Dancing Soundscapes

Acoustics driven design

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Dancing Soundscapes

Final Project

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of Technology
Faculty of
Architecture and Town Planning

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Footsteps echo, sharp and fast,
Snippets of voices, drifting past.
Sirens cry in distant wails,
Horns weave through the city’s trails.
Everywhere motion, everywhere sound,
The city’s pulse is strong, unbound.
It never stops, it never sleeps,
Its voice a tide that swells and sweeps.
In choosing the city, do we embrace,
A world of noise that grows in space?
Or could it change, could silence grow,
A quieter rhythm we’ll never know?

Introduction

Noise pollution is a growing issue in urban environments, affecting human health, wildlife and ecosystems. In the European Union, approximately 1 in 5 people (equivalent to 100 million citizens) are exposed to unhealthy levels of noise.

> “The World Health Organization (WHO) has classified traffic noise, as the second most important cause of ill health in Western Europe, behind only air pollution”. [1]

Prolonged exposure to environmental noise can lead to negative cardiovascular and metabolic effects, reduced cognitive performance in children and sleep disturbance. These are estimated to cause 12,000 premature deaths and 48,000 new cases of ischemic heart disease per year in the European territory.[2]

Noise pollution is both a product and a consequence of the Industrial Revolution. As industrialization spread, traditional sound environments dominated by natural sounds and human voices were replaced by the mechanical, high-intensity noise of factories, transport, and dense urban living.[3] In the late 19th century, awareness and attention to the relationship between urban design and built environment to human well-being and health increased.[4]

1 World Health Organization (WHO) (2018). “Environmental Noise Guidelines for the European Region

2 World Health Organization (WHO) (2018). “Environmental Noise Guidelines for the European Region

3 Bijsterveld, Karin. Mechanical Sound: Technology, Culture, and Public Problems of Noise in the Twentieth Century. MIT Press, 2008.

4 Theme Cities: Solutions for Urban Problems. 2015 Mar 24;112:477–531

Global urbanization continues to accelerate, with more than 55% of the world's population now living in cities, projected to reach 68% by 2050.[5] Urban centers and Megacities are rapidly expanding, therefore the number of vehicles has been increasing at an unprecedented rate, causing severe traffic congestion and posing significant challenges for urban infrastructures and environmental sustainability.[6] In recent years, there are efforts to monitor and regulate noise levels in cities. For example, in 2021 Paris deployed a citywide network of sensors aimed at monitoring noise pollution generated by vehicles. In Israel, the "Quiet Cities" program was launched in 2024, enabling residents to report noise incidents, thereby facilitating both enforcement and the mitigation of urban noise pollution. While monitoring and enforcement are essential in addressing noise pollution, they are not sufficient on their own to ensure acoustic comfort and quality of life in the urban environment.[7]

The emerging research field of Soundscapes offers a multidisciplinary approach to acoustic design, suggesting absolute factual parameters in addition to personal subjective ones.[8] This approach provides the opportunity for architectural solutions and innovations regarding acoustic design and quality of life in cities.

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5 United Nations, Department of Economic and Social Affairs, Population Division. World Urbanization Prospects: The 2018 Revision, Highlights. New York: United Nations, 2019

6 United Nations, Department of Economic and Social Affairs, Population Division. "Urbanization." United Nations. Accessed March 16, 2025.

7 Kang, Jian, and Mark Dubois. "Acoustic Comfort Evaluation in Urban Open Public Spaces." Applied Acoustics 66, no. 9 (2005): 665–678

8 ISO 12913-1; Acoustics—Soundscape—Part 1: Definition and Conceptual Framework

The project, *Dancing Soundscapes*, addresses the urgent issue of noise pollution and proposes a parametric, soundscape-driven design methodology aimed at enhancing acoustic comfort and well-being in dense metropolitan environments. A site in the heart of Tel Aviv's central business district was chosen as a case study. By integrating acoustic analysis at multiple design scales, the project demonstrates how urban form can be shaped to reduce noise exposure while simultaneously generating diverse and positive sound experiences. Through these strategies, *Dancing Soundscapes* raises critical questions about the architect's role in shaping acoustic environments and about the capacity of urban design to respond to contemporary environmental challenges, when the main question is – ***How can soundscape driven design provide acoustic comfort and promote well-being in urban environments suffering from noise pollution?***

1 in 5 (EU)
exposed to unhealthy noise levels

43,000
Hospital admissions (EU per year)

12,000 | 400
Premature deaths (EU | ISR

Metabolic effects, Cardiovascular diseases, Sleep disorders, Cognitive deficits, Annoyance and discomfort, Hearing impairments, Newborn effects, wellbeing and mental health (WHO 2011 report)

01

Sound and the City

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What is Soundscape?

The term "Soundscape" was coined and introduced by Canadian composer Raymond Murray Schafer in the late 60s and since then has been studied in various fields such as architecture, urban design, environmental psychology and acoustics. Schafer initiated and founded The World Soundscape Project (WSP), which aimed to document and analyze various soundscapes worldwide, to raise awareness of the changing acoustic environment and the impact of urbanization and industrialization on natural soundscapes.[9] Subsequently, in 1977 Schafer wrote the book "The Tuning of the World ", in which he explored the historical evolution of soundscapes, analyzing how man-made and natural sounds have shaped the auditory experience. He emphasized the need to preserve and design soundscapes which enhance human well-being and environmental harmony.[10]

Belgiojoso Ricciarda continued Schafers' work and defined 2 types of soundscapes. Hi-Fi Soundscape, prominent in rural environments, where the foreground sounds are higher therefore the sound is clear and easily perceived. This is opposed to Lo-Fi Soundscape, prominent in urban environments, where background noise is higher therefore the quantity of acoustic information is excessive and communications are difficult to understand, because they are masked by a generic broadband noise. Belgiojoso's work

9 Truax, Barry. "R. Murray Schafer (1933–2021) and the World Soundscape Project." Organised Sound 26, no. 3 (2021): 419–421

10 Schafer, R. M. (1977). The Tuning of the World. Knopf. Truax, B. (1984). Acoustic Communication. Ablex Publishing.

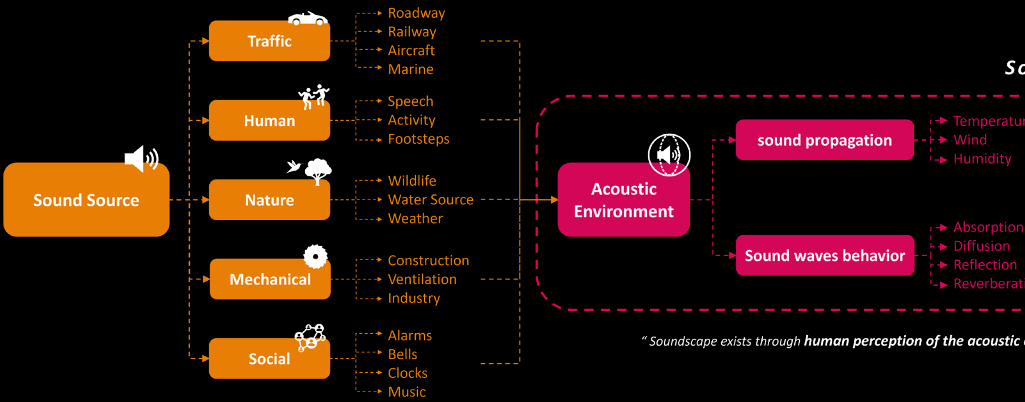
raises the question of acoustic balance and soundscape shaping.[11]

ISO (the International Organization for Standardization) has defined soundscape as “the acoustic environment as perceived or experienced and/or understood by a person or people, in context”. Meaning, soundscape is created individually through human perception of the acoustic environment.[12] When analyzing this definition, we identify that soundscape has absolute factual parameters while also having personal perception factors. The acoustic environment is created by sound, coming from a source, and its way of traveling in time and space. It’s affected by climate conditions, such as temperature and humidity, and sound waves behavior. Therefore, the acoustic environment is a physical environment defined by absolute factual parameters. When sound reaches the human ear, two processes occur simultaneously-conscious and unconscious processing, which define our auditory perception. These processes are subjective and are influenced by cultural social economical factors such as age, sex, religion, class, etc. The combination of the acoustic environment and the auditory perception results in the creation of Soundscape, the simultaneous physical and social environment. This can be seen in *figure 1*.

The importance of sound balance and various soundscape characteristics, in addition to understanding that the experience of sound is subjective and affects well-being, is the foundation of the project and its proposed solution.

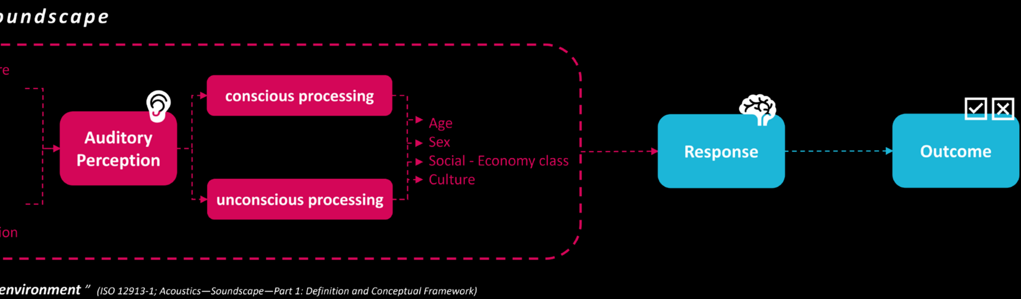
11 Belgiojoso, Ricciarda. Constructing Urban Space with Sounds and Music. Farnham: Ashgate Publishing Ltd, 2014

12 ISO 12913-1; Acoustics—Soundscape—Part 1: Definition and Conceptual Framework



Based on diagram - From understanding to designing soundscapes, 2010

Figuare 01 | Hearing process and soundscape definition


oundscape
re
Auditory Perception
conscious processing
unconscious processing
Age
Sex
Social - Economy class
Culture
ion
Response
Outcome
environment ” (ISO 12913-1; Acoustics—Soundscape—Part 1: Definition and Conceptual Framework)

Urban soundscape shaped by Urban design

Urban soundscapes, the auditory environments of cities, are profoundly influenced by urban design.[13] The spatial arrangement of buildings, streets, public spaces, various programs and their distributions, and the integration of natural elements all contribute to the acoustic character of urban areas and how sound is experienced in them.

