Extending the scope of urban sound planning by education and research

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ABSTRACT

Based on continuous research work as well as on growing demands of all involved it is widely agreed today that acoustic comfort in cities should aim for more than just preventing and controlling given noise. However, in practice this typically fails because of two dilemmas: Acoustical aspects are considered too late and with a limited scope only, limited to make other non-acoustic planning acoustically acceptable. This then prevents any approaches to plan and go for desired sound scenarios from being applied.

The European Integrated Training Network SONORUS tries to overcome this restriction by application oriented research, exemplary application to test sites and – above all – by education. Nine partners from all over Europe, coordinated by Chalmers University of Gothenburg, work together to educate 14 young researchers in urban sound planning. Apart from complementing available tools for practical application and testing these tools in case studies provided by five associated European cities, the basic idea of the project is to supply the researchers with all skills enabling them to acoustically contribute with competence to a holistic urban planning process. It is hoped that the concrete availability of their respective competence will help to extend the scope of Urban Sound planning in practice.

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1. INTRODUCTION

Better cities are required and better cities are possible. Such statements can be met whenever the situation and the living conditions in cities are reflected. This holds in a general sense but it is particularly true with respect to the acoustic quality of cities. Like any other environment, urban environments strongly impart themselves by acoustic sensations whose permanence gives them dominant importance. This instinctively contributes to perceptive socialization which, however, turns to annoyance and risk if corresponding limits for undesirable sounds are exceeded.

To avoid or reduce such annoyance many efforts have been made over more than hundred years. Multiple laments and complaints together with early medical insight that high noise exposure causes discomfort and disease finally resulted in acknowledging that noise protection and noise control is a public duty.

This concept of noise abatement has initiated many decades of continued political, administrative and engineering efforts to limit the noise pollution caused by growing industrialization, mechanization and mobility. However, a more comprehensive approach focusing on sound quality in a wider sense than just reducing and limiting corresponding noise levels has found more professional interest in recent years only.

This may be surprising in view of the long tradition in investigating the many effects of sound perception, sound evaluation and sound quality description and classification. The discipline of Psychoacoustics has successfully established an understanding of the basic mechanisms of subjective hearing sensations and introduced basic descriptors for this. Later, soundscape research was able to demonstrate the mutual effects of contextual parameters and their joint influence on the resulting overall sound impression. To evaluate such impression and to integrate it into concrete planning and design, objective instrumental descriptors have to be complemented by context dependent subjective assessments given by people involved and immediately affected.

Although this approach has found great applicative interest in product sound quality design, it lacks corresponding interest in environmental applications. This may be understood in view of essentially increased efforts for evaluating advanced sound descriptors and for integrating involved inhabitants. Also, the lack of acknowledged and standardized procedures withstands the definition of clear step-by-step procedures and thus stirs up the fear of unforeseeable planning sequences and efforts.

Nevertheless, the unsatisfactory acoustic situation in many urban places together with growing demands of a growing number of urban inhabitants increasingly claims for broadening the scope of urban sound planning to find better, more appropriate designs. Starting from this situation, the European Union Integrated Training Network (ITN) SONORUS aims to initiate sustainable urban sound planning and put it into practice as an integral part of urban planning. In line with the concept of ITN projects, this is done by research, application and – in particular – by education, thus providing not only the corresponding know how but also a nucleus of well-trained people with all skills to anchor this novel discipline in the daily routine of urban planning processes.

2. STARTING IDEA

It is unfortunate but frequent practice to involve acoustical aspects in general too late and too narrow in perspective. This typically is due to the adjunctive attribute which acoustic aspects typically are given by designers and design engineers. However, sound and vibration is inherently coupled to mechanical dynamics and thus cannot be seen as independent or independently controllable. Any motion generates vibration and sound and thus, any sound requirements restrict the design parameters of the underlying technical process or layout. Or – if such in time restrictions had been neglected – later sound requirements may lack efficiency or feasibility even.

Of course, apart from products and technical processes, this is equally true for the acoustical design of cities where all foregone planning fixations limit the acoustic effect of remaining later ones. It is thus obvious that the effectiveness of sound control measures crucially depends on involving acoustic aspects at the earliest stage.

