

CREATING IMMERSIVE SOUNDSCAPES FOR URBAN OPEN SPACES

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Abstract

How do typological urban factors influence the possibility to experience designed immersive soundscape within the urban landscape? Are there similarities between different projects built during the last 50 years across the world?

Soundscapes in situ can be designed by lowering noise levels and adding new sounds. Several urban open spaces (in Paris, Bern, Vienna, Graz, Zadar, Thessaloniki, Sheffield, Cardiff, Dordrecht, Miami Beach, New York City, Phoenix, San Francisco, Chicago, San Louis Potosi, Melbourne, Sydney, Campbelltown, Onohama and Xi'an, for instance) are characterised by designed soundscape elements that have the immersive quality - they offer the 'surround sound' designed experience.

This interdisciplinary analysis covers urban (spatial), environmental acoustic (and electroacoustic) and music factors and their mutual influence. Different methods of designing immersive soundscapes within the urban landscape are being analysed using the geospatial data.

Methods of achieving designed soundscape span from electroacoustic multichannel soundscape systems to the soundscape articulated through mechanical and acoustic qualities of urban design elements, such as pavement, vegetation or a built structure designed for a specific waterfront promenade, square, plaza or park. Two general spatial principles are recognised: open and enclosed. The former can feature different levels of integration of a soundscape design into an urban design, while the latter tends to isolate certain places from unwanted factors to a certain degree using strong architectural elements.

The spaces here analysed were rarely conceived solely to enhance an urban soundscape. Designed immersive soundscapes intertwine contemporary sound art, music and urban design and enrich urban open spaces giving them a new layer of a landmark quality.

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1. Introduction

The quality of urban open spaces contributes directly to the quality of city life. Soundscape is a significant factor of the urban ambience's integral experience and influences the mood and health of the population. However, benefits of the holistic approach to the phenomenon of sound in cities have hitherto not been made distinct enough for such an approach to be widely accepted even though the significance of soundscape has also been recognised in defining the spirit of a place from the aspect of urban planning, landscape architecture and the protection of cultural heritage.

With an aim to contribute to the methodology for the enhancement of soundscape in urban open spaces, this paper explores interdependencies of various urban and acoustic factors influencing the possibility to experience the designed immersive soundscape. Several urban open spaces are being analysed using the geospatial urban data and literary sources. The research is conducted within the framework of the Heritage Urbanism - Urban and Spatial Planning Models for Revival and Enhancement of Cultural Heritage research project, financed by the Croatian Science Foundation.

1.1. Designed soundscapes as an enhancement of urban open spaces

With an aim to mitigate the distinctly negative influence of noise on the quality of life, the quantitative approach to soundscape in the form of noise mitigation measures has been included in the systematic planning and design of the built environment. Noise mitigation does not completely encompass the issue of urban open spaces or the attainment of acoustic comfort as a significant requirement for the planning and design of urban open spaces which can be planned solely by including the qualitative approach entailing the consideration of soundscape content. For the aspect of planning and design of the built environment, this entails the following: 1) the suppression of unwanted sounds with landscape and architectural barriers, 2) the valorisation of existing preferable sounds by attentively treating their sources, and 3) the addition of new sources of preferable sounds into the urban open space (Murray Schafer, 1994, p.271). The latter principle, as well as the combined approaches, is in the focus of this research.

This paper therefore aims to contribute to the systematisation of the method of adding new preferable sound sources into urban open spaces from the viewpoint of urban design.

1.2. Typology of urban open spaces

The terms *urban open space* and *public space* are not precisely defined and differ from one discourse to another. They overlap in the case of types of squares and streets but tend to differ when it comes to

other spatial-functional types. Urban open spaces are places of social interaction and important factors for creating healthier sociable communities. Urban open space is a term that covers a wide range of public, semi-public and private publicly accessible spatial-functional types (***, 1986, p.2).

Urban open spaces are places accessible to the public, used for collective or individual purposes. They are created using a minimum of two different principles, applicable to the whole built environment - by planned or *ad hoc* interventions (Carr, Francis, Rivlin, Stone, 1992, p.50). This research focuses on holistically designed urban open spaces, where *aural experience* is included in the design.

