EXPLORING URBAN SOUNDSCAPES

Course: AAHM01: Examensarbete i arkitektur/Degree Project in Architecture, LTH

Year: 2020

Title: (Swedish) Utforskning av Urbana Ljudlandskap, (English) Exploring Urban Soundscapes

Author: Kristin Nedlich

Examiner: Mattias Kärrholm

Supervisors: Ida Sandström, Sandra Kopljar

CAN ARCHITECTURE BE HEARD?

MOST PEOPLE WOULD PROBABLY SAY THAT AS ARCHITECTURE DOES NOT PRODUCE SOUND, IT CANNOT BE HEARD. BUT NEITHER DOES IT RADIATE LIGHT AND YET IT CAN BE SEEN.WE SEE THE LIGHT IT REFLECTS OF FORM AND MATERIAL. IN THE SAME WAY WE HEAR THE SOUNDS IT REFLECTS AND THEY, TOO, GIVE US AN IMPRESSION OF FORM AND MATERIAL.

FROM LJUDPLANERING.SE

FORM CAN AMPLIFY OR MUFFLE SOUND. WHEN ARCHITECTS DESIGN LANDSCAPES OR ROOMS TO SUPPORT SOUND, THEY OFTEN START WITH FORM. SOUNDS, LIKE SHADOWS, REQUIRE FORM TO EXIST. FORMED SURFACES SUPPORT THE REVERBERATION OF SOUND WAVES, AND WHEN ARCHITECTS DESIGN ROOMS TO SUPPORT SOUND, THE PROPERTIES OF SOUND INFLUENCE HOW DESIGNERS SHAPE THE FORM OF THE SPACE.

MEYERS, VICTORIA. SHAPE OF SOUND

UNLIKE VISION WE CANNOT AVERT OUR EARS OR DIRECT OUR HEARING AT WILL, BUT RATHER SENSE SOUND CONTINUOUSLY.

BUCK, DAVID NICHOLAS. A MUSICOLOGY FOR LANDSCAPE

SUMMARY OF GUIDING PRINCIPLES

From the book by Nadia Amoroso; The Exposed City, Mapping the Urban Invisibles:

• Treat data as spatial representations

• The visual representation of the data is related to the numerical representation

• Use the data as a palette to guide the form

• Use effective artistic licenses

• Dramatize the data

• Choose an appropiate method of representation

• Apply more lighting to emphasize larger quantities or points of interest in the data

• Select the most telling viewpoint to profile the map-landscape

• Visually represent the overall communicative message

A successful map-landscape should be spatial, suggestive, seductive, informative, revelatory - exposing the invisibles of the city through tantalizing new kinds of urban form - transforming banal data into a spatial outcome.

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Visualizing the Invisible

Intent

My intent with this thesis is to explore urban sound and architectural drawing techniques which can be used to represent sound qualities in existing or projected areas.

By using experiential data, I will investigate methods and various sets of diagrams and drawings to illustrate psychoacoustical qualities in urban environments.

This research can hopefully point a way to methods that provide more useful information than the existing, conventional noise-mapping, which in existing sound mapping mainly deals with sound pressure (dB).

What I am much more interested in exploring, is how ***placement and shaping*** of urban spaces can affect the urban sound experience in a positive way.

This work is about dealing with the **built-in sounds of architecture and urban space**, not electronic amplifiers, digital facades or such likes.

I will investigate visualization methods that could be of practical use when analyzing and planning urban spaces either before they are built or after.

Background

More often than not, I experience a disharmony between rendered images and real life experience of the spaces. A glossy image is often beautiful and invites the viewer to think that it will be a pleasurable experience to be in that space.

But the ears are harder to fool than the eyes. That makes me wonder why we focus so much on the visual rather than experiential qualities of architecture. The ocularcentrism is hard to overcome.

The practical benefits of this work will hopefully be the emerging interest in developing drawing conventions that facilitates the analysis of existing environments or building proposals before they are initiated, thus giving the design a chance to take the sonic environment into deeper consideration in the planning stage.

Thereby, hopefully, avoiding the need for cumbersome noise reducing interventions such as oddly placed barriers and/or extra glazing or other types of noise reducing techniques on domestic buildings.

Disposition

My thesis is divided into two halves. The first part of this work is an investigation of existing methods used to document, analyze and visualize space and soundscapes.

By applying these methods to the sites I've visited around the world, different qualities of sound will emerge and we will move towards a more general set of visualization techniques.

By doing these exercises, I have started to build an archive of key factors in aural design and annotation. The archive will be put to practical use in the final part of the thesis.

Method

The major method used in this thesis is based on auto-ethnographical work, meaning that the data is measured in personal experience and not in objective numbers or statistics.