Together with the intended extension of scope from noise control to sound design, the above extension of involvement outlines the conceptual intention of SONORUS: to improve urban sound planning by defining and introducing holistic approaches, i.e. approaches which

- involve acoustics at the earliest planning stage,
- consider acoustic aspects altogether, as an integral part of all other planning disciplines,
- extend the scope from pure noise control to sound and sound design.

Following a summary of the project setup and the respective partners, the subsequent sections will describe by what means, i.e. by what research topics and by what specific training program this conceptual objective is going to be followed up in order to finally force it to the routine of urban planning processes.

3. PROJECT SETUP

The above starting idea has been picked up as proposal for the so called Integrated Training Network (ITN) SONORUS to be funded by the European Community as part of its Marie-Curie-action program ([1]). ITN's "offer early-stage researchers (ESR's) the opportunity to improve their research skills, join established research teams and enhance their career prospects" ([2]).

The Latin word "sonorus" which means sounding, sonorous, has been chosen to describe a professional vision. Following the symbolic meaning of "aquarius" to specify a water expert, "sonorus" has been given the meaning of a sound expert, a skilled person with full expertise in all matters of (urban) sounds and soundings.

The proposal for SONORUS has been accepted and finally contracted for financial support in 2012. The consortium comprises 9 full partners from 7 European countries, among them 5 universities, 3 research institutes and 1 acoustic engineering company:

- Division of Applied Acoustics, Chalmers University of Technology, Gothenburg, Sweden
- Research Group Acoustics, Ghent University, Gent, Belgium
- Department of Architecture, Second University of Naples, Italy
- Building Acoustics Chair, Eindhoven University of Technology, Netherlands
- School of Architecture, University of Sheffield, United Kingdom
- Italian National Institute for Environmental Protection and Research (ISPRA), Rome, Italy
- SP Technical Research institute of Sweden, Section of Acoustics, Boras, Sweden

- Swiss Federal Laboratories for Materials Science and Technology (EMPA), Dübendorf near Zurich, Switzerland
- Müller-BBM GmbH, Technology Department, Planegg near Munich, Germany

In addition, 5 associated partners, one research organization and 4 European cities complete the consortium's competence and experience:

- Netherlands Organization for Applied Scientific Research (TNO), Netherlands
- City of Antwerp, Belgium
- City of Rome, Italy
- City of Gothenburg, Sweden
- City of Brighton, United Kingdom

While full partners are responsible for the realization of the project's work program in both, training and research activities, the associated partners are important touchstones of the project's practicability.

Each of the full partners employs one or two young professionals and thus is responsible for their training by education and research. Two ESR's per university and one ESR per other partner add up to 14 ESR's in total. The respective positions were advertised by job offers and finally could be filled before summer 2013 by 14 young researchers from 6 European countries.

It should be noted that the ESR's in SONORUS cover a broad range of primary education. Apart from engineers with acoustic and physical background, neighbouring disciplines like architecture and city planning contribute to a holistic spectrum of basic educational skills.

4. URBAN SOUND PLANNING

As stated before, the key issue of SONORUS is to complement – by training and research – the aim of controlling urban noise in cities by planning and designing the sounds in our cities in a wider sense. It is important to state that this approach is an extension and - as such - by no means in contradiction to the many pressing necessities of reducing the noise in cities. Although noise abatement and reduction must be recognized as the most important approach in lessening the severe health effects of noise, there are situations where differing views and focusses turn out to be more appropriate.

Classical examples are given by realizing and/or preserving quiet recreational areas or by targeting the preservation or even provision of familiar, habitual sound characteristics for given environments in a contextual sense.

Such objectives require different tools, instruments and methods many of which have been developed and provided in recent years. Obvious examples are the

- need for more powerful numerical methods to predict sounds and sound propagation in quiet environments,
- improved auralization techniques to allow for intuitive interactive presentation of predictive simulation results
- review of novel noise control technologies and provision of improved modelling and design tools
- adaptation and application of the soundscaping approach to practical urban sound planning

Starting point for the SONORUS work program is the assessment that some important recent research results need methodological or applicative extension and completion only to be ready for practical application and testing. The most relevant themes among these were picked up as fundamental research topics and work packages in SONORUS. They will be described in the next section.