Pre-Industrial Cities | The Organic Soundscape

Before industrialization, cities developed organically with narrow streets, enclosed courtyards, and mixed-use spaces which created distinct sound environments. The absence of mechanized noise meant that urban soundscapes were dominated by human voices, animals, church bells, and market sounds. For example, in Medieval and Renaissance Cities the compact urban layout limited sound travel, fostering intimate soundscapes dominated by human activities. Town squares and cathedrals served as focal points for sound, with bells marking time and regulating social life. Courtyards acted as buffers from street noise, influencing later designs of enclosed, sound-mitigating spaces.[14]

Industrialization and the Rise of Noise

The Industrial Revolution (18th-19th century) introduced mechanized processes, altering urban soundscapes significantly.

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13 Schafer, R. Murray. The Soundscape: Our Sonic Environment and the Tuning of the World. Destiny Books, 1994.

14 Garrioch, David. “Sounds of the City: The Soundscape of Early Modern European Towns.” Urban History 30 (2003): 5–25.

Cities became louder due to factory machinery and steam engines, the rise of mass transit systems and increased number of vehicles in the city, rapid population growth which amplified everyday noises and limited number of green spaces to absorb sound.[15]

The Garden City Movement and Soundscape Design

In response to industrial-era noise and congestion, Ebenezer Howard proposed the Garden City Movement in the late 19th and early 20th centuries. Garden Cities aimed to balance urban and rural qualities by incorporating green belts and parks to buffer noise, zoning to separate residential areas from industrial areas and radial street layouts with open spaces to reduce sound concentration.[16] At the time, one of the main movements was the Garden City movement which was initiated by Ebenezer Howard. It emphasized the harmonious blend of urban and rural elements to improve quality of life by "marrying town and country" and creating a new form of urban planning where "life may become an abiding joy and delight".[17] This can be seen in *figures 2-3*.

Modernist Urban Planning and Soundscapes (1920s–1960s)

Modernist architects introduced new urban forms, such as high-rise buildings and large open spaces. While these forms aimed to improve living conditions, they had unintended soundscape consequences. High-Rise buildings emphasized verticality which

15 Bijsterveld, Karin. Mechanical Sound: Technology, Culture, and Public Problems of Noise in the Twentieth Century. MIT Press, 2008

16 Ward, Stephen. The Garden City: Past, Present and Future. Routledge, 2005

17 Howard, E., 1965. Garden cities of tomorrow. MIT Press: Cambridge.1

led to changes in how sound traveled, with potential for increased echoes and wind-induced noises. Large plazas and wide streets resulted in sound reflections which amplified urban noise, and large concrete surfaces which increased sound reflection and amplified noise in open spaces.[18]

Contemporary Urban Soundscapes (1970s–Present)

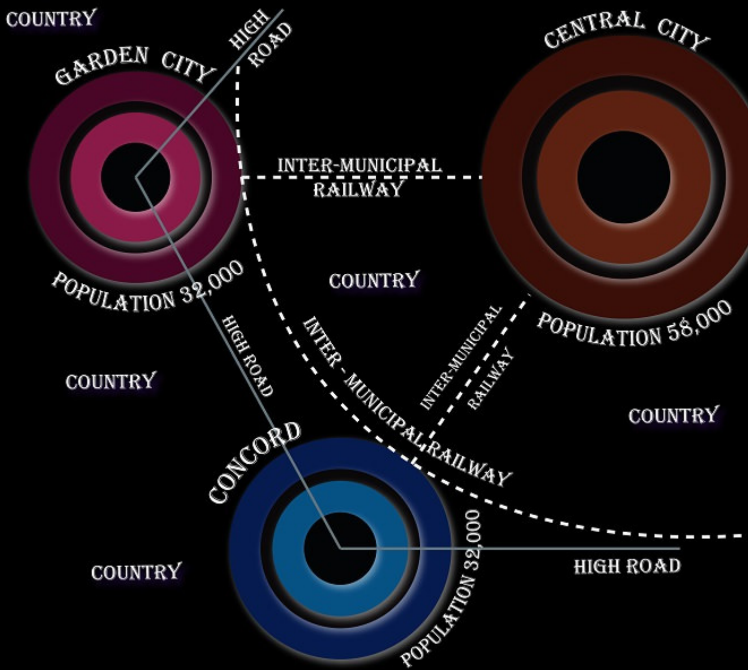
As cities expanded, noise pollution became a major concern and threat to human health, wildlife and ecosystems. This emphasized the importance of sound and acoustic comfort in designing livable cities.[19,20] Early efforts in addressing the issue included zoning by separating industrials areas from residential ones and noise regulations to restrict excessive street noise (especially traffic and public events). Later, quieter machinery was produced, and buildings began to be soundproofed with absorbing materials.

While the field of urban soundscapes has made impressive strides, sound is still treated as a problem which needs to be mitigated, controlled, and a design after thought. This conception is the starting point of the project and its goal- harmonious design where sound is celebrated, where the built environment contributes not only to visual and spatial experiences but also to auditory well-being and human experience.

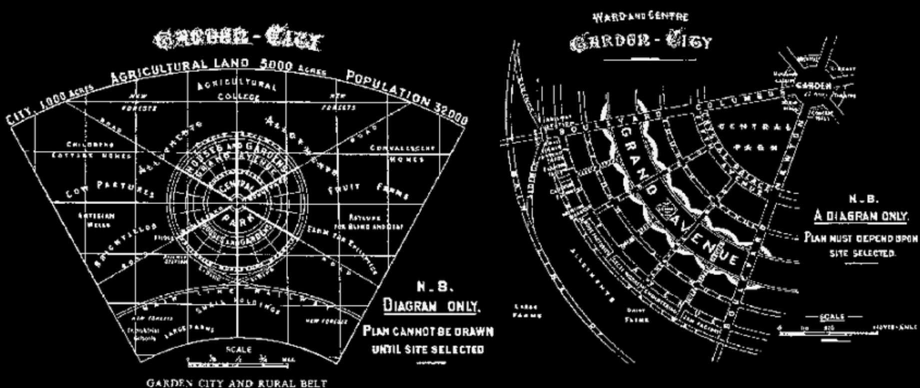
18 Zhang, Wenjing, Jian Kang, and Francesco Aletta. "Effects of Façades on Urban Acoustic Environment and Soundscape." Sustainability 14, no. 15 (2022): 9670

19 Kang, Jian, and Brigitte Schulte-Fortkamp, eds. Soundscape and the Built Environment. CRC Press, 2015

20 Pijanowski, Bryan C., et al. "Soundscape Ecology: The Science of Sound in the Landscape." BioScience 61, no. 3 (2011): 203–216.



Figuare 02 | Garden cities, from Garden City Movement by Sir Ebenezer Howard



Figuare 03 | principle of the Garden City, from Urban Segregation and urban form

02 Measuring Sound

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Units

Sound can be measured and evaluated according to two primary parameters, intensity and frequency. Sound intensity refers to how loud or soft a sound is and is measured in decibels (dB). Different noises register at different intensities, as shown in *figure 4*. Quiet sounds are defined as those below 50 dB, such as the rustling of leaves or the ticking of a clock, while the threshold of pain begins around 90 dB, with exposures longer than half an hour carrying significant health risks. Loud sounds include alarms, explosions, and vehicle sirens.

The second parameter is frequency, which defines how low or high a sound is (Pitch), and is measured in hertz (Hz). As illustrated in *figure 5*, the human hearing range spans from 20 to 20,000 Hz, encompassing both low (bass) and high-pitched sounds, each requiring different strategies of acoustic treatment.

Grounded in a holistic approach to soundscape design, the project engages with both parameters to move beyond noise mitigation toward the active curation of auditory experience. By treating sound as a material of design, the architecture is conceived not only as a spatial and visual construct, but as an acoustic landscape that shapes how intensity and frequency are perceived, orchestrated, and lived within the urban environment.

Acoustic comfort

Acoustic comfort is defined as "the absence of unwanted sound and having the opportunity to perform acoustic activities without disturbing others".[21] This definition emphasizes not only the reduction of intrusive noise but also the provision of an environment that supports desired acoustic activities without causing disturbance to others.

Assessing acoustic comfort involves both objective measurements and subjective evaluations to determine how individuals perceive and are affected by their auditory environment. Objective measurements involve quantifiable parameters such as sound pressure levels, reverberation times, and frequency distributions. Since acoustic comfort is subjective, its ranges and values are influenced by demographic factors. Studies show that older individuals often exhibit increased sensitivity to auditory distractions, as opposed to younger individuals which have higher tolerance noise levels. Gender also plays a role, where studies have shown that women may report higher levels of noise disturbance compared to men.[22] In addition, the nature of activities significantly impacts acoustic comfort. Tasks requiring high concentration, such as reading or detailed work, are more susceptible to noise disruptions, whereas activities like casual conversations or

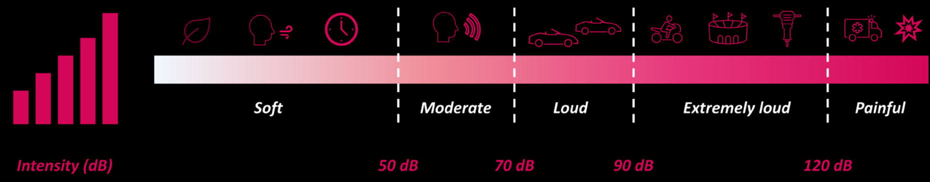
21 van den Berg, Frits, and Bauke de Rooij. "Acoustical Comfort as a Design Criterion for Dwellings in the Future." Proceedings of Euronoise 2015, Maastricht, Netherlands, May 31–June 3, 2015.