In this thesis I will analyze these different soundscapes, located all over the world. The idea is that by going over the same type of spaces (same type but different in terms of culture, geography and history) over and over again, using a varied set of techniques of visualization, we can start to narrow down what the key factors of soundscape visualization are.

The sites chosen for the gathering of data are located all over the world and have distinct geographical and cultural differences as well as morphological characteristics.

I will walk you through each site and try to pinpoint what aspects of that soundscape that is of interest when performing a sound scape analysis.

The sites were chosen on the basis that they were large cities (suggesting a large variety of urban spaces) and they were far away from each other (suggesting cultural differences in terms of soundscape).

When I was sifting through the massive amount of data that I collected on my journey, I started to notice certain patterns. These patterns are perhaps exclusive to me and my personal behavior, previous experiences and preconception, but I think they do a good job of identifying which aspects of the soundscapes that, in general, appears to be of importance (to me).

My sonic heritage

My aim was to experience these places with as little bias as possible. However, it is almost impossible not to value or criticize anything without basing that on your sonic heritage.

To give you an idea of where I come from, sound wise, I will give you a brief summary of my personal background.

I was born and raised in Stockholm, Sweden, and my parents divorced when I was just a small child. This gave me a dual experience in upbringing.

On the one hand I lived poorly in a "modern (1960's), concrete filled, social housing area", while at the same time I lived part-time in a more well-off neighbourhood where the playgrounds had actual grass and not just gravel or asphalt.

In one world the noise of cars was what I fell asleep to and in the other one I was soothed by the wind whispering in the trees.

Equipment

The tools used for these recordings were: a cheap mobile phone, a small compact digital camera (with the ability to record sound), SLR camera, Zoom sound recorder and my journal(designedlich.wordpress.org).

I was very grateful that I chose to bring with me such a variety of different types of equipment for recording. In Johannesburg, for instance, the small compact camera and my cheap, disposable mobile phone were basically the only digital tools that I used there.

The idea of walking around with valuable and bulky equipment was very unappealing in that particular environment, not only because of the dangers but also practically.

Recording

We all know that cameras, sound recorders and even our own bodies, picks up information and filters it before it either reaches our brain or the digital sensors. I therefore choose to think of my recordings as memory aids and as a mean to give the reader an idea of what these sites are like.

I will present the case studies in the order that I went to them, the sequence in which I encountered them, because the order of exposure to the soundscapes has had an influence in how or what I heard in each city.

Confirmation bias

One of the most challenging parts of my travels was to listen carefully and consciously while at the same time avoiding ear fatigue or focusing so much on one particular sound that my brain would inadvertently edit out the 'true' ambient sound.

The human mind is excellent at filtering out sounds that we grow accustomed to or that we find annoying. Car noise, airplanes, ventilation fans and other Low Frequency Noises are examples of sounds that we get so used to and really don't notice consciously until they suddenly come to a stop (e.g a ventilation fan or rush hour-traffic).

Our adaptive mind and senses are actually disadvantages when exploring urban soundscapes, because of the filtering that I just mentioned. That is why it was very important to me to sort of relax my ears, or actually my brain, and sometimes just let it all in without actively focusing on any specific sound.

Every night when I went back to my hotel room I would save all the data on my hard drives and then write a blog entry about my day. Mostly they would be about my sonic experiences, but also about my experience of the cities in general.

Establishing local contact

I did manage to make friends with people almost everywhere I went and it was great to talk to someone who actually lives in a city about the city and how they experience the soundscape that they live in on a daily basis.

I did, however, get a chance to interact closely with a couple of students in Johannesburg. The University of Johannesburg was the only university that even replied to my inquiries if they could ask their students to guide me through the city.

My intention with contacting universities in all the cities I went to was on the one hand to get into immediate contact with someone who had knowledge of the city, but also to get fellow architect's view on the soundscape.

Acoustics

Why not just use the acoustical technology and knowledge to design spaces?

Acoustics is the ***means*** by which we modulate and modify spaces, but the aural ***design and intent*** of the designer comes from a different place and the experience of a space is more on a psychological level, rather than an engineering level.

This is what is known as ***psycho-acoutics***[1].

1 - **Psychoacoustics**: the study of the perception of sound. (Blesser B. 2007)

Disposition - Table of content

CHAPTER I

SOUNDHUNTER

CASE STUDIES

Sound Hunter

I've been asked many times about the reason for my research. First I will tell you about my sonic awakening, and why I chose to go to the cities that I went to.

It was a late night in the spring seven years ago. At that time I lived in central Stockholm, at Torsgatan, just across a large recreational park called Vasaparken.

The park was on a hill and from my bedroom window I had a wonderful view of the trees.

That particular night I couldn't sleep for some reason, and it didn't help that the sand sweepers made a real ruckus some time around midnight.