Their role is ambiguous. Streets, roads and squares have a basic traffic function on which other roles are superposed. Functional social and ritual activities take place in urban open spaces - daily routines and occasional or periodic ceremonies. They are used for private activities such as shopping, recreation, exercise and stay. Sometimes they happen to be the scene of activities that threaten the society on a certain level, such as crimes and protests. There are also distinct types with the principal function of stimulating social life: parks, plazas and children's playgrounds (Carr, Francis, Rivlin, Stone, 1992, pp.11-12). Parks and plazas are among the most frequent types within this research.

According to the synthesis of different authors, the following types of urban open spaces can be distinguished based on the spatial-functional criteria: square, sequence of squares, plaza, pedestrian street, city stairway, portico, urban park, waterfront park, waterfront promenade, public garden, neighbourhood park, memorial, urban forest, forecourt, pocket park, market, children's playground, sports playground and infrastructural spaces.

Within the framework of this research, all of the included urban open spaces are primarily intended for pedestrians. The broadest definition of the term *urban open spaces* was initially used so as to include a large number of examples in the consideration and to reduce the possibility of non-recognition of certain factors.

2. Methodological framework

In order to systematise the principles for the enhancement of soundscape in urban open spaces, from the viewpoint of urban design, key urban and acoustic factors must be defined. Key urban and acoustic factors were chosen for this study with an aim to detect the trends in urban soundscape design with implications for the planning practice: the type of urban open space, the type of designed sounds, sound source localisation, the acoustic aspect of elements of urban design and the spatial aspect of elements of soundscape design.

2.1. Key urban and acoustic factors

Noise mitigation methods include factors primarily related to legal, economic or city management measures, such as motor traffic speed reduction. On the other hand, this research focuses on factors directly influenced by the urban acoustic design.

Therefore, key urban and acoustic factors refer to the general principle of soundscape enhancement proposed by Bill and Mary Buchen. Their principle of designing a theme sound park includes the use of noise protection and placement of sound sources in the area of acoustic shadow it creates (Buchen, Buchen, 1991, p.8). Its implementation varies regarding the type of urban open space and external factors.

The analysed urban and acoustic factors influence the design of the following principles: 1) adding sound sources (acoustic art installation, electroacoustic system, alarm system, fountain), 2) attenuating

sound sources (engineered acoustical barriers), and 3) achieving acoustic distinctiveness (designed acoustic effect).

For the purpose of this research sound sources are reduced to **the types of positive sound sources** in order to facilitate comparisons by individual sound sources, by which the aural experience of the analysed urban area is generated (similar to those used in the standard questionnaire on the quality of the sound environment - Swedish Soundscape Quality Protocol (Axelsson, Nilsson, Berglund, 2009)): 1) sounds of people (talk, laughter, steps, suitable music, children's plays, bicycles), 2) sounds of nature (wind, rustling of leaves, water, waves, birds), and 3) sounds of designed sources (category added specifically for the needs of this study - musical sounds, art installations, signal sounds). The sound of architecturally designed sources may occur by mechanical, acoustic or electro-acoustic means.

Sound source localisation directly influences the immersiveness of the designed soundscape. A soundscape is considered immersive if designed soundscape elements can be experienced simultaneously from two or more directions. Sound sources can be arranged to act as a point, line, field or a complex spatial form. While the first is the most common arrangement of sound sources in urban open spaces, others offer the designed immersive soundscape experience (Oberman, 2015, pp. 130-143). The immersive character of the designed soundscape can positively influence the overall assessment of an urban open space (Oberman, 2015, pp.288-299).

Linear arrangement of sound sources means that, while being in the inner space of the designed soundscape, users are able to experience the added soundscape elements from two different directions. The line may consist of a single physically elongated source or of a number of point sources spatially close enough to be considered a line. Sound propagation from a linear source can be diffused or directed. Orientation is often influenced by the existence of architectural and landscape elements, such as topography or barriers limiting the propagation of sound in one direction and localising its diffusion in the other, or by the possible directivity of speakers (in case of an electro-acoustic system). A linear directional model, for example, is conditioned by the speakers placed alongside the facade of a building (part of the electroacoustic multi-speaker system at the Yarra River Southbank Promenade in Melbourne, for example) or a fountain of an elongated plan which is designed as a waterfall (at the Sheaf Square in Sheffield, for example).