22 Schlittmeier, Stefanie J., and Jürgen Hellbrück. "Acoustic Comfort in Open-Plan Offices: The Role of Employee Characteristics." Applied Acoustics 70, no. 5 (2009): 748–757

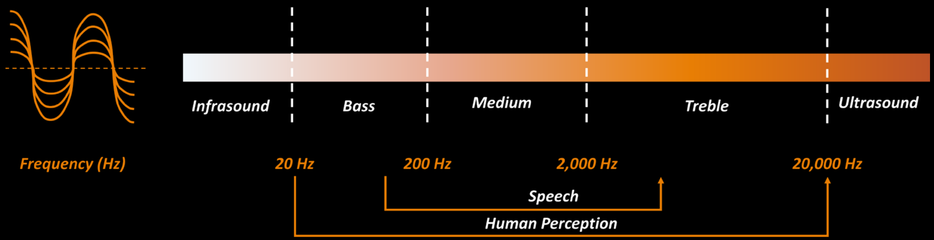
collaborative work may be less affected by ambient noise levels.[23]

Acoustic comfort is a crucial aspect of environmental design, influencing health, productivity, and overall quality of life and well-being. Understanding its factors is crucial for designing urban environments which cater to diverse populations and ensuring spaces are tailored to the specific acoustic needs and preferences of their users. The project's goal is to create spaces with acoustic comfort, where each space has a different range of said comfort-according to program and users. This is also shown in *figure 6.*

23 Yadav, Manuj, Jungsoo Kim, Valtteri Hongisto, Densil Cabrera, and Richard de Dear. "Noise Disturbance and Lack of Privacy: Modeling Acoustic Dissatisfaction in Open-Plan Offices." arXiv preprint arXiv:2501.15744 (2025).



Figuare 04 | Sound Intensity levels



Figuare 05 | Sound Frequency range

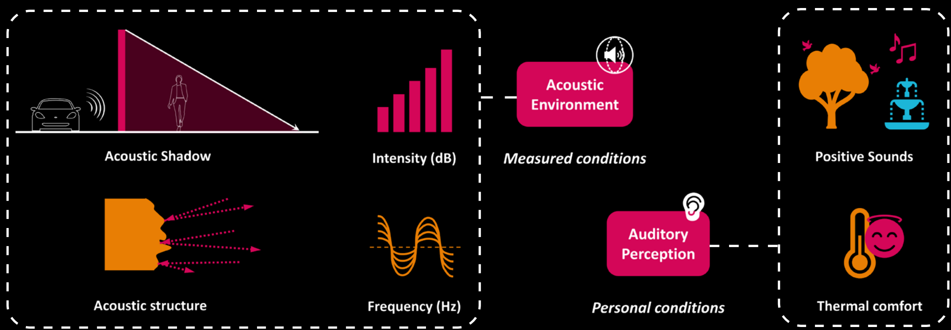


Figure 06 | Acoustic comfort

Acoustic comfort is shaped by both the objectively measured environment and individual subjective factors. Each person responds to different acoustic parameters, which require specific design strategies. Personal comfort can be enhanced by introducing masking sounds, such as water features, vegetation, or wildlife, and by improving thermal conditions that influence overall well-being. Meanwhile, environmental conditions can be improved through acoustic shadowing and targeted frequency absorption.

03

Sound across scales

Urban	24
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Sound across scales

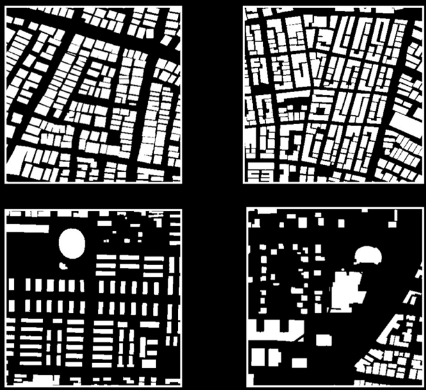
Sound movement in space can be examined across three distinct scales, from the large (urban) to the small (material), with each scale defined by different influencing factors and modes of impact.

At the **urban scale**, the configuration of the city grid plays a critical role. In dense fabrics with narrow streets, noise levels tend to be lower than in areas structured around wide boulevards and highways. This is because sound waves have less space to disperse, while closely spaced buildings cast stronger acoustic shadows on one another, thereby reducing noise intensity. In contrast, when buildings are further apart, acoustic shadowing diminishes, resulting in higher overall noise levels. A closer examination of the street section further reveals its impact: the relative height of the road influences sound intensity, as sunken roads create acoustic shadow zones and reduce noise compared to roads at grade. Similarly, buildings positioned closer to the roadway provide more effective acoustic screening than those set back, while vegetation contributes additional absorption by capturing part of the sound energy. Examples can be seen in figures *7-8*.

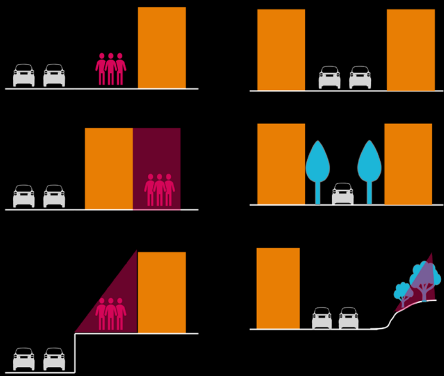
At the **intermediate scale**, sound waves encountering obstacles such as walls or facades are subject to a combination of phenomena—absorption, transmission, reflection, scattering, and diffraction—whose proportions define the acoustic efficiency of the element. This efficiency is also frequency-dependent - lower frequencies are more difficult to absorb, requiring greater depth within the element to effectively attenuate them. Examples can be seen in figures *9-10*.

At the **material scale**, the microstructure of a surface significantly shapes its acoustic performance. The more porous and permeable the material, the better its internal cavities trap and dissipate sound energy, reducing transmission and enhancing absorption.

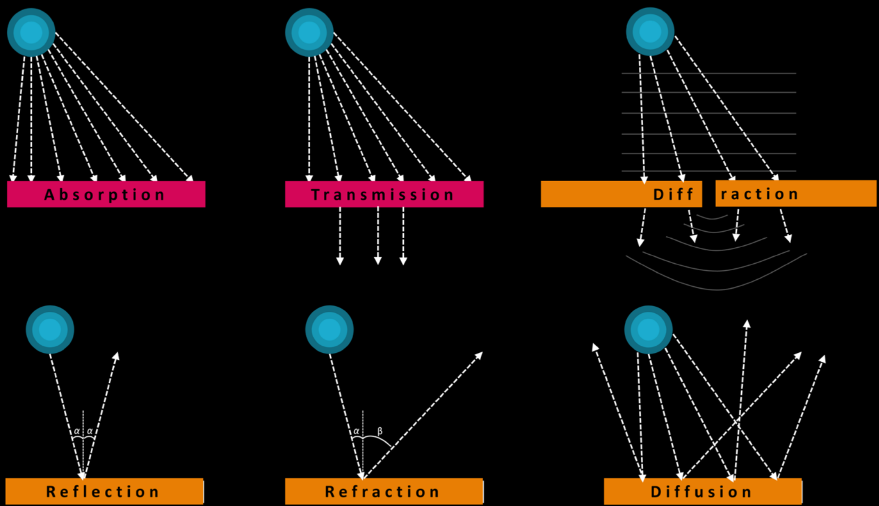
Together, these three scales and the distinct ways in which sound waves interact within each, establish a multilayered framework for acoustic architectural design, enabling the project to move beyond mere mitigation of noise toward the active shaping of urban soundscapes that enhance comfort, experience, and quality of life.



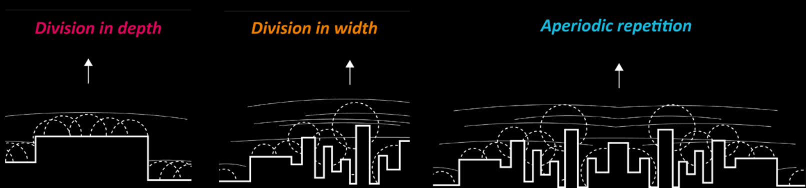
Figuare 07 | Different urban grids



Figuare 08 | Street sections and acoustic shadow



Figuare 09 | Sound waves encountering obstacles



Figuare 10 | Complexity - Acoustic Bricks ETH Zürich 2014

04

Testing Ground

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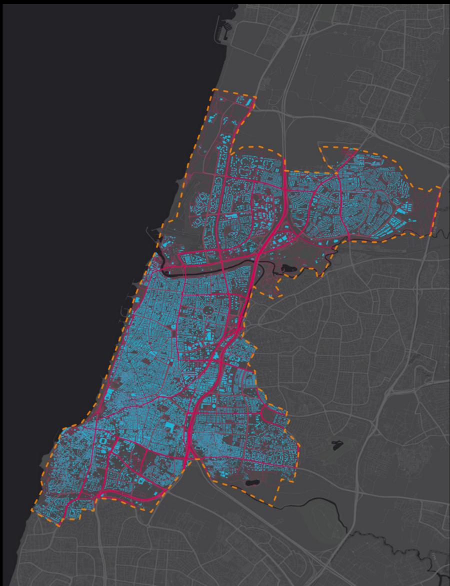
The Site

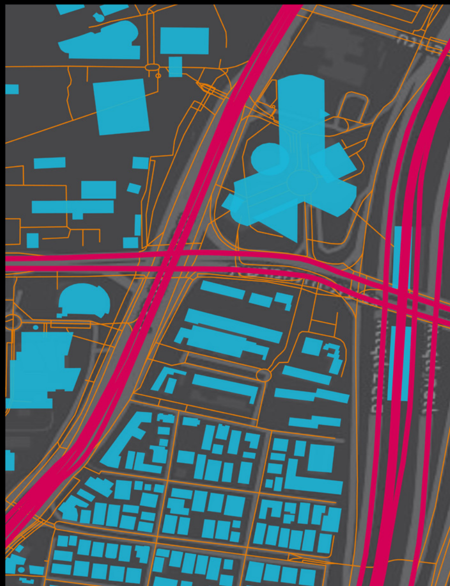
Given the project's focus on acoustic comfort and well-being in noise-polluted dense urban environments, the site selected for investigation lies within Tel Aviv's central business district. The site, Shefa Tal compound, is bordered on three sides by high-traffic roads and adjoining the Montefiore neighborhood.

