THE CITY AS A RESONANCE SPACE

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1 INTRODUCTION

This paper focuses on urban acoustics and the key role architecture and urban design play in this connection, according to our independent interdisciplinary research.[1]

We argue that in the present planning practice it is generally underestimated how complex and diverse the acoustical effects of architecture and urban structures are, and subsequently environments with adverse acoustical characteristics are produced.

We outline a new and comprehensive approach to the built environment: showing that urban acoustics by far exceed the subject of noise; that acoustics are highly relevant not only concerning the ability to grasp situations but also for the ways locations are used; that architecture and urban design – by building large scale resonance spaces – are at least as influencial on urban acoustics as sound sources are; and how this can be put to use for creating livable, sustainable environments.

2 A NEW APPROACH TO ARCHITECTURE AND URBAN DESIGN

2.1 Why to question present planning practices

The necessity to question existing design, planning and building practices arises, we think, from the increasingly complex and all too often unsatisfactory situation in urban areas today.[2] This is especially true for urban acoustics. We believe that the acoustics are a key to the overall quality of environments, and thus they ought to be regarded, and treated, as an essential element of the *built environment*.

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From the perspective of acoustics, architecture and urban design can be compared with the building of complex musical instruments. This means that every partially or completely surrounded space (interior space, buildings, streets/squares, etc.) is a resonance space that reacts to sounds (triggered by its users or by natural events, or produced by other surrounding resonance spaces), amplifying and altering them. As a space is shaped by building, its acoustical characteristics are shaped accordingly.

However, in today´s planning practice, things are looked upon in a rather simplified way. Concerning acoustics, the built environment is increasingly determined by what is usually called “noise-control” or “noise abatement”.[3] In the present form, this has many negative effects on the environment and its users and thus it has to be regarded as a negative development.

2.2 The city *is* a resonance space

The focus of present approaches concerning urban acoustics lies on *sound sources*. We think that thus the point is missed. By using the example of musical instruments, it is easy to show that the complete system of producing sounds involves the player, the vibration generator, and the resonance body. Regarding a violin, for example, these elements are the musician, the strings and the corpus of the violin. Considering what largely determines the audibility of a violin, as well as its timbre, it becomes clear that the *resonance body* is most important.

This applies to the built environment in a similar way: The resonance space of a location determines the acoustical characteristics of this very environment. A simple example: a car in the city sounds much louder and heavier than in an open landscape. Put it in a tunnel, and even a small car sounds like a truck. And this is not just a funny picture, considering what is being built in cities around the globe today: canyons of large, smooth façades of hard, monotonous materials like glass, steel, aluminium, or concrete, straightly aligned to form monotonous, seperate-use urban structures.

Physically-acoustically this international style of urban design produces, to name but the strongest effect, an unbalanced acoustical frequency spectrum. This results in monotonous, intransparent soundscapes with dominant (mostly low) resonance frequencies, which – almost independent of the sound level – cause mental and physiological stress in a health-threatening way[4], and undermine the functionality of spaces/environments in general.

2.3 The effects urban resonance spaces have on their users

The effects urban acoustical situations have on the users are more wide-ranging than generally assumed. As a human being´s sense of hearing is capable of reacting to signals by far faster, more precise, and covering a wider area than their sense of seeing, the human auditory system is an important tool for orientation in an environment. Given that the signals are useful – for if and to what extent the acoustics of an environment suits the human dispositions (or exceed their physiological adaptability) is crucial for the ability of human beings to interpret situations, and is thus essential for the basis upon which they act.[5] This means that not only the individual´s development depends upon it, but also the quality of the interactions between individuals and thus the development of communities.

Furthermore, spatial acoustics are highly relevant not only concerning the ability to grasp situations but also for the ways locations are used: different functions require different acoustical conditions. Thus the usability of locations depends on acoustical conditions, as well as how locations and their purpose are interpreted (what is usually called *legibility*).[6]

Taking these interrelations into consideration, it becomes evident how, in turn, the spatial-acoustical characteristics of an environment affect the emergence and characteristics of sound sources (e.g. in connection with users and their actions).

We argue that these qualities are a strong, yet at present quite underestimated influence on how successful environments will be, socially, culturally, but also economically and ecologically.