5. SONORUS RESEARCH OBJECTIVES

In line with the basic concept of Integrated Training Networks (ITN), the aim of project research work within SONORUS is twofold:

- technically substantiate the specific training of young researchers by own research, thus assuring this training to be concluded on a state-of-the-art level.
- completing the methodological toolbox of concepts, approaches and methods to provide a fully operational profile of urban sound planners in both, practicable methodology and applicable qualification. In this sense and in view of today's common practice, research needs for holistic urban sound planning are mainly seen in the above (section 4) areas.

5.1 Prediction Methods and Auralization

Although proven methods of predicting sound propagation and incidence cover a broad range of practically relevant applications, there is a considerable number of cases where the underlying models cannot cope with. Examples are reliable analyses of shielded areas as well as quiet (low sound level) areas or the fields generated by high sources placed and radiating above any shielding elements involved. However, predictive approaches for such situations are needed if quiet zones are to be included in urban sound planning.

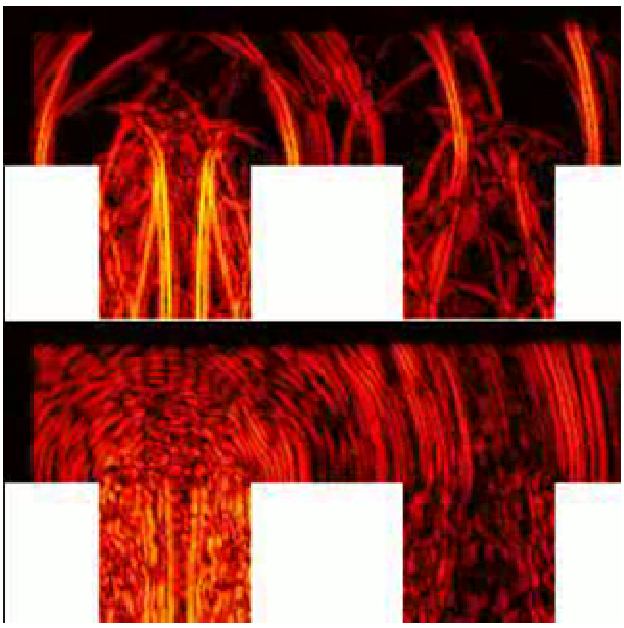

Figure2 – Example for numerical prediction of sound propagation ([3])

In recent years progress has been made for an efficient wave-based method for prediction of sound propagation in urban areas. To illustrate the potential of this method, fig.1 gives an example where a sound source in area A meets reflective (above) and absorptive (below) boundaries. It can be seen that the absorptive boundaries below reduce the sound level in A and consequently come up with reduced sound amplitudes of the sound propagated to area B.

The numerical method used here allows simulations of sound propagation which cannot be obtained by conventional software tools for sound propagation. If practically applicable, this approach could overcome today's limitations. The improvements needed for better applicability mostly relate to improving the accuracy of new prediction methods with reasonable, acceptable numerical efforts.

Another important aspect of sound prediction is the question how to present and evaluate predictive results. Although experts with long experience in the field may be able to interpret physical estimates and to relate them to presumable perceptive scenarios, state of the art in auralization has established the synthesis of real sounds as common practice today. Such auralization gets indispensable even if representatives of those being exposed to or effected by the respective sound fields or other non-experts are to be included. In particular, if soundscapes, i.e. acoustic environments as perceived, experienced or understood by people in context, are to be considered, a well-founded assessment of such non experts will depend on experiencing and comparing audible events.

It is thus necessary to combine improvements of new numerical prediction models with related auralization techniques to allow for intuitive interactive presentation of results.

5.2 Noise Control and Design

In theory and practice, design and realization of sounds typically depends on effective possibilities to control the sounds involved and this is of particular importance if these are unwanted sounds, i.e. noise. State of the art sound planning therefore assumes that state of the art noise control technology is available and that handsome tools allow its targeted and efficient design and use.