The arrangement of sound sources determining the field within an urban open space means that multiple sound sources are distributed in space in a way that makes the area in which the added soundscape element is being experienced as spatially continuous. The user in the strict space of the designed soundscape can experience the added soundscape elements from at least three different directions.

Urban design elements can directly generate different acoustic effects, mitigate noise and define spatial ensembles. Regardless of the level of noise in a particular urban open space, there may or may not exist an architectural barrier designed for noise mitigation.

The optimal space of designed aural experience can be articulated by varying degrees of architectural boundedness relative to the contact area, usually with the goal of a separation from external influences to allow unhindered imaginary aural experience. Designing a pavilion intended for a specific aural experience is the most common way to envelop the inner space of an optimal aural experience.

On the other hand, the inner space of the designed aural experience may not be highlighted by architectural design, but purely acoustically. In that case soundscape becomes the sole means of separation of a certain space by highlighting its part.



Figure 1. (Left) *Sea Organ in Zadar*. The space of optimal aural experience is architecturally indicated by steps that descend to the sea, but is not separated from the contact area (Google Street View, photo taken during October 2011)

Figure 2. (Right) *Echo pavilion in Zagreb*. The space of optimal aural experience is defined within the pavilion building (Google Street View, photo taken during August 2011)

Pronounced acoustic effect, significant for experiencing an achieved sonic environment, can be a designed (Echo Pavilion in Zagreb's Maksimir, for example) (Oberman, 2015) or an unintended consequence of architectural and urban interventions (such as Youngstorget in Oslo) (Maag, 2013). This implies an acoustic effect in the strict sense (such as a reverb or a pronounced echo) rather than being understood in the way interpreted by the theory of sound effects whose starting point is that every aural experience can be explained by one or more acoustic effects, i.e. that an aural experience deprived of the acoustic effect is not possible (Augoyard, Torgue, 2011).

2.2. Criteria for the selection of analysed urban open spaces

This study includes an overview of urban open spaces from around the world (Regarding the Augoyard's recommendation (Augoyard, 1978) to avoid research on soundscape that does not include the field experience in the first person, this study includes specific urban soundscapes around the world, while referring exclusively to the factors that have been estimated not to be influenced by direct experience). The main criteria for choosing the relevant urban open spaces for the analysis was their acoustical specificity which is documented well enough to allow assessment of key urban and acoustic factors.

The research is based on urban geospatial data provided by the *Google Earth Pro* application which enables an overview of the historical satellite imagery, area measurement, the screening of spatial-functional type of the urban open space, the position of the urban open space in the city, pedestrian accessibility of the urban open space, changes in the urban open space over a certain period of time, the characteristics of the urban structure in the contact area and the recognition of the designed sound sources documented in other literary sources.

3. Designed immersive soundscapes within urban open spaces

A total of 25 urban open spaces characterised by the designed immersive soundscape, built in 21 different cities in Europe, the United States of America, Australia, Japan and China, were analysed in relation to key urban and acoustic factors explained in the previous section (Table 1).

The majority of the analysed urban open spaces and/or designed soundscapes implemented within them were built between 1999 and 2011 (the newest public space being the Wilgenwende Dordrecht Park designed by Lola architects in 2009, still unfinished at the time of this research). The oldest analysed designed immersive soundscape within an urban open space was the electroacoustic sound

art installation *Times Square* by sound artist Max Neuhaus, implemented on the Times Square in New York City in 1977. It was built underneath the pedestrian area, with the speakers in the ground plan forming a field (Neuhaus, 2009, p.49).