The site, currently occupied primarily by light industrial and workshop structures, falls within the scope of the 'Tel Aviv 5000' masterplan and is designated for urban renewal. It is classified as a Metropolitan employment area near Mass Transit System 1, intended to evolve into a mixed-use urban area incorporating employment, commercial, and residential functions. The plan also envisions the integration of a city square and public facilities within the site. Additionally, Metro Line M2 is planned to run beneath the site, with a station located in close proximity, further enhancing its strategic urban connectivity and intensity. This can be seen in figures *11-14*.

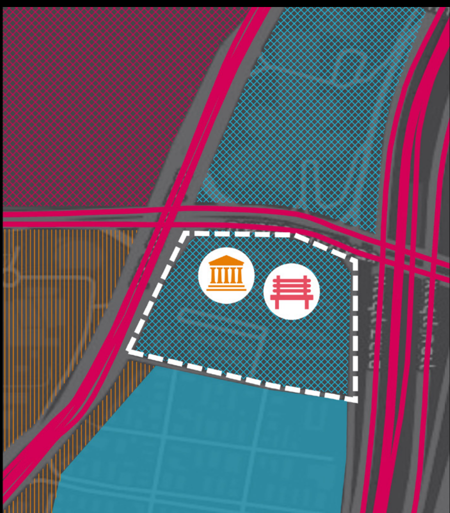
Acoustic simulations conducted by the Tel Aviv Municipality in 2015 indicated elevated noise levels in the area (*figure 15*). Updated simulations carried out as part of this project reveal a significant increase in noise exposure—over 10 dB higher than previous levels, indicating a worsening of environmental conditions. Given this context, the site was chosen as a case study for an acoustics driven design approach, aiming to position acoustic comfort not as an afterthought, but as a guiding parameter in shaping future urban environments.



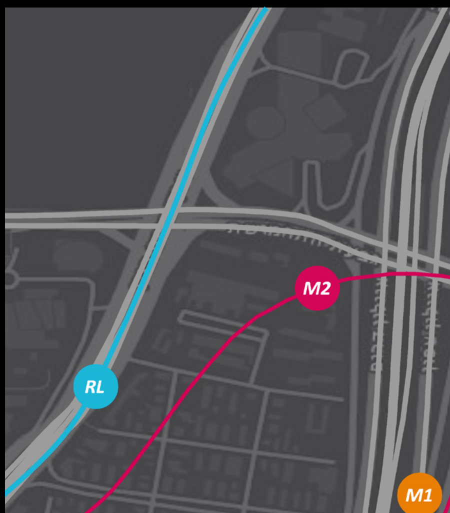
Figuare 11 | Urban context , Tel Aviv



Figuare 12 | The site , Shefa Tal



Figuare 13 | Tel Aviv 5000 Masterplan

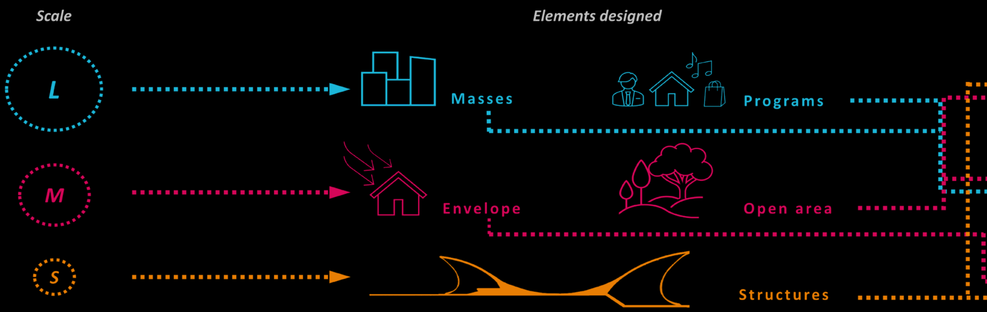


Figuare 14 | Main Transit lines

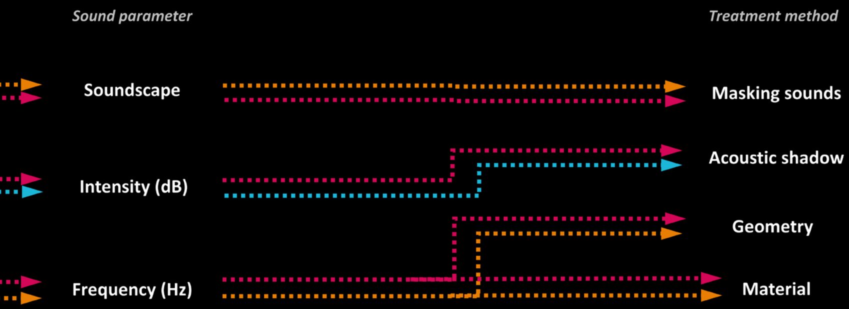
Figuare 15 | Noise Levels 2015

Methodology

In continuity with the previous chapters, where the movement and behavior of sound were examined across three spatial scales, the design process was likewise structured through these scales. The project was developed through a tripartite framework, in which each scale was addressed by means of a specific architectural element. Each element was associated with a relevant acoustic parameter and an appropriate strategy of sound modulation. This methodological approach is illustrated in *figure 16*. For instance, at the large (urban) scale, the massing was articulated in response to the parameter of sound intensity, employing the strategy of generating an acoustic shadow.



Figuare 16 | Methodology across scales


Sound parameter
Treatment method
Soundscape
Masking sounds
Acoustic shadow
Intensity (dB)
Geometry
Frequency (Hz)
Material

05

The Design

Large Scale 35

Medium Scale 44

Human Scale 54

The Large Scale

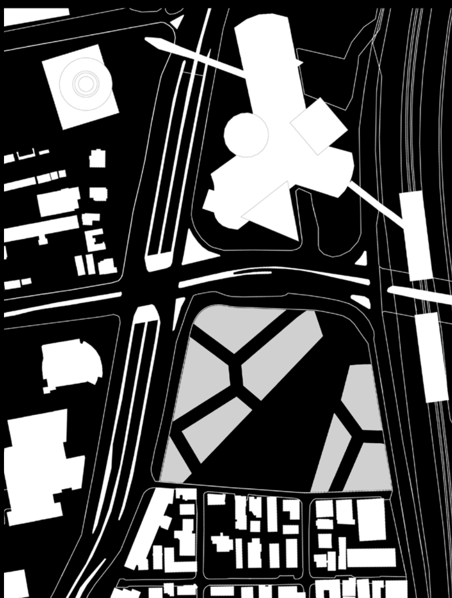
The large scale addresses the structural masses and the general programmatic distribution across the site. The design of the massing was guided by the parameter of sound intensity, specifically through the acoustic shadows that the volumes cast onto the site and onto one another. According to the Tel Aviv Master Plan TA/5000, at least 40% of the site is designated as public open space. This space was therefore conceived as a circulation corridor connecting the northern and southern parts of the site. It opens toward the northeast, where pedestrian flows arrive from HaShalom train station and, in the future, from the planned M2 metro station, and continues south-westward, linking to the Montefiore neighbourhood and the Red Line of the light rail.

The first step was to understand the overall geometry of the massing. I investigated how manipulations of a generic square grid could influence the acoustic performance of the site. The site was organized into two built strips, separated by the public open space. Four alternatives were tested, which can be seen in *figures 17-20*. As shown in *figures 21-24*, the greater the manipulation of the grid, the better the acoustic performance. Less regular façade orientations increase sound wave diffraction, resulting in greater absorption near the built mass and reduced sound penetration into the site's interior. Furthermore, variation in the size of the masses enhanced the effect of acoustic shadowing. In conclusion, the Voronoi grid, which introduces variation both in mass size and in orientation, offers a geometric complexity that significantly improves acoustic performance. For this reason, it was selected as the organizational framework for the site's massing strategy.


Figuare 17 | Option 1 , Square grid


Figuare 18 | Option 2 , Square grid with 1 facade rotation

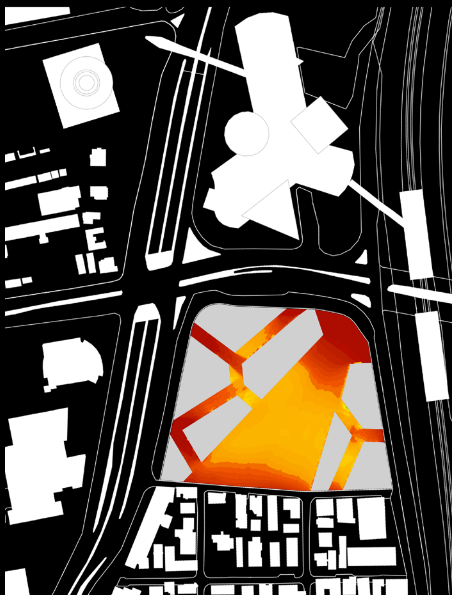

Figuare 19 | Option 3 , Square grid with 2 facade rotations


Figuare 20 | Option 3 , Voronoi grid

Figuare 21 | Option 1 , Square grid

Figuare 22 | Option 2 , Square grid with 1 facade rotation

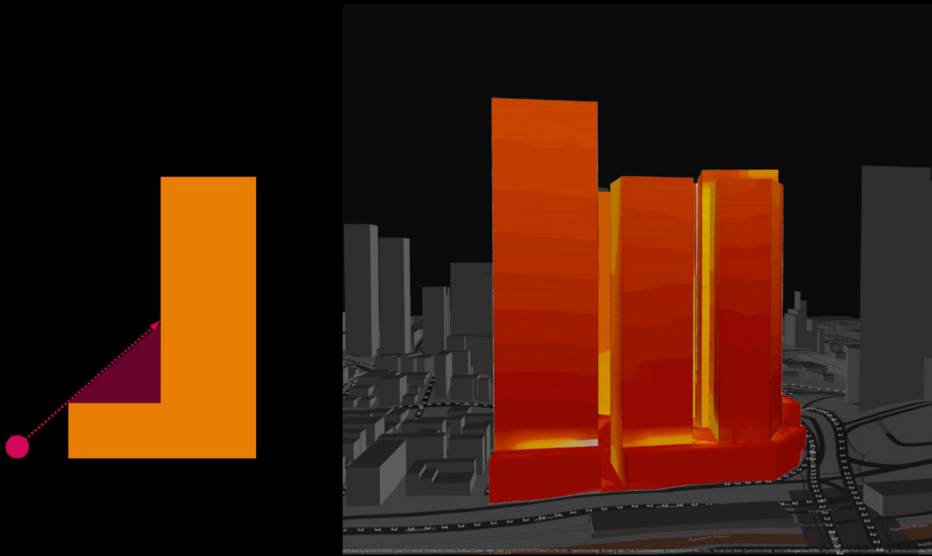
Figuare 23 | Option 3 , Square grid with 2 facade rotations



