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The City as a Resonant Space

Inès & Fabian Neuhaus

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Published in: „Proceedings of the Institute of Acoustics", IOA/UK, 2008.

Introduction

In this paper we present results of four years of independent interdisciplinary research on urban acoustics, focusing on the connections between architecture/urban design and the acoustic conditions of urban environments.

We argue that in today's planning and design approaches the complexity and diversity of acoustical effects produced by buildings and urban structures are generally underestimated, and that subsequently environments with unfavourable acoustic properties are created.

We outline a new approach to the built environment: showing that urban acoustics by far exceed the subject of noise; that acoustic quality plays a major role in how we perceive and thus use places; that architecture and urban design — by building large-scale resonant spaces — are at least as influential on urban soundscapes as sound sources are; and that this knowledge is critical for the creation of an effective and sustainable public realm.

A New Approach to Architecture and Urban Design

Why question present design approaches?

The necessity to question current approaches to design, planning and building arises, we think, from the increasingly complex and all too often unsatisfactory situation in urban areas today.[1] 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 a key element of the built environment.

We argue that the complexity and diversity of the acoustical effects of buildings and urban structures are generally underestimated, and subsequently environments with adverse acoustical characteristics are produced.

From the perspective of acoustics, architecture and urban design can be compared with making complex musical instruments. This means that every partially or completely surrounded space (room, building, street, square, etc.) is a resonant space that reacts to sound (triggered by its users or by natural events, or produced by adjacent resonant spaces), amplifies and alters it. Hence, shaping a physical space means shaping its acoustical characteristics.

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However, in the current planning and design worlds, 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".[2] In its present form, this has many negative effects on the environment and its users, and thus it has to be regarded as a negative development.

The city is a resonant space

The focus of current approaches to urban acoustics is 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 resonating 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 resonating body is the most important element.

This applies to the built environment in a similar way: The resonant spaces determine the acoustical characteristics of an environment. A simple example would be: a car in the city sounds much louder and heavier than in the 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 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) resonant frequencies, which — almost regardless of the sound pressure level — cause mental and physiological stress in a health-threatening way[3], and undermine the functionality of spaces/environments in general.

The effects urban resonant spaces have on people

The effects the acoustical conditions have on people are more wide-ranging than generally assumed. As a human being's sense of hearing is capable of reacting to signals by far faster, with greater resolution, and covering a wider area than their sense of seeing, the human auditory system is an important tool for getting one's bearings in an environment. Given that the signals are useful — for if and to what extent the acoustics of an environment suit 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.[4] This means that not only the development of the individual person depends upon it, but also the quality of interactions between people and thus the development of communities.

Furthermore, spatial acoustics play a key role in what is usually called legibility (the ability to interpret situations) as well as in the ways environments are used: different purposes require different acoustical conditions.[5]

Taking these interrelations into consideration, it becomes evident how, in turn, the spatial-acoustical characteristics of an environment affect the appearance and characteristics of sound

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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.

Reading the city as a resonant space: common mistakes in urban design

We think that the methods in use today in architecture and urban design do not provide the necessary basis for creating acoustically good environments. According to our research, the most relevant planning and design mistakes are basically the following:

Firstly, approaches focus on sound levels and/or noise, and — despite the official definition — on the incorrect assumption that "noise equals high sound level".[6] 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 human dispositions, we think that monotony (in the sound spectrum, timbre, level, duration, etc.) is a key aspect of noise, because 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 an isolated system, instead of as a result of complex interactions between several (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. This means that, although widely used today, noise barriers alongside streets and, in interiors, absorbing material on the ceiling have to be criticised.

Noise barriers create new (mostly monotonous) resonant spaces, that drive up the sound pressure level in the low frequency area often ignored in measurements; they can cause reflections leading to new problems, even in places a long distance away.

The focus on absorbing sound frequently causes new monotonies; it reduces the acoustic information, with negative consequences for the acoustic quality as well as the identity of environments.

Unfortunately many errors have been institutionalised in the form of technical standards and uniform "solutions" lacking any reference to the situation. When it comes to spatial acoustics, architectural and urban design is currently, to a great extent, based on theories and models over-simplifying or ignoring interrelations.[7]

Shaping the city as a resonant space: new methods of urban design

We think it is necessary that in architectural and urban design the focus gets shifted to what makes good resonant spaces. There is a lot to be learned from well-functioning historic places that are pleasant to use even today.[8] What such places have in common architecturally are complex site-specific arrangements, human-scale dimensions, with great variety in their forms,

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the articulation of surfaces, and building materials. We argue it is possible to achieve a similar quality of spaces based on a contemporary approach.

A good composition of architectural resonant spaces that are well formed and articulated in a great variety of dimensions, are the basis for a balanced urban soundscape with good acoustic quality. This creates conditions in which the information of every part of the frequency spectrum is easy to perceive (i.e. is useful for the human auditory system). It prevents the occurrence of acoustic monotonies, which are the main cause of problems such as high sound pressure levels, low frequency noise, intransparency, etc.[9]

Conclusion

We are convinced that a new, more holistic approach to architecture/urban design and acoustics needs to be adopted, which considers that built structures form large, complex resonant spaces. We believe it to be equally important that present standards and techniques are examined and, if refuted by the results they produce, are corrected or replaced. Especially in times of fast growing cities, we think these steps are necessary to achieve quality urban areas that are able to provide a basis for thriving communities.

References

1. George Brugmans, director of the International Architecture Biennial Rotterdam, writes in his preface to the Biennial 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).

2. This affects in particular the theoretical foundation of urban design: while there are positive criteria for working with light and colour, the acoustics are treated as a problem to be solved. In the question of form, many aspects are considered, but not 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.

3. On the subject of the connection between environmental acoustics and the both 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 an influences adverse acoustical conditions have on human beings. However, we do not concur with all conclusions drawn in the Guidelines, especially not with the technical and architectural measures suggested.

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4. 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 for developing sustainable solutions. On human dispositions see: Karl Popper, John Eccles, *The Self and Its Brain — An Argument for Interactionism*, Heidelberg etc. 1977.

5. 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.

6. The technical standards and measuring methods in use today focus first and foremost on sound pressure 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 périphérique*, 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.

7. 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.

8. 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). We think that an organisation doing exemplary work in this respect is The Prince's Foundation for the Built Environment, and especially its president, HRH The Prince of Wales, with his precise analysis of both the challenges we are facing and possible paths towards sustainable development.

9. 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 distinctly articulated Renaissance architecture account for this quality to a great extent: both getting your bearings and localizing events — to satisfy the natural need for safety — take little effort, and thus a lot of energy is saved for other processes.

Cover picture: Streetscape in the City of London (photo by Inès Neuhaus).