Table 1. Chronological overview of analysed urban open spaces and key urban and acoustic design factors which influence the immersiveness of the designed soundscape (Oberman, 2015. pp. 322-467)

Urban Open Space, Year of the Implemented Soundscape Design	Spatial-functional Type	Designed Immersive soundscape elements	Sound Source Localization Characteristics	Boundedness by Urban Design Elements
Times Square, New York City, 1977	Square	Sounds of designed sources (musical sounds - multi-speaker system)	Field	Open
Yacht Road, San Francisco, 1986	Seafront promenade	Sounds of designed sources (musical sounds - mechanical system)	Lines	Enclosed by pavilion elements
Arizona Science Center Plaza, Phoenix, 1986	Plaza	Sounds of designed sources (musical sounds - mechanical system)	Line	Open
<i>Le Jardin de Bambou (Parc de la Villette)</i> , Paris, 1987	Theme garden within an urban park	Sounds of nature, sounds of designed sources (musical sounds - multi-speaker system)	Lines and Field	Enclosed by garden and pavilion walls
Lassallestrasse 1, Vienna, 1992	Plaza	Sounds of designed sources (musical sounds - multi-speaker system)	Field	Open
Yarra River Southbank Promenade, Melbourne, 1992	Riverside promenade	Sounds of designed sources (musical sounds - multi-speaker system)	Field	Open
Forecourts of ANZ Stadium, Sydney, 1999/2000	Plaza	Sounds of designed sources (musical sounds - multi-speaker system)	Fields	Open
Pedestrian bridge <i>Lorrainestrasse</i> , Bern, 1999	Footbridge	Sounds of designed sources (musical sounds - multi-speaker system)	Line	Open

Aquamarine Fukushima, Onahama, 2000	Seafront promenade	Sounds of nature (amplified by acoustic design)	Line	Open
Campbelltown Art Center, Campbelltown, 2001	Urban park	Sounds of designed sources (musical sounds - mechanical system)	Field	Open
Birrarung Marr Park, Melbourne, 2002	Urban park	Sounds of designed sources (musical sounds)	Field	Open
Millenium Stadium River Promenade, Cardiff, 2002	Riverside promenade	Sounds of designed sources (signal and musical sounds - multi-speaker system)	Line	Partially enclosed by the stadium building
Lendkai 1, Graz, 2003	Plaza	Sounds of designed sources (musical sounds - multi- speaker system)	Line	Partially enclosed by the museum building
Millenium Park, Chicago, 2004	Urban park	Sounds of designed sources (musical sounds - multi- speaker system)	Field	Open
<i>Obala Petra Krešimira IV</i> , Zadar, 2005	Seafront promenade	Sounds of nature, sounds of designed sources (musical sounds - mechanical system)	Line	Open
Sheaf Square, Sheffield, 2006	Square	Sounds of nature (designed sound source - water fountain)	Line	Enclosed by the sculptural wall
Linz AG Center, Linz, 2006	Plaza and portico	Sounds of designed sources (musical sounds - multi- speaker system)	Field	Enclosed by the portico
William Barak Bridge, Melbourne, 2006	Footbridge	Sounds of human beings (designed sound source - multi- speaker system)	Field	Open

<i>Kipos Tou Ichou (Nea Paralia)</i> , Thessaloniki, 2008	Seafront promenade	Sounds of nature	Lines and field	Open
<i>Laberinto de las Ciencias y las Artes</i> , San Luis Potosi, 2008	Urban park	Sounds of designed sources (musical sounds - multi-speaker system)	Field	Enclosed by the pavilion walls
Forecourt of AAMI Park, Melbourne, 2010	Plaza	Sounds of human beings (designed sound source - multi-speaker system)	Field	Open
Les Erdi Plaza, Melbourne, 2010	Riverside promenade	Sounds of designed sources (musical sounds - multi-speaker system)	Line	Enclosed by the wall with mounted multi-speaker system
Lincoln Park, Miami Beach, 2011	Urban park	Sounds of designed sources (musical sounds - multi-speaker system)	Field	Open
Garden of Labyrinth (Master Gardens Expo 2011), Xi'an, 2011	Theme garden within a urban park	Sounds of designed sources (musical sounds - mechanical system)	Field	Enclosed by the garden and pavilion walls
Wilgenwende Dordrecht Park, Dordrecht, -	Urban park	Sounds of nature (designed sound source - selected treetops)	Field	Enclosed by the artificial topography

Previous research (Lacey, 2014) on the influence of spatial-functional types on the designed soundscapes pointed out two factors that benefited the public acceptance of the designed soundscape: 1) the transit character of the urban open space, and 2) the non-disruptiveness of the soundscape experience.