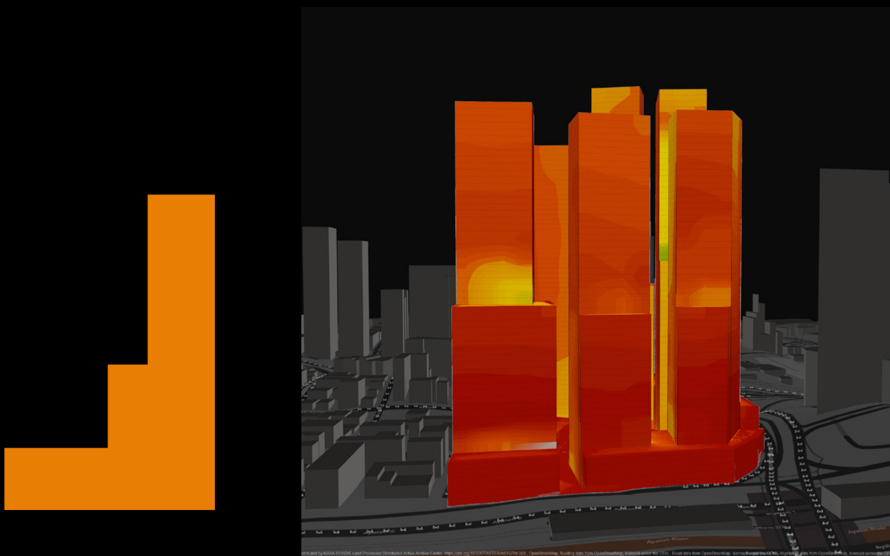
Figuare 24 | Option 3 , Voronoi grid

At the sectional level, the principles of acoustic shadowing suggest that broader building forms perform more effectively than narrower ones. For this reason, the sectional morphology was developed as a podium with a tower above it. The podium generates an acoustic shadow over the lower floors of the tower, enabling the "ground level" of the tower to operate under reduced noise conditions while simultaneously diminishing sound intensity along the tower's façades. Similarly, introducing additional setbacks in the tower massing further decreases sound levels on the façades while creating opportunities for integrating additional programs, such as residential uses that require lower sound levels. This approach is illustrated in *figures 25-26*.

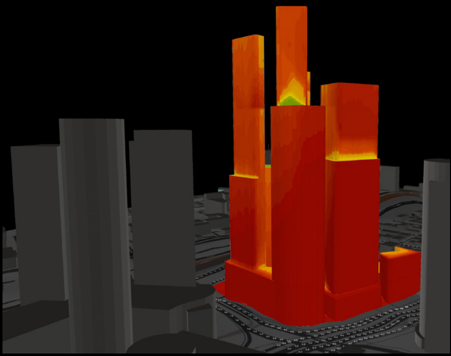
The acoustic analyses presented in *figures 27-32* illustrate the inner façades of the masses, highlighted in yellow as a result of the acoustic shadows cast by adjacent volumes. These conditions allow for the incorporation of openings and the placement of residential functions. The diagrams also demonstrate the use of two levels of setback in the massing, as well as roof surfaces that appear in yellow, indicating their potential to accommodate public programs. In the northwestern part of the site, however, the façades remain marked in red, signifying very high sound levels despite the application of massing setbacks. By contrast, the eastern façades appear in orange and yellow, reflecting lower levels of noise exposure. This analysis provides a basis for the effective distribution of program across the site, aligning existing noise conditions with the acoustic requirements of each programmatic function. In addition, the central public open space running through the heart of the project is rendered in yellow, while the areas adjacent to the surrounding roads are marked in red. The strategies for addressing these high-exposure zones are discussed in the following section, under the medium scale.



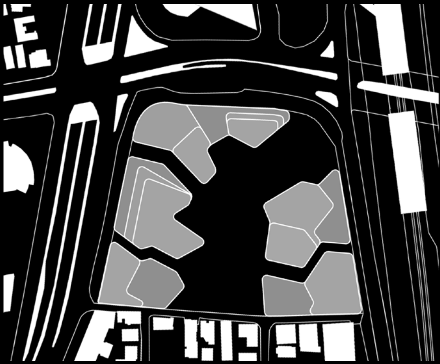
Figuare 25 | 1 setback



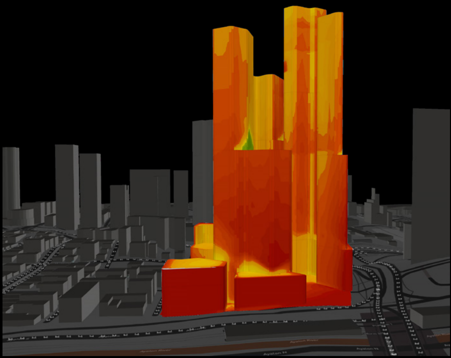
Figuare 26 | 2 setbacks



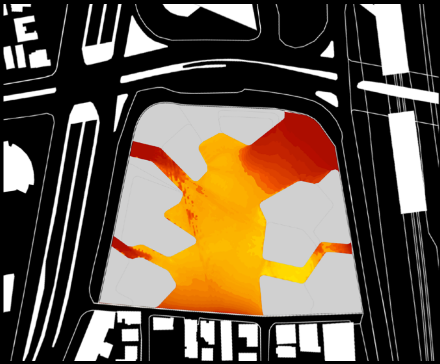
Figuare 27 | Acoustic analysis North-west facades



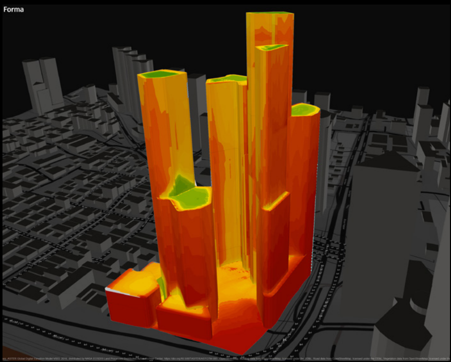
Figuare 30 | The masses



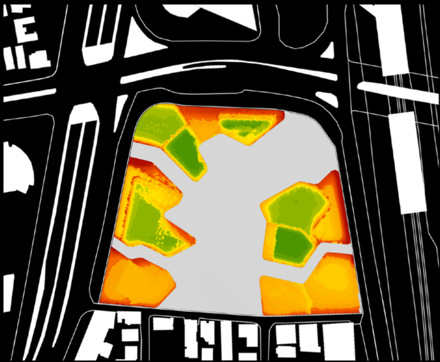
Figuare 28 | Acoustic analysis East facades



Figuare 31 | Acoustic analysis ground floor



Figuare 29 | Acoustic analysis South-east facades

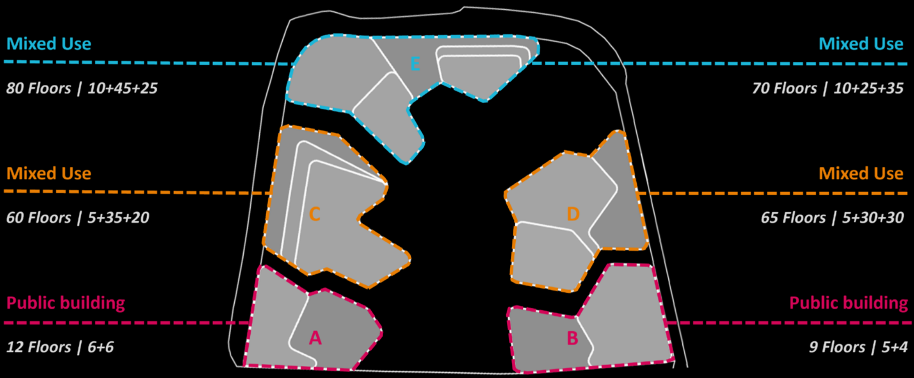


Figuare 32 | Acoustic analysis rooftops

As illustrated in *figure 33*, the site is organized into three bands. The southernmost band, adjacent to the Montefiore neighbourhood characterized by low-rise development, accommodates community-oriented public programs within a similarly low-rise built fabric. Functions such as a community center, kindergartens, small-scale commerce, and an academic institution are positioned here to establish a functional and social connection between the site and its surrounding context.