2.4 Considering the city as a resonance space: Common mistakes of urban design

The methods in use today in the architectural and urban planning practice do not, we daresay, provide the necessary basis for creating acoustically good environments.

According to our research, the most relevant mistakes in the present practice are basically the following:

Firstly, approaches are focused on sound levels and/or noise, and – despite the official definition – on the incorrect assumption that "noise equal high sound level".[7] However, neither can everything loud be called noise, nor is noise only what´s loud. Noise being any sound perceived as bothering, it has nothing to do with the actual sound level at all. Considering the human dispositions, we think that *monotony* (of sound spectrum, timbre, level, duration, etc.) is a main aspect of noise, as monotony of any kind has adverse effects on the human organism and psyche.

Secondly, urban acoustics are mostly regarded as a result of limited events within isolated systems, instead of as a result of complex coherences and interactions between many (open) systems.

The combination of these approaches leads to the omnipresent methods of trying to block off or absorb noise, both of which are, depending on the very situation, either impossible to do, or do not solve the problem of achieving better acoustics. Although widely used today, noise barriers alongside streets and, in interiors, absorbing material on the ceiling have to be sharply criticised in this respect.

Unfortunately many errors have been institutionalised in the form of technical standards and uniform "solutions" lacking any reference to the situation. At least concerning spatial acoustics, architectural and urban planning is currently, to a great extent, based on theories and models over-simplifying or ignoring coherences.[8]

2.5 Considering the city as a resonance space: New methods of urban design

We think it is necessary that in architectural and urban planning the focus gets shifted to resonance spaces and their formal characteristics: environments should be specifically designed spatial-acoustically according to their desired function. What is already normal procedure for planning concert halls – to consider the kind of music to be played, the instruments to be used, the character of the events – should be adopted for planning and designing *every* part of the built environment. There is a lot to be learned from well-functioning historic places that are pleasant to use even today.[9] What such places have in common architecturally are complex site-specific arrangements, human-scale dimensions, including a huge variety of formal and surface structures as well as building materials. We argue it is possible to achieve a similar quality of structures based on a contemporary approach.[10]

Resonance spaces structured on every scale (from one centimeter to many meters; this applies to façades, buildings, and ensembles equally) are the basis for a balanced urban soundscape with good acoustic quality.[11] This means that the information of every part of the frequency spectrum can be perceived easily, i.e. is useful for the human auditory system.

In this connection the problems caused by absorption techniques become evident: through absorption, information of the frequency range is eliminated, and thus the acoustical quality as well as the *identity* of locations suffer.

According to our theories on resonance spaces, we developed the abstract walk-in city model "acoutopia" (FIGURE 1), which was exhibited at a Swiss museum in 2006 [12]. The city model was located in a high, 200 sqm space with very intransparent acoustics. Our aim was to create a number of different areas with specific acoustical characteristics according to their respective basic functions, as would be found in an ideal city. Therefor we developed variedly structured architectonic elements made of varnished cardboard with strong reflecting properties, and positioned them very specifically. This resulted in, we are glad to say, perfectly transparent

acoustics and an astonishingly pleasant overall atmosphere. As our investigations show, it would *not* have been possible to achieve the same quality by using absorbing material.

FIGURE 1

3 CONCLUSION

For being able to deal with urban acoustics in a constructive way, we are convinced that new and comprehensive approaches to architecture/urban design and acoustics are necessary. We think it will be crucial that these approaches concretely incorporate the actual physical coherences in different spatial situations, as well as the strong interrelations between the physical environment and its users. We believe it to be equally important that present standards and techniques are examined critically and, if refuted by the results they produce, are altered or replaced. Especially in times of fast growing cities, we think these steps are necessary to achieve urban areas of higher overall quality providing a basis for thriving communities.

Growing urban areas and increasing density belong to the most important topics and difficult problems throughout the world today and will even more in the near future. Needless to stress the social as well as the ecological responsibility that arises with these facts. However, we think that this opens a vast, exciting and very important field for researchers and practicioners of environmental acoustics. We think that acousticians have the responsibility, on the one hand, to take part in the discussions of architecture and urban development, and, on the other hand, to produce results that truly support sustainability and humanity.

