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ArAc- Multibook of Architectural Acoustics

Karolina Jaruszewska[a]*, Monika Rychtarikova[b], Thomas Wulfrank[c], Joanna Jablonska[d], Magadelna Boeck[e]

[a]*KFB Polska, Mydlana 7, Wroclaw 51-502, Poland*
[b]*KU Leuven, Dep. of Physics and Astronomy, Celestijnenlaan 200 D, Leuven 3001 , Belgium*
[c]*Kahle Acoustics, Avenue Molière 188, Brussels B1050, Belgium*
[d]*Faculty of Architecture of Wroclaw University of Technology, Boleslawa Prusa 53/55, Wroclaw 50-317, Poland*
[e]*gfai tech, Volmerstr. 3, Berlin 12489, Germany*

Abstract

This presentation introduces a didactic tool ArAc- Multibook of Architectural Acoustics (an interactive publication) whose main objective is to innovatively fill the gap in technical literature and to increase architects' awareness about the role acoustic comfort plays in the life of human beings.
The ArAc project demonstrates an innovative approach to education and professional development of architects in the area of acoustics. Professional books on architectural acoustics are aimed chiefly at readers with mathematical or technical background, usually graduates of electronics or physics faculties. Such studies have only a limited usefulness to architects, who intend not to study architectural acoustics as a separate area of knowledge, but to search for an inspiration regarding acoustically correct architectural solutions. The materials included in the multibook are to help architects in correct and unassisted solving of common and unsophisticated noise protection and interior acoustics problems. This type of knowledge is most useful in conceptual design works related to architectural acoustics, as well as in mutual understanding of different priorities that architects and acoustician working together may have.

ArAc-Multibook of Architectural Acoustics is a four-language application for mobile devices (tablets, smartphones both for iOS and Android) and on website. The Multibook is the first application of this kind in the form of a acoustics manual for architects enriched with audio, image galleries, animations, instructional videos and elements of interactive infographics.

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* Corresponding author. Tel.: +48717072400; fax: +48717072401.
E-mail address: k.jaruszewska@kfb-polska.pl

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1. Introduction

This article presents an innovative approach to lifelong learning in the field of architecture and construction. The application Arac-Multibook of Architectural Acoustics is the result of collaboration between researchers and entrepreneurs. The project team's wish was to create a 'multimedia book' that will be useful in architects' daily work. This means a tool perceived not only as an introduction to acoustic problems, but also as a constant help in the design process.

1.1. Needs Analysis

The analysis which lies at the root of the project shows the acoustic gap in recent architecture education program across European Universities. The difficulties described above are confirmed by the SME's. Companies complained about a lack of appropriate education and training, leading to weak competitiveness in the employee. In the participating regions, there is a need for competent and skilled employees, as well as a stronger role for educational organizations in fostering modes of action to improve quality of education in acoustics. To fill the gap between theoretical knowledge and practice experience with lifelong learning opportunities Partners have come up with the idea to develop in interactive tool in theme of Architectural Acoustics.

Current situation and desired change is to develop product aimed at adult learners, teachers, trainers, educational institutions, continuous education centres, via the partners in the consortium reaching across Europe. It is crucial for architects to learn more about modern methods of acoustic measurements, methods of design, solutions and materials in order to expand creation standards and quality of inner and outer build environment. This matter is important not only for large-scale investments like: concert halls, opera houses or theaters but for every-day use objects: single- and multi- family housing, commercial objects, etc.Constant development of both domain mentioned requires from professionals to extended and actualize their knowledge constantly in the field of equipment and technologies, solutions, materials as well as changing law and standards.

1.2. Teaching Method

The choice of a multimedia form of teaching was deliberate. The idea is to simply describe and visualise acoustic phenomena and to present acoustic knowledge in a practical way. It is difficult to present acoustic issues in printed form as it is impossible to visualise 'invisible' phenomena on paper. A tool to convey acoustic knowledge is multibook. Its form allows to explain problems and issues connected with architectural acoustics in a broader aspect.