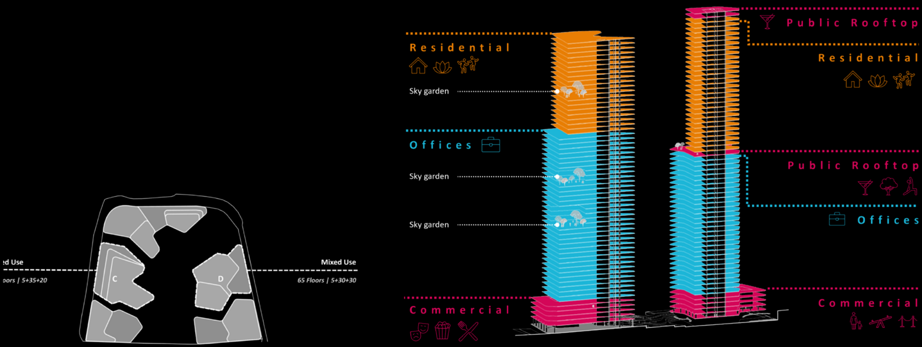
The middle band contains two mixed-use buildings. At the podium level, commercial and cultural programs are introduced, with functions such as auditoria and theaters oriented toward the road-facing façades, where openings are not required, while programs such as restaurants and small workshop spaces are oriented toward the central park, where façades can be opened. The upper floors contain office spaces and residential units, complemented by publicly accessible rooftop terraces.

The northernmost band, situated opposite the Azrieli Towers and functioning as a direct extension of the central business district, addresses the most dynamic and public edge of the site. Here, a mixed-use tower with a broad podium accommodates large-scale retail, food halls, and programs such as a fitness center, serving the high density of users in the upper tower levels. The distribution of these programs is further illustrated in *figures 34-36*.

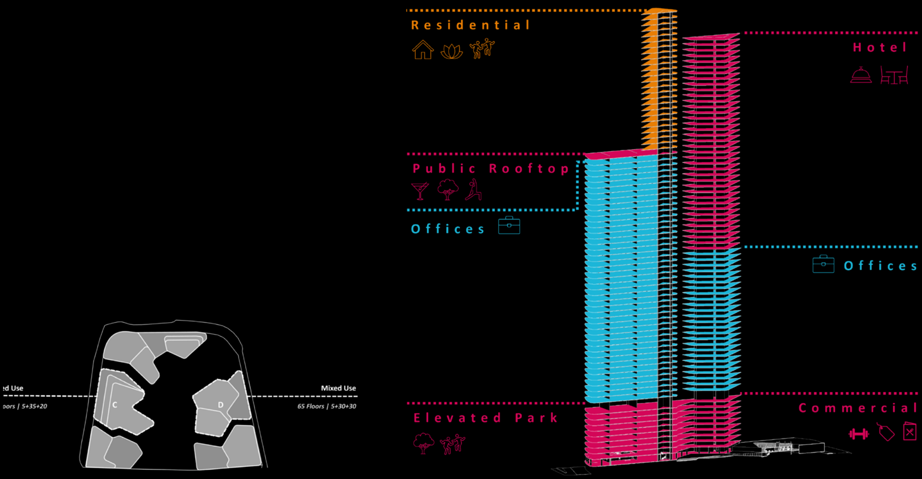


Figuare 33 | Plan by bands

Figuare 34 | South public strip



Figuare 35 | Middle mixed-use strip

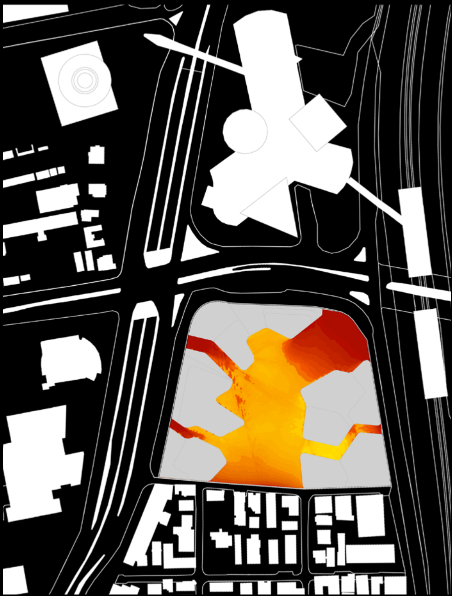


Figuare 36 | North mixed-use strip

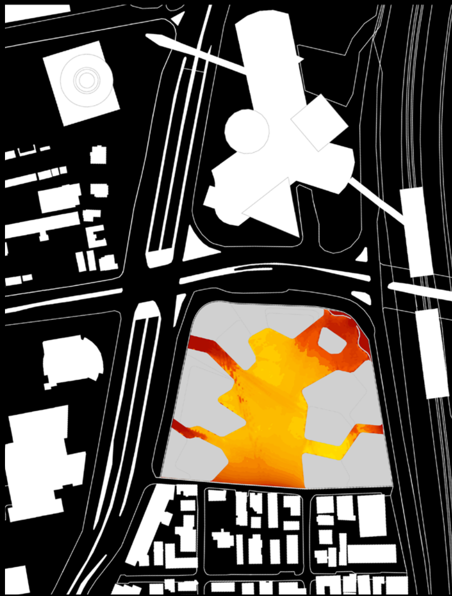
The Medium Scale

In order to create diverse soundscapes and to achieve areas with lower noise levels than those indicated in the initial massing analyses, the park was structured through a series of differentiated levels. These varying heights generate acoustic shadows, similar to the effect produced by the towers.

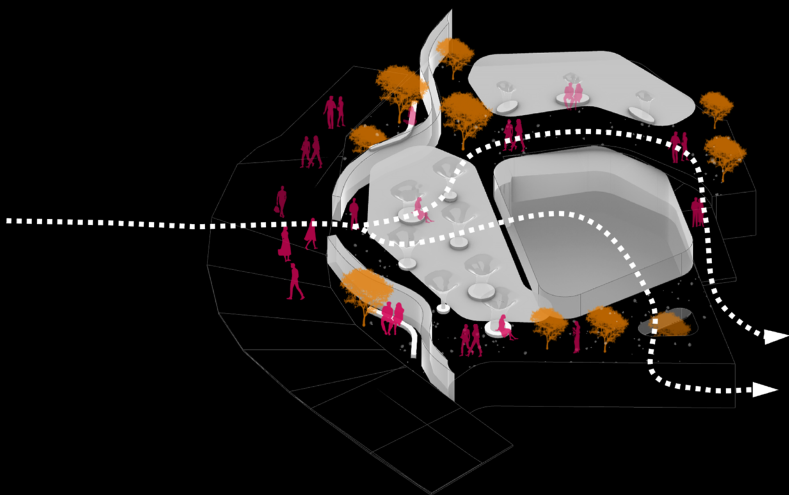
The first area addressed was the northernmost entry zone, which serves as the main pedestrian gateway from the HaShalom train station into the site. At the center of this area, a two-level pavilion with a café was introduced, connecting to the adjacent towers. The pavilion produces an acoustic shadow across the space, as evidenced by the acoustic analysis: the area immediately to its south shifts from red (very high noise levels) to orange (moderate levels) when the pavilion is present. Additionally, two acoustic walls were positioned, linking to the podium levels of the neighbouring buildings. These walls frame the street while widening at certain points, thereby casting acoustic shadows over pedestrian circulation. At the same time, they provide opportunities for vegetation, shading, and seating along the street edge. Together, these elements establish a clear gateway into the site, leading to shaded seating areas from which the ground plane steps down by three meters. This drop in level generates another acoustic shadow, further reducing noise levels deeper into the park. In this way, both acoustic and programmatic separation is achieved.



Figuare 37 | Acoustic analysis ground floor



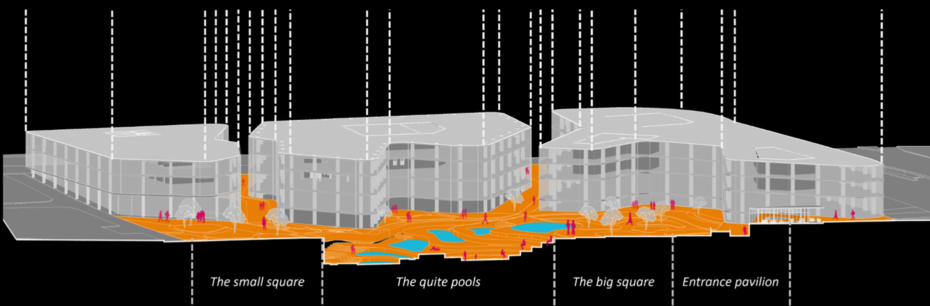
Figuare 38 | Acoustic analysis ground floor with pavillion treatment



Figuare 39 | The entrance pavillion

Figuare 40 | Multilevel Park

Figuare 41 | Acoustic analysis park



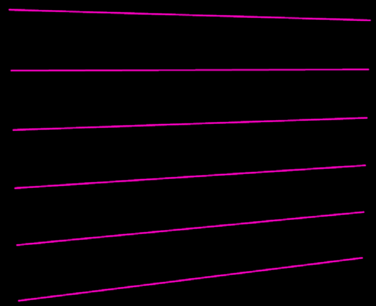
Figuare 42 | Multilevel Park section north-south

Further level changes are introduced throughout the park, as shown in the section spanning its full length (*figure 42*). At its core lies a cascading water feature, composed of a sequence of pools descending to a depth of eight meters below the entry level. The water produces beneficial white noise, masking the surrounding environment and positively influencing users' acoustic perception, while the drop in height simultaneously contributes to reduced noise intensity through acoustic shadowing. The acoustic analysis of the park, following these level manipulations, reveals large areas rendered in green, representing noise levels below 55 dB—considered low and pleasant sound levels for public use.

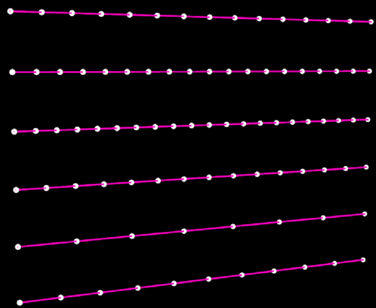
Another element developed at this scale is the façade. As outlined in the methodological diagram at the beginning of the chapter, the façade addresses the parameter of sound frequency and is treated through its geometry. Transportation-related noise typically falls within the mid-frequency range of 250–1000 Hz, and the façade is therefore required to respond to this spectrum. Research findings, along with the diagrams presented on the following page, demonstrate that the more complex the geometry of an acoustic element—whether through varied sizes, differing depths, or non-repetitive/randomized patterns—the better its acoustic performance. Accordingly, the façade was conceived as an amorphous surface of high geometric complexity, articulated with a variable vertical section in order to respond to different sound frequencies.

