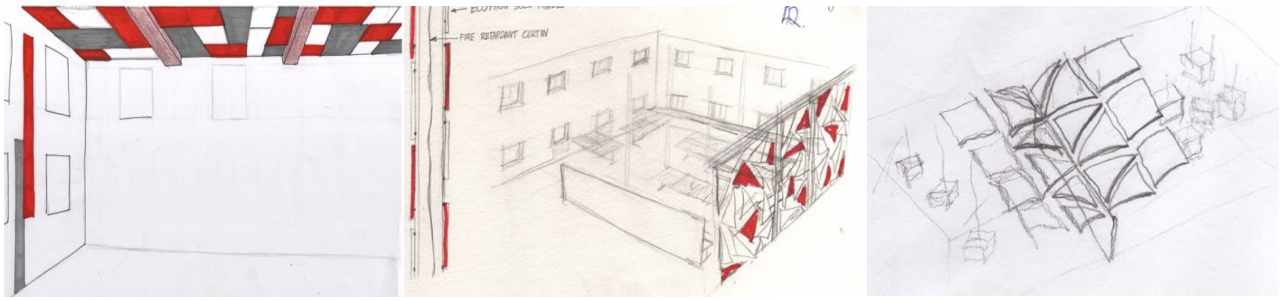
One of our 2nd year students reflected on how human behaviour influenced sound and vice versa, how sound influenced human behaviour.

A typical example of this in our class room environment is the speaker who tends to increase the volume of his or her voice, because it is apparently so noisy. Acousticians call this “auditory masking”, or the “Lombard effect”. Some may call it a “Cocktail party effect”. Consequently, we now call our following student workshop an acoustical cocktail party.

The Acoustical Cocktail-Party

Stimulated by the listening experiences, informed by an excellent lecture presented by industry, and hardened by the stark realism of our acoustic environment, we asked our students to discuss and to sketch design ideas of how to improve the sound in the class room.
Being creative is not easy; being creative by order is almost impossible. Nevertheless, our students came up with some first ideas within slightly more than an hour.

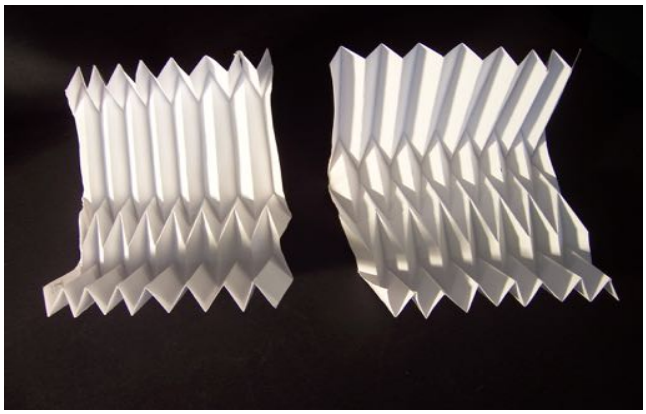
Students presenting workshop ideas

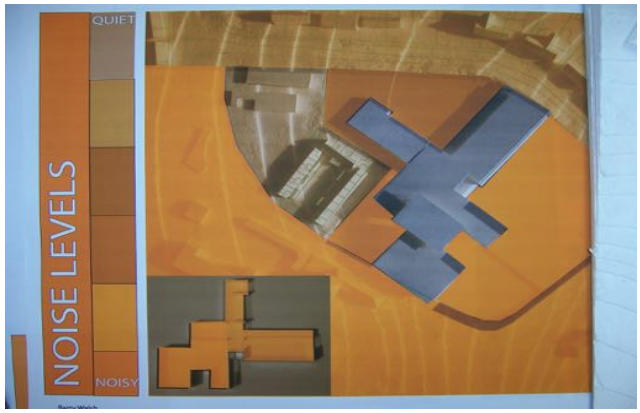


Workshop design sketches

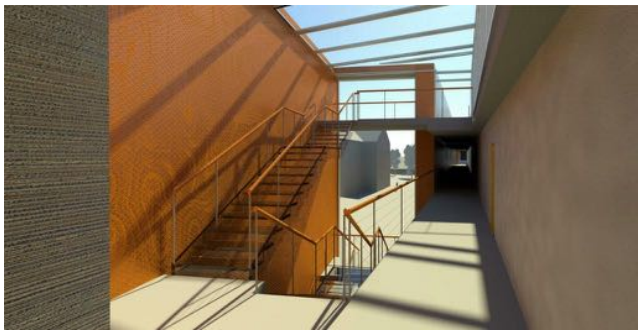
The design sketches, as such, are surely less significant than the fact that 2nd year students develop an architectural idea that is mainly sound-informed. Obviously, some new discoveries about sound have contributed to the intuition of the young designers: they transformed a noise problem into a sound project, or: an architectural landscape into an architectural soundscape.

However, this is the outcome of a workshop session and the group dynamics of the day.
Would the students keep reflecting on sound? Would this have an impact on their current individual semester projects? How would their projects sound, and how would they visualize sound in their final presentation?