Apart from reviewing recent progress and development of such technologies, special emphasis will be given to novel solutions for quieter and greener cities as recently elaborated and compiled in the EU-funded HOSANNA project. A comprehensive compilation of ways using vegetated surfaces and

recycled materials to reduce road and rail traffic noise and to improve the perceived sound environment can be found in a compact brochure ([4]).

Within SONORUS, existing models of describing the effects of urban parameters on noise propagation will be modified and further developed to better evaluate and assess application of novel noise control measures in specific urban areas. The related steps will be

- further investigations including measurements to better understand and overcome existing modeling limitations,
- implement and provide improved models for designing and assessing related noise control measures
- providing useful guidance to the design of such noise control measures
- verify and test of noise control measures and their design in selected application studies

5.3 Soundscaping

As outlined above, integration of the soundscape approach to urban sound planning in practice is one of the key issues of the SONORUS project. Concentrating on the way people consciously perceive their environment, this approach should finally lead to more relevant assessments of the perceived environment and related actions in a holistic sense.

Based on many successful efforts which have been made in the past to set the basics and to develop the approach, the tools provided so far shall be complemented for effective use in urban sound planning. In particular, related research will focus on

- improvement of computational models of auditory attention in urban environments,
- application of new audio-visual tools for assessments of noise annoyance ,
- evaluation of new indicators for soundscape perception.

6. HOLISTIC APPROACH

As outlined in section 2, it is the conceptual intention of SONORUS to improve urban sound planning by defining and introducing holistic approaches involving acoustical aspects at all (time and discipline related) planning stages and with reference to the entire perception. As this approach is seen to be crucial for any efficient and sustainable planning and design of acoustic environments, it is given special emphasis within the SONORUS project.

Based on a thorough analysis of the characteristics of typical planning processes, the many influential entities and interfaces between all institutions and aspects and the multiplicity of interests behind will be identified. This then shall be taken as the starting point for guidance how to make sure that all aspects, interests and possibilities are taken into account just in time. Further guidance shall try to formulate a logical strategy with respect to technical sound control measures. By experiencing such elements of an holistic approach at the test sites and eventually at other planning scenarios, the guidelines shall be tested and improved. Also, the benefits and the potential of a holistic approach shall be estimated. More details on the holistic concept for urban sound planning can be found in [5].

7. SONORUS TRAINING SCHEME

In spite of its considerable research activities, SONORUS essentially is a training project to provide - together with its novel planning and working concept - a group of young professionals with all skills to implement the new concept in practice. The related training follows a specific program with given objectives. The elements of this training program for all early stage researchers (ESR) are:

- multiple working experience (local training) in the specific area of excellence of the recruiting institution,
- research visits and secondments (for a minimum of 3 months) with at least 2 other network partners,
- 4 summer schools on particular technical topics organized by the network,
- selected other training activities for planning and other complementary skills,
- participation in practical test site work and related working groups,
- scientific publications and presentations.

The summer schools will particularly teach basic and selected topics in

- urban sound propagation,
- noise control in urban areas,

- auralization and visualization as communication tools in the context of acoustic planning,
- computational sound scape analysis.

The whole educational program is clearly structured in a way which finally qualifies for a credit-based competence certificate for an “Urban Sound Planner”. To guarantee a well-balanced education for all ESRs, individual training and career development plans have been fixed and will be followed up by the ESR and his/her supervisors. The scheme of the SONORUS training and qualification program may be summarized in the diagram of fig. 2. It illustrates the elements of research and education to define and provide a holistic approach and to train qualified urban sound planners committed to implement the approach in practice.