The façade geometry is governed by a series of parameters, as illustrated in Diagrams *figures 43-48*, which show how variations in these values affect its performance. The geometries were further analysed through a curvature analysis, which highlights the convex and concave regions of the surface. This analysis (*figures 49-52)* indicates the zones that benefit from acoustic shadowing (the concave surfaces, shielded by the convex ones), and how these zones absorb different frequencies according to the depth of concavity—each depth being effective in absorbing a specific frequency range. The greater the distribution of such concave areas across the façade, the stronger its overall acoustic performance.

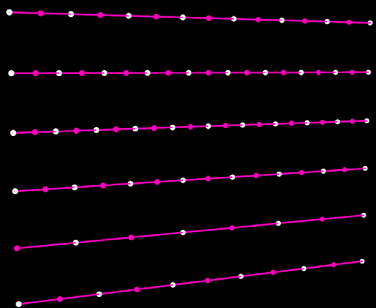
A direct relationship also exists between frequency absorption capacity and the height of the element relative to the noise source. As shown in *figure 53*, even when the façade element is positioned significantly higher than the source, low frequencies remain more difficult to absorb, whereas high frequencies are more readily attenuated. This indicates that the podium levels demand a more complex acoustic treatment, capable of addressing a broader frequency range, in comparison to the upper levels of the towers (*figures 54-56)* .



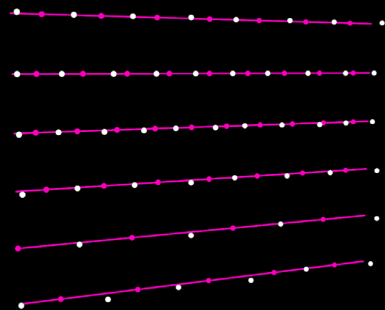
Figuare 43 | Vertical division



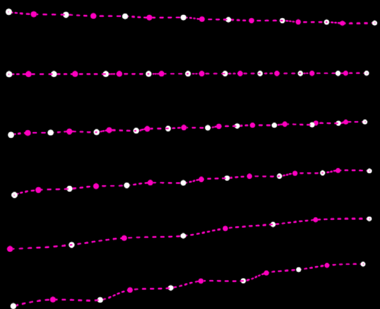
Figuare 44 | Horizontal division



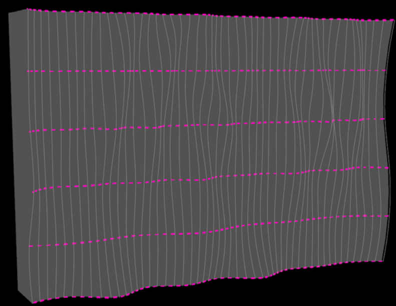
Figuare 45 | Picking movment points



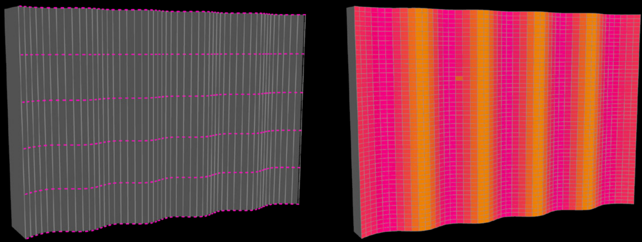
Figuare 46 | Movment in different values



Figuare 47 | Creation of the horizontal section

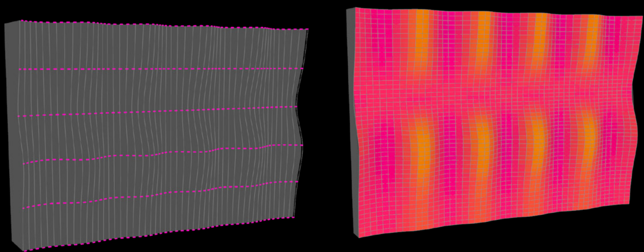


Figuare 48 | Acoustic facade



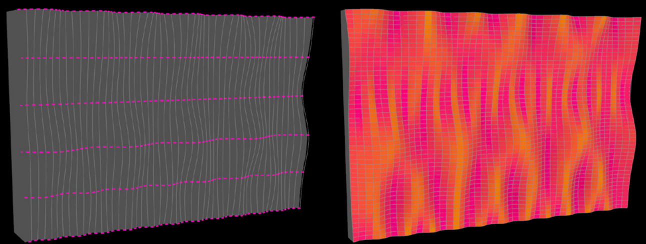
Vertical division | 5
Horizontal division | 10
Cavity depth | 0.6 m

Figuare 49 | Variation 1



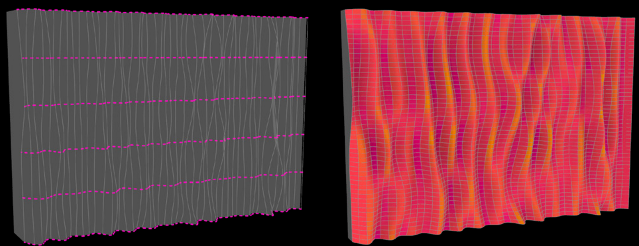
Vertical division | 5
Horizontal division | 10
Cavity depth | 0.1 - 0.8 m
Depth seed | 5

Figuare 50 | Variation 2



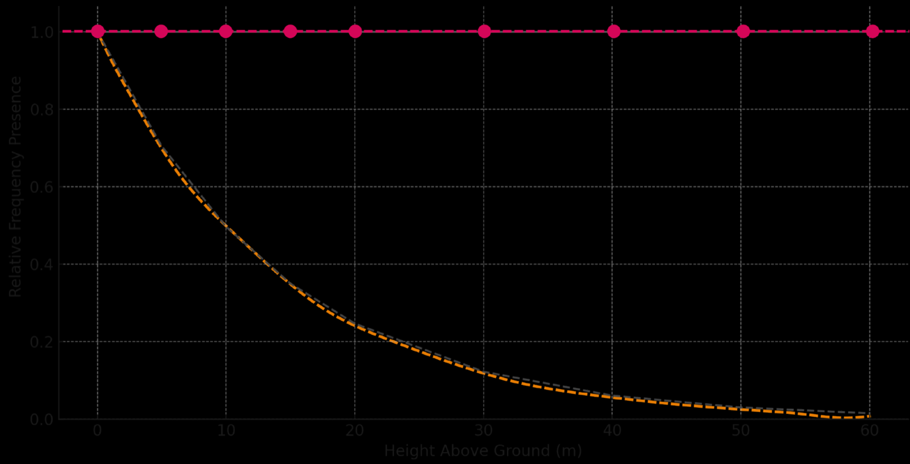
Vertical division | 5
Horizontal division | 5 – 30
Horizontal division seed | 2
Cavity depth | 0.1 - 0.8 m
Depth seed | 5

Figuare 51 | Variation 3

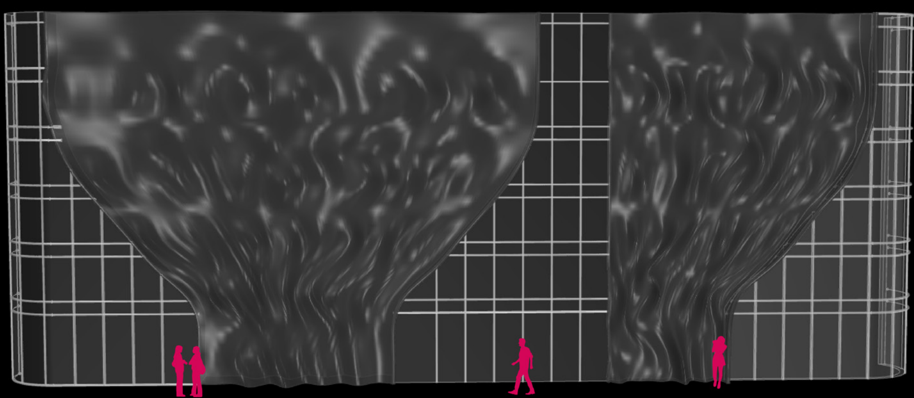


Vertical division | 5
Horizontal division | 5 – 30
Horizontal division seed | 6
Cavity depth(per point) | 0.1 - 0.8 m
Depth seed | 7

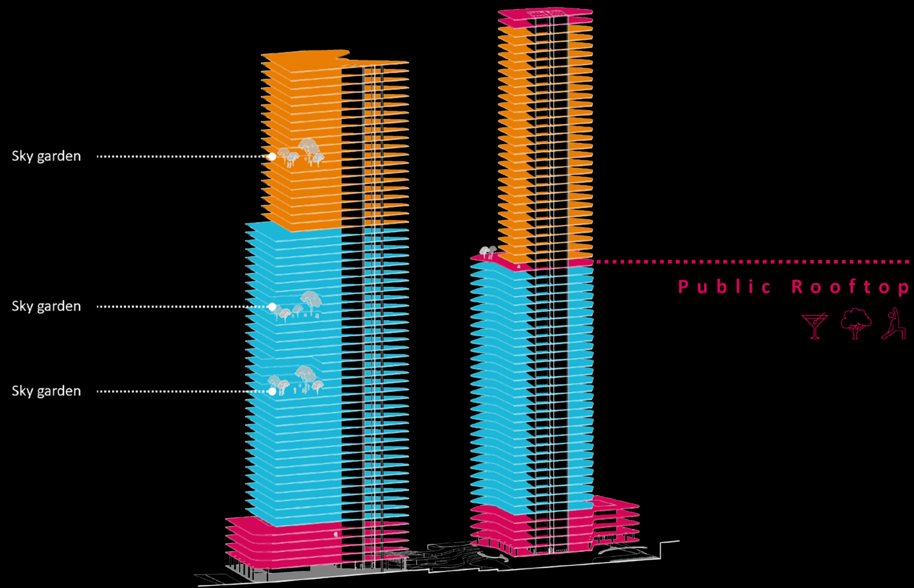
Figuare 52 | Variation 4

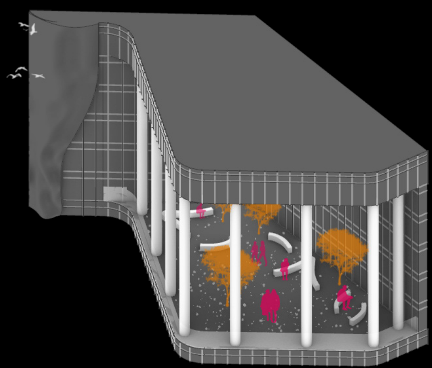


Figuare 53 | Graph showing connection between frequency presence drop to height above ground
Levels 0-5 require full frequency range treatment
Levels 5-15 require low and some high frequencies treatment
Above level 15 require only Low frequencies treatment