4 REFERENCES

1. Our professional training and experience include philosophy, musicology, composition, electroacoustics, and making of musical instruments. Our theoretical and practical work is based on the investigation of architecture and urban design by means of both philosophy (precisely: critical rationalism and evolutionary epistemology) and physics (particularly

acoustics), especially considering the interrelations between the built environment and the users. See also: www.sonicatelier.net.

2. George Brugmans, director of the International Architecture Biennale Rotterdam, writes in his preface to the Biennale publication: “Every single day over 150,000 people escape the countryside and pour into the overcrowded lifeboats represented by cities. [...] [The world] is not only warming up, it´s also urbanizing much faster than originally predicted: cities will account for most of the future world population growth, an estimated four billion people between now and 2050.” (George Brugmans, What about the Lifeboats?, in: “Visionary Power - Producing the Contemporary City”, Rotterdam (2007), 8-9).
3. This affects in particular the theoretical foundation of urban design: while there are positive criteria for the work with light and colour, the acoustics are approached as a *problem to be solved*. The question of form is also dealt with under many aspects, but not concerning the acoustics thus produced. This becomes apparent, for example, in an otherwise very good and informative book on urban design: Jürgen Hotzan, “dtv-Atlas Stadt”, Deutscher Taschenbuchverlag, München (1994).
4. On the subject of connections between environmental acoustics and the physical and mental well-being of people, see, for example, the “Guidelines for Community Noise” by the World Health Organisation (www.who.int/environmental_information/Noise). Published as early as 1995, it shows that in the medical field there has been an awareness for some time of how strong and far-reaching the influences of adverse acoustical conditions on human beings are.
   However, we do not concur with all conclusions drawn in the Guidelines, especially not with the technical and architectural measures suggested.
5. Our theories owe a lot to Karl Popper and his work. His critical-rationalist approach in general, and his work in the field of Evolutionary Epistemology in particular, provide a solid basis for reconsidering the *fundamentals* of architectural theory as well as of acoustics, and eventually developing sustainable solutions. On human dispositions see: Sir Karl Popper, Sir John Eccles, “The Self and Its Brain – An Argument for Interactionism”, Heidelberg etc. (1977).
6. A comprehensive deduction of how the quality of an environment determines the way it is used and will develop, is provided by Umberto Eco in: Umberto Eco, “Einführung in die Semiotik”, München (1972).
7. The technical standards and measuring methods in use today focus first and foremost on sound levels. Thus it is no surprise that urban designers get the impression that “noise can be measured” (see e.g. TOMATO architectes, “Paris. La ville peripherique”, Paris (2003), 102-109.) – which is not only wrong but leads to serious misconclusions and far-reaching misconceptions in the fields of architecture, urban design, and environmental acoustics.
8. We criticise, for example, the way measuring methods are applied: The fact that, by law, the dB(A)-scale (focusing on a higher part of the spectrum) is used to describe the sound level (and even the acoustic quality) of environments, actually *leads* to architectural and urban designs that, however unwillingly, amplify and further low frequencies.
9. In this connection we find the theoretical and practical work of the following two architectural theorists / urban designers most interesting and helpful: The Austrian Camillo Sitte (see: Camillo Sitte, “Der Städtebau nach seinen künstlerischen Grundsätzen”, Wien (1909).) and Luxembourg-born Léon Krier, the master-planner of Poundbury, near Dorchester (Leon Krier, “Architecture: Choice or Fate”, Berkshire (1998).)
10. We think that an organisation doing exemplary work in this respect is The Prince´s Foundation for the Built Environment, and especially its president, His Royal Highness The Prince of Wales, with his precise analysis of both the challenges we are facing and possible paths towards sustainable development.
11. Italian Renaissance squares and their quality may be somewhat of a cliché, but for a good reason: although combining many different functions (providing space for motor traffic, pedestrian traffic, the market, gastronomy, a playground, etc.) and usually full of people, they give an impression of liveliness rather than stress. We think that the good, transparent acoustics of strongly structured Renaissance architecture account for this quality to a great extent: both orientation and localisation of events – to satisfy the natural need for safety – take little effort, and thus a lot of energy is saved for other mental processes.

12. „sonic atelier: acoutopia – City & Sound“, a walk-in city model, Museum zu Allerheiligen, Schaffhausen, Switzerland, 22 February – 23 April 2006. Reviews on “acoutopia” see: www.sonicatelier.net > Response