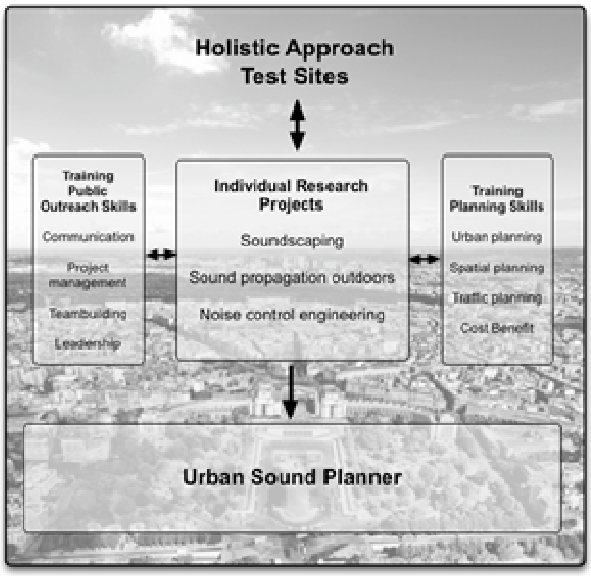

Figure 2 – Elements of SONORUS

8. TEST SITES AND CASE STUDIES

8.1 Associated Partners

Committed to generate a nucleus of urban sound planners, SONORUS needs to provide profiles of competence and approaches which meet the requirements of planning practice. To achieve this, the associated partners are highly welcome to join and to contribute to the project by practical experience and advice. Furthermore, they provide urban test sides for practical case studies to apply and test the skills together with the research results of the partners and their employed ESR’s.

8.2 Practical Case Studies

To apply and submit the methods and approaches developed and provided by the different working packages of SONORUS, five test sites have been defined for practical case studies. Each test site is related to an associated partner and will be coached by this partner together with the local university located in the respective country. The five test sites will be shortly presented in the following summary. More details on these test sites and the respective case studies are found in [5].

8.2.1 Antwerp

A largely populated area (Borgerhout) lacks green and open spaces although the largest park of the city is nearby but separated by lines of extreme traffic. The task could be to investigate, develop, assess and suggest solutions to improve the sound quality in the park and to provide attractive connections between the residential areas and the park.

8.2.2 Brighton

There is a green area (Valley Garden) in the city center of Brighton which could offer attractive spaces for public and private activities if there were not the main traffic route carrying city and seaside access. The task could be to develop solutions based on measurements, interaction with local users and some complementary research to substantiate additional proposals to existing plans and noise control measures.

8.2.3 Gothenburg

A former industrial area (Frihamnen) in the most inner harbor will be restructured to a residential and recreational area with cultural activities. The task could be to analyze the acoustic situation and understand the impact of future developments on the acoustic environment. Based on this, scenarios for residential and recreational use as well as measures to assure good acoustic quality could be developed and assessed.

8.2.4 Rome

The famous archeological area of Colosseum and Forum Romanum fail their acoustic class 1 target values because of high inner city traffic flow. The area is not a quiet one, annoys inhabitants and its soundscape does not contribute to the enjoyment of 6 Mio touristic visitors per year. Based on careful analysis of the situation and future developments, the task could be to investigate possibilities to improve the situation while balancing the need for protection of the archeological site against allowance of maximum access.

8.2.5 Rotterdam

In view of rapid densification of the inner city (doubled population by 2030 expected) measures are needed to preserve acoustic quality in spite of increased traffic. The task could be to improve and implement existing traffic models in noise maps and study the related impact on people. This may include test and optimization of particular noise mapping tools for different predictive planning scenarios.

9. CONCLUSIONS

Sound and noise in cities essentially contribute to their attractiveness and, moreover, to their annoyance, their repulsive potential and health risk even. The Integrated Training Network SONORUS aims to extend the scope of proven noise control technology to a comprehensive, all-embracing consideration and treatment of acoustic environments in the context of global perception and expectation.

Methodologically this holistic extension is substantiated by providing

- improved complementary methods for sound prediction and auralization,
- improved implementation and design aids for new noise control technologies,
- applicable practical guidance to using and implementing the sound scape approach.

Apart from being applied methodologically, the holistic approach shall also apply to its integration into the whole planning process. Acoustical aspects have to be considered at all stages of this process to exploit all possibilities of acoustic (sound) design. The necessary and thus-obtained upgrading of acoustics to the level of equal treatment with other planning disciplines is emphasized by providing a group of qualified young scientists representing the new professional group of urban sound planners. It is expected that the methodological and personnel outcome of SONORUS will set the starting point for anchoring its results and its matter in the long term of urban planning.

10. ACKNOWLEDGEMENT

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