Once they were done, there was an unusual silence in the otherwise very busy street below my window. Dawn was already approaching and the sky was turning brighter.

In the middle of this almost dead silence a bird started singing in one of the trees in the park. I remember feeling very annoyed at first because the sound felt so clear and strong to me.

But then I realized that the reason why I was so aware and agitated by a noise that, from a biological perspective, should be 'natural' and calming was because I wasn't used to it.

Image nr.1

Torsgatan, Stockholm, Lat 59.338510 , Long 18.039970. On the left-hand side you see my old bedroom window (circled in red), and just straight across from there is the park where the bird was (also circled in red). Normally, the noise from the street between the building and the park would mask the natural sounds from the park.

I determined that I was sound polluted by the constant noise of traffic that I had to live with every day and night.

Research

I thought about this project for a long time and after a lot of research on soundscapes I decided that I needed to have a bigger picture; more experience and my own personal knowledge of different urban soundscapes.

I think it is almost impossible to know what a place is like unless you experience it yourself.

And, when you start to add to your personal library of experiences, you inadvertently re-evaluate all your previous experiences.

I grew up in Stockholm and I think that I know it very well, but after my trip around the world I have developed a better understanding of what Stockholm sounds like.

Choosing cities

I would like to say that the cities were chosen arbitrarily, but when I think about it they're actually not.

Rome

I chose Rome because of its history, the layers of new on top of old and because it seemed to be a city that could be considered to be 'settled' as a city.

By settled I mean that it has undergone numerous transformations over the centuries and from the needs, habits and uses of its inhabitants it has been carefully molded into what it is today.

In Rome, the master plan of old has been reshaped and adapted into the needs of its inhabitants.

Tokyo

Tokyo was chosen because I figured that even though it too is old, it seemed to have been more rapid in its transformations than Rome. A settled city that isn't settled at all, and most likely never will be.

Johannesburg

This was the wild-card of my case studies. I didn't really know what to expect or even if anything interesting would come out of it. As it were, I think it was extremely interesting sonically as well as a life experience.

Los Angeles

I was very ambivalent about choosing Los Angeles. I wanted to go there, because I am not really sure that it should be called a city at all. It isn't really, it is a gathering of several cities in a vast landscape.

Admittedly, I was a bit apprehensive about going to the US at all, because the cities are 'young' and unsettled in comparison to European cities. But then I thought that that in itself actually was a very strong reason for going there.

Mexico City

Mexico City was chosen almost exclusively on the fact that it is, relatively, close to both Los Angeles and New York.

It also has a huge population on a relatively small area. It has an old history as well as modern features. It made sense to add it because I also wanted my research to be a bit more culturally diverse.

New York

As my last stop I chose New York because it felt like a nice contrast to Los Angeles.

Two extremes, both geographically and typographically. Fortunately, they were also very different in terms of soundscape and sonic experience.

SOUND
47, AND A HALF, DAYS

Rome

Unfortunately, Rome was my first visit on this two month long field study. I say unfortunately, because I didn't realize how and what I should document. I hadn't perfected my organizational skills and unfortunately some of the gems are lost, or only documented in my memory.

What I can tell you is that Rome was my favourite city sound wise. Due to the layout the city has what I have come to call "soundpockets".

Diagonally cut narrow streets leading from one space to another, thus clearing them from noise spill. It could very well be that this was not the intention of the city planners, and is instead the product of millenia of layering, heat management and political boundaries.

Whatever the reason, it works beautifully as a varied and harmonic soundscape. I am not one to advocate silent cities. On the contrary, I think it is important, for more than one reason, that they do sound.

But, there should be variation and places where the ears can rest and take in just the one sound of per example a fountain, a tree whispering in the wind, the gentle clapping of a few pedestrians passing by.

The best places I went to were;

The Pantheon – with its amazing rotunda shape it has exceptional qualities in form, lighting and sound.

Piazza Navona – it becomes compartmented, sonically as well as physically, because of the fountains that acts as soundscreens making the big square feel like a cozy and personal space, and a variety of simple little squares (some with fountains, some without) hidden away in the back alleys.

The Old Aqueducts – I have always love aqueducts for some reason, and the ancient ones in Rome were beautiful and impressive. But my favourite experience this far, when it comes to aqueducts, is the one I once visited in Istanbul.

Nasoni

Image nr.2

Johannesburg

There is much that can be said about Jozi, but if we only look at the soundscape and audial identities, one can see that history and politics have had a great impact on its soundscape.

For instance, when walking through a residential area, I heard a weird noise that I mistakenly thought came from insects of some sort. But when I asked my companions about it they pointed to the top of the high walls that surrounded each individual property.

On top of the walls there were electrified fences and that was the sound that I had heard. A completely novel