The research on multi-speaker electroacoustic systems in Melbourne's urban open spaces, conducted by SIAL Sound Studios (SIAL Sound Studios are a multi-disciplinary research facility at the Royal Melbourne Institute of Technology), indicates that added soundscape elements are better accepted in spaces intended for transit (such as streets, footbridges and underpasses) than in spaces with high social presence (such as squares, plazas or promenades). For instance, the designed immersive soundscape such as the one designed for the Yarra River Southbank Promenade in Melbourne (built in 1992) proved to be an imposition on the existing spatial programs (Lacey, 2014, p.10). On the other hand, the mechanical acoustic installation of the Sea Organ in Zadar (built in 2005), built also in the waterfront (seafront) promenade (*Obala Petra Krešimira IV*), is being highly praised both by the local community and tourists (Jambrošić, Domitrović, Horvat, 2013; Zanki, 2013). The latter is 13 years younger than the former which was decommissioned after some 20 years. This case only speaks for the site specific character of research results within the field of architecture and urbanism.

Urban open spaces offering the non-disruptive advantage are beneficial for the experience of the designed soundscape since it can be experienced as a more traditional piece of art - the passer-by has the opportunity to become the listener of the musical composition (Lacey, 2014, p.11). In that way the urban open space can become an integral part of an art piece. On the other hand, the aforementioned installation *Times Square* was conceived to be experienced within a loud and noisy soundscape and perceived as a work of art mainly by an informed group of individuals (Neuhaus, 2009). Therefore, the boundedness of inner spaces of the designed immersive soundscape is analysed via the enclosed and open principles. The enclosed principle is considered to offer a higher degree of non-disruptiveness on two levels: 1) the urban design element acts as a noise barrier in case of adjacent noise sources, and 2) the urban design element influences the integral perception of the urban open space by emphasising the inner space of the designed soundscape experience in case noise is not an issue.

A small number of analysed projects are urban open spaces dedicated to the experience of the designed soundscape. For example, in *Le jardin de bambou* (designed by Alexander Chemetoff in Parc de la Villette, Paris) water channels were designed along the entrance steps to draw attention to the acoustic experience created by the sound of rippling water with an aim of 'introducing' passers-by to *Le cylindre sonore* pavilion (designed by architect and sound artist Bernhard Leitner) dedicated to the acoustic experience. Speakers' locations in the pavilion are highlighted by concrete perforated masks. The whole garden lays *cca.* 3 meters lower than the surrounding surface to acoustically separate passers-by from the soundscape of the rest of the *Parc de la Villette* (Leitner, 1998, p.144-148).

4. Conclusion

Without attempting to draw a definite conclusion (due to methodological limitations characteristic for the scientific research within the fields of urbanism and architecture, such as the influence of external factors and specificity of each site) on the influence of typological urban factors on the possibility to experience the designed immersive soundscape, the following trends are visible: 1) the most complex designed soundscapes (which include the principles of adding different types of sound sources and different urban design elements that influence the designed soundscape experience) appear within urban open spaces designed with the goal of experiencing them (typologically it comes to theme parks), 2) all of the analysed sound source patterns can be found in all of the analysed spatial-functional types of urban open spaces, regardless of their inherent shape (which can be linear or field-like), although sound sources forming a field are more common in urban open spaces having the characteristics of a field than in linear ones, and 3) the analysed urban open spaces characterised by the designed soundscape typologically include plazas, squares, urban parks, waterfront promenades and pedestrian routes like footbridges and underpasses.

The most common spatial-functional types of urban open spaces characterised by the designed immersive soundscape are urban parks (32% of the 25 spaces analysed), waterfront promenades (24%) and plazas (20%). Large urban parks are considered to offer the highest degree of non-disruptiveness and are not characterised by high social presence and functional complexity like other analysed urban open spaces. In 3 out of 6 cases, waterfront promenades contain the designed soundscape elements which are inspired and generated by the sea itself. Plazas, being semi-public spaces, are considered to represent the adjacent building as well as the investor, so the designed soundscape has the goal of contributing to their attractiveness.

The spaces here analysed were rarely conceived solely to enhance the urban soundscape. Designed immersive soundscapes intertwine contemporary sound art, music and urban design and enrich the urban open spaces giving them a new layer of a landmark quality.