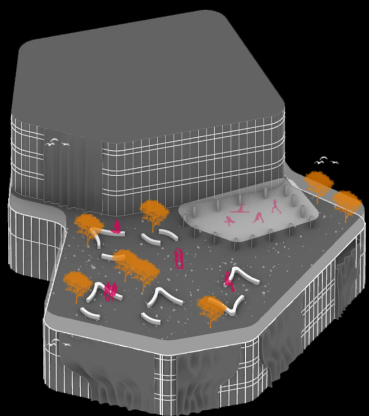


Figuare 54 | Acoustic facade at podium levels





Figuare 55 | Tower terrace



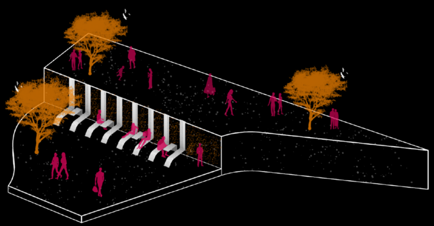
Figuare 56 | Tower rooftop/groundfloor

The Human Scale

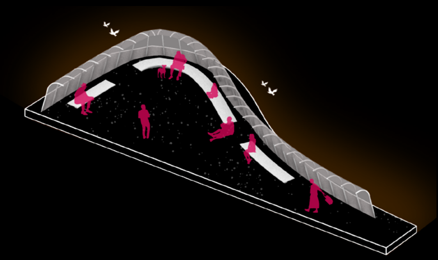
The smallest scale, and the final layer of the design, focuses on specific zones within the project that combine both engineered acoustic treatment and the design of soundscapes. The variety of acoustic experiences across the project can be seen in *figures 57-63* on the following page. These experiences shift in both noise intensity and in the types of sounds to which users are exposed as they move through and dwell within the site—ranging from the highly public entry area, to more intimate seating zones, to the cascading water pools that offer a sense of calm in the heart of the city, and back to the public southern edge of the site. Such experiences also extend into the buildings themselves, in semi-public and semi-open spaces within the towers that benefit from acoustic shadowing, as well as on active rooftops where relatively low noise levels allow for the integration of public programs.

Taken together, the three design scales form an integrated acoustic design strategy for the project. Through this multi-layered approach, the project not only mitigates the environmental challenges of urban noise but also transforms sound into a generative design tool, shaping both the physical form of the architecture and the quality of experience within it.

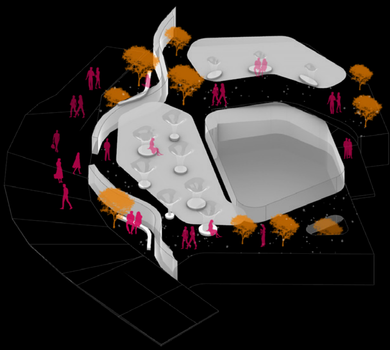
Figuare 57 | Ground floor plan and different areas of the park



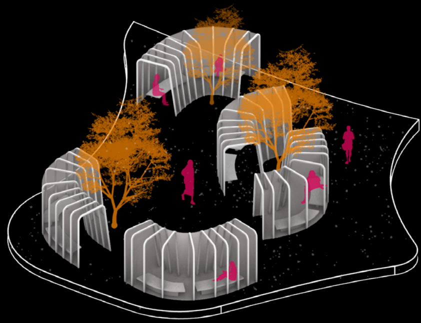
Figuare 58 | Entrance and drop-level seating



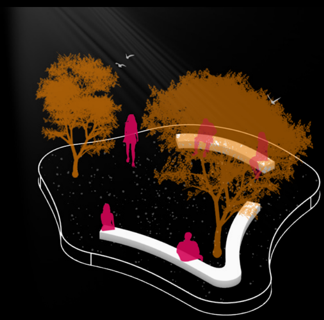
Figuare 59 | Shell sitting



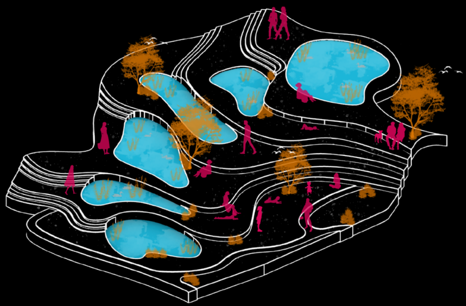
Figuare 60 | Entrance pavillion



Figuare 61 | Intimate sitting



Figuare 62 | Sitting area



Figuare 63 | The pools

06 Final Note

Summary and Outlook

This project examined the role of acoustics as a central driver in architectural and urban design. The selected site, one of Tel Aviv's noisiest junctions, served as a testing ground for strategies that transform sound from a limiting factor into a design catalyst.

Across three interrelated scales, acoustics shaped spatial, formal, and programmatic decisions. At the urban scale, massing was informed by an acoustically derived Voronoi grid, producing variation in orientation and height that generates acoustic shadows and quieter interior zones. At the park and façade scale, level differences, acoustic walls, and water features created diverse soundscapes, while complex amorphous façades with variable depth responded to mid-frequency traffic noise. At the human scale, intimate public and semi-public spaces curated a sequence of auditory experiences, from the vibrancy of urban entrances to the calm of water gardens and sheltered courtyards. Through this multi-scalar framework, the project demonstrated how sound can guide the distribution of programs, the articulation of surfaces, and the quality of urban life. Rather than treating noise as an external problem to be mitigated, it became a formative parameter that enriched the design process.

Looking ahead, the project points to a broader vision for urban renewal: one in which environmental conditions such as acoustics are integrated into the logic of urban form. As density and infrastructure continue to intensify, acoustically informed design strategies can ensure that future cities balance growth with comfort, and vitality with well-being.

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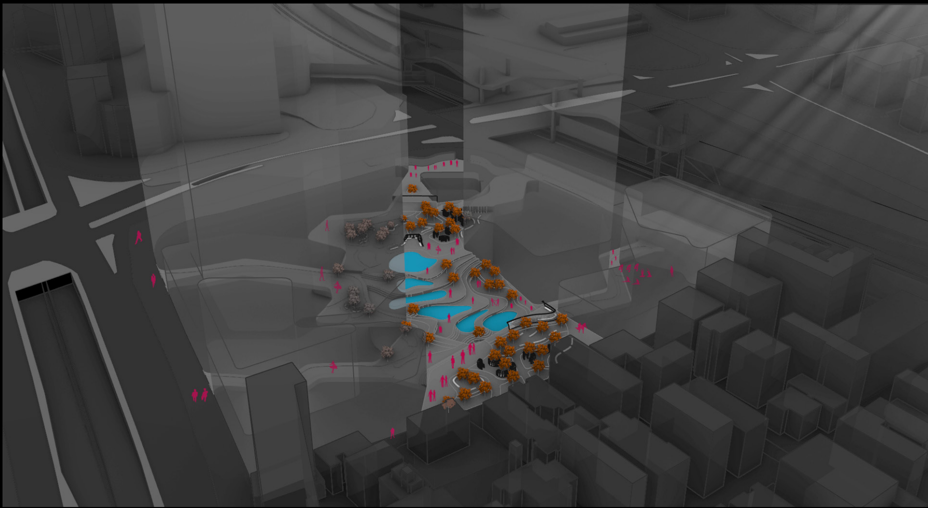

Noise pollution has become one of the most pervasive environmental challenges in dense urban environments, directly influencing human health, well-being, and the quality of public space. Traditional strategies of monitoring and enforcement, while important, are insufficient to provide true acoustic comfort. This thesis explores the potential of architecture to actively engage with sound as both an environmental parameter and a design material, proposing a holistic soundscape-driven approach that integrates acoustics into the core of spatial and formal design.

The project, Dancing Soundscapes, is situated in the heart of Tel Aviv's central business district—an area characterized by high traffic and human intensity, elevated noise levels, and imminent urban renewal. Using this site as a case study, the research investigates how sound can be addressed across three interconnected scales. The urban (street grid, road sections, and spatial density), the architectural (facade geometry, massing, and spatial configuration), and the human (individual experience). Each scale reveals distinct interactions between sound waves and the built environment, together forming a multilayered framework for acoustic architectural design.

Through parametric design methods, the project develops architectural elements that respond to both sound intensity and frequency. At the urban scale, massing strategies generate acoustic shadows and quieter zones; at the architectural scale, complex facade geometries diffuse and absorb mid-range. Beyond mitigation, the project emphasizes the creation of experiential soundscapes—shaping moments of calm, intimacy, and interaction within an otherwise noisy city. By positioning sound not merely as a problem to be reduced but as a spatial driver, Dancing Soundscapes demonstrates how architecture can contribute to healthier, more resilient, and sensorially enriched urban environments. The project points toward a future where acoustic comfort becomes an integral parameter of sustainable and human-centered urban design.