1.3. Partnership created multibook

The partnership consists of experienced teams from organizations representing several European countries. KFB Poland provides expert knowledge in the field of architectural acoustics, industrial acoustics, vibroacoustics and environmental acoustics. The Laboratory for Acoustics situated in the Department of Physics and Astronomy of the Science Faculty of Katholieke Universiteit Leuven deals with physical acoustics, room, building and environmental acoustics. Kahle Acoustics provides acoustic consulting services to performing arts venues, such as concert halls, opera houses, theatres and auditoria. Wroclaw University of Technology (WUT) is one of the largest and the best technical universities in Poland. Research and education are strongly influenced by international cooperation with over 430 partner universities all over the world. gfai tech GmbH is an industry-oriented company specialized in production, marketing and sales of advanced innovation technologies. Project partners possess skills in the area of Architecture, Acoustics, e-learning tools and design thinking.

2. Multisensory teaching

A multibook is a form of publication offering great prospects for conveying information. Hence, animations and instruction videos are an ideal way to convey knowledge; the content is enriched with videos, audio, photos, graphics and elements of infographics (that allow you to see an object and understand how acoustic phenomena work).

This is a multisensory way of teaching. Multisensory teaching is based on involvement of various senses. It bridges two fields of knowledge where the language of physics merges with the language of images. For many years this process has proved to be more efficient and attractive for students and adults at all levels. New and innovative technologies allow application and common access to materials that comply with these assumptions. That is why significant emphasis should be put on the form and coherence of the materials.

Nowadays, learning becomes more ubiquitous than ever. With a personal computer and the Internet we have gained access to vast amount of data and owing to the mobile revolution this access is limitless. This is a powerful tool. Now we must learn how to use it efficiently. A possibility of learning in mobile environment responds to current situation of many people. They are constantly in a hurry doing a couple of things at the same time. Mobile access to learning database gives them a great possibility to spend potentially non-productive time for acquiring new information and skills. The multibook is the first publication of this sort in form of a coursebook on the subject of acoustics for architects.

3. Teaching content

Acoustic field in the aspect of architectural environment can be divided into three parts: building – connected with physical part of structure, interior – focused on inner sound quality and environmental – for value of urban space. In each domain we can find a substantial number of books dedicated either to architects or acousticians. The first publications can be subdivided into books presenting architecture and describing general acoustics parameters of presented examples and albums which mainly contain pictures without content. Publications devoted to acoustic are strictly specialized and cannot be treated as knowledge source to a wider publicity. There is a lack of tools which can be used by both groups as a platform of communication and exchanging concepts.

Content of the multibook is divided into two parts:

- Theoretical part. Scientific content which explains the nature of acoustic phenomena and problems in an efficient way
- Practical part with case studies. This part demonstrates how two disciplines, acoustics and architecture, merge and exploit their knowledge.

Theoretical chapter introduces the physical phenomena involved in architectural acoustics and forms the basis for further explanations in the following chapters. The key goals of acoustic design in an architectural context are to provide a reduction of unwanted sounds, noise and vibrations (field of building acoustics) and to ensure the most favourable conditions for the generation, transmission and perception of desirable sounds (mostly speech or music) inside buildings (field of room acoustics).

Building acoustics is related to the assessment and improvement of the degree of sound insulation of building elements for airborne noise and impact noise in buildings and to develop solutions for global noise control and acoustical comfort improvement.

Room acoustics deals with the effect that the geometry and surface properties of an enclosed space have on sound field, applying qualitative analysis of sound, and assessment of speech intelligibility and music perception in that space.

The next chapter addresses acoustic simulations and measurements. It presents classical and innovative methods of testing acoustic parameters. It also includes specifications of the standards with the description of requirements for

measurements and calculations that are very useful from the architect's work perspective. A measuring system enabling visualization of sounds, an acoustic camera, has also been shown. The Acoustic Camera is a beamforming device consisting of a microphone array with a built-in digital camera, a data acquisition unit/ data recorder and a computer running the measurement and analysis software. Measurement results are represented in the form of acoustic maps that can be superimposed on pictures of the actual measurement scene (built-in digital camera) or even 3D models to identify the acoustic properties of the object (product/ room/ building/…) at hand. A 3D laser is used for obtaining three-dimensional geometries. These scans are then used to visualize the results of Acoustic Camera measurements on 3D models. Together with the 3D laser, the Acoustic Camera represents a powerful tool which provides the possibility to "see sound".