2nd year student projects -
Danilo Suhrweier: Acoustic Panel
Barry Walsh: Sound Mapping



2nd year student projects -
Andy Kiely: Polished Concrete Floor on Composite Deck versus Solid Timber Flooring on Acoustic Batten

No doubt, the topic of sound has resonated in these projects. A student performance like this would prove that more listening experience for architects is a good idea and that acoustics does not limit, but enhance the design process.
Spaces are more harmonious when the stimuli of all senses are balanced. In order for architectural students to achieve this, their aural sense should not only be provoked or sensitised, but trained.

From Noise control to Sound Design: Conclusion

One of our students said: “I cannot get my head around how to get a sound into an architectural drawing”. Apparently, this is a hard task. However, the Audiovisual Design Workshop approach will support implementing sound issues into architectural design as follows:

1. Analyzing sound and breaking it down into components, or: “identifying the players in the drama”

An architectural project is not generated by intuition alone. Every building concept is based on the analysis of the site and the users' needs: the brief.
“Identifying the players in the drama” means that specifically identified issues can be addressed individually. This includes sound being addressed more specifically.

2. Working with contrasts, or: “clear versus blurry”

Developing a project in alternatives and variants is an approved design technique. The final solution will result from discussion and the interpolation between extremes.
“Clear versus blurry” can be one way to explore a sound atmosphere in a design proposal, by playing with materials, surfaces and fittings, and last but not least, with the shape of a space.

3. Building up both a visual and an audio archive, or: “remembering sound”

Like all professions, architects build up a mental archive of knowledge and methods. Maybe unlike other professions, their archive is presumably one that is full of visual images.
“Remembering sound” is a process that would add sound to these images. The outcome of this process is a soundscape archive.

4. Using sound as a design resource, or: “envisaging sound”

If site and brief analysis are essential to develop a design idea, as a response, the site has also to be questioned in terms of its sonic components and the brief has to be investigated in terms of acoustic requirements.
“Envisaging sound” is the essence of the audiovisual design workshop. The appreciation of the sonic environment and the understanding of sound phenomena are developed by hearing experiences and the exploration of architectural case studies in which sound is a strong factor in the design process.

The class room as a soundscape project with our 2nd year architectural students has been a tool to discover sound, to (roughly) identify its components and to inform design projects by this.
We have wondered why we have not done this much earlier, but we hope that our listening ability has improved by the whole process.

However, is listening really a key asset for creating architecture?
In an interview with the BBC in 2004, the Italian architect Renzo Piano was asked: “... how do you

begin to start thinking about a building?" He answered: "... I don't remember one single job, even when they are so far away, that I started to work on without trying to understand the place, and to listen. You know place[s] talk, you just have to shut up and listen." (BBC 2004)
Maybe this statement should be taken literally.

Acknowledgements:
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Contact:

Juergen Bauer
Dipl. Ing. Architekt MRIAI MRIBA
Department of Architecture
Waterford Institute of Technology
The Granary
Hanover Street
Waterford, Ireland.
Email: jbauer@wit.ie

Credits:

Building Bulletin 93: Acoustic design in schools, p14. Published by the Department for Education, Runcorn Cheshire UK, February 2004, for free download see:
https://www.education.gov.uk/publications/standard/publicationDetail/Page1/BB93

Ecophon UK kindly did a rough calculation of the reverberation time that was based on a student survey of the volume and the surface areas:
Surface Area 917 m² / Volume 1135 m³
Reverberation time RT -
Variant "Without" = Current Situation: Tmf = 1.277 sec
Variant - Baffles (free hanging, 110 m²): Tmf = 0.867 sec
Variant - Wall Panels (60 m²) : Tmf = 0.953 sec
Variant - Ceiling Panels (270 m²): Tmf = 0.486 sec
Variant "Solo" (free hanging 18 m²): Tmf = 0.858 sec

The BBC Interview with Renzo Piano was produced in July 2004. It can be accessed online:
www.bbc.co.uk/radio3/johntusainterview/piano_transcript.shtml

Images (unless Waterford Institute of Technology, 2nd Year B.Sc. Arch):
The Third Man (UK 1949): www.dvdtimes.co.uk, retrieved March 2008
The Torn Curtain (USA 1966): www.johngoto.org.uk, retrieved May 2012
Granary Building Waterford: www.archiseek.com, retrieved May 2012

Websites used for audio samples (May 2012):
www.armstrong.com/reverb/main.jsp
www.ecophon.com/en/Acoustics/Room-Acoustic-Design
www.wilhemi.de/index.php/akustik-in-schulen/klassenzimmersimulation.html

Recommended Reading for our 2nd year students:

Steen Eiler Rasmussen: "Hearing Architecture" in:
Experiencing Architecture. Cambridge U.S.A. 1959, reprint 1989, pp. 225.

Peter Grueneisen: Soundspace – Architecture for Sound and Vision,
Basle Switzerland 2003, p 18 - 19 and pp. 42

Building Bulletin 93: Acoustic design in schools. Published by the Department for Education, Runcorn Cheshire UK, February 2004 (see above)