A key assumption for the work on the multibook was to create a tool that would become an inspiration for an architect at the designing stage. The architect's job requires skills in combining a number of components and expertise in various areas. The way in which the created urban space or interiors will affect the acoustic climate, and thus the feelings of users of a given space. It is a very responsible task as there are long - term consequences involved. The multibook contains a number of practical concepts that organise the acoustic and architectural designing components and objective and subjective acoustic parameters in a systematic way to enable us describe acoustic conditions in a given facility. In room acoustics, it is possible to distinguish certain architectural parameters that have an influence on the room acoustics of space. All these architectural, subjective and objective parameters are tightly interwoven and they all describe the acoustic quality of the space. The links between the parameters are complex, especially the links with the subjective criteria, and while good basic knowledge is available, many links merit further scientific research.

A key issue to be addressed is a division of facilities into functions they should perform including the acoustic requirements relative to a given function. Architectural acoustics is a science that answers the question how to achieve a good sound in any space in relation to its function. This part of multibook looks at a wide range of functions that many public and private building types have, from an acoustic point of view. In particular, the most important acoustic requirements are summarised for every type. This general chapter is not intended to be exhaustive, as there are a lot more functions and building types and not all acoustic requirements can be presented in a general description. Instead, the intention is to make architects aware of some important acoustic aspects for various different situations they will encounter during their design work.

The book ends with the examples of acoustic projects in several facilities in Europe: KONSERTHUS in Stavanger, KRAAKHUIS (MUSIC CENTER DE BIJLOKE) in Ghent, NOUVEAU SIECLE in Lille, MUSIKINSEL in Rheinau, ENSEMBLEHAUS in Freiburg, CAMPUS ONE in Karlsruhe and VOLVO CONSTUCTION EQIUPMENT in Poland. Case studies have been presented in a form of video tutorials. Each video presents acoustic solutions, assumptions of a given project and shows the way in which fantastic results were achieved. These are the examples of all-purpose solutions that provide an inspiration for trouble-shooting in numerous projects. A form of the video tutorial enables "hearing the space", hearing the difference, while looking at a specific solution and architectural space.

In the design process there are a lot of elements that architects must take into consideration and coordinate in the scope of the project. Created space, building compartments, structure, moving and transparent closings, materials and their characteristics, ducks, electrical cables, ventilation, air conditioning, SAP and others fire safety systems, monitoring, fittings, finishing and costs – just to mention a few. They are also responsible for proper communication and cooperation of all engineers, designers and technologists who take part in the investment process.

It is important that the architect and the users are aware that the acoustic requirements depend on the functions and the uses that buildings have, and not on the type of a building as such. It is therefore essential that from the onset of a project there is a good programme (or so-called "brief") describing the functions and uses of the future building, providing a clear understanding to the designers of how the future building will be used. A very important element of these "design puzzle" is acoustics – a part of overall integrated design process.

4. Conclusion

The underlying idea of the established partnership was to create an educational tool for architects on the subject of architectural acoustics. The outcome of the cooperation within the partnership are materials in the form of content and audiovisual elements converted into a multibook. The Multibook of Architectural Acoustics is an application for mobile devices (tablets, smartphones; both for iOS and Android) and website, available in four languages EN, PL, DE and FR. The user has mobile access to information at any time and in any place.

The project represents an innovative approach to education and career development of architects in the field of acoustics. Its geographical range is not be limited only to those countries participating directly in the project. The mode of disseminating the project (App Store, Google Play, webpage) allows to spread it worldwide. The effect of collaboration between researchers and entrepreneurs is response to meet demands of modern information society and also architects who require a lot as far as quality and presentation of information are concerned. Hence, deepening, improving and broadening knowledge is transferred into the virtual reality, in which a traditional, printed book is replaced with mobile data carriers. This implies a new way of society education- "the futuristic way of education".

Fig. 1. ArAc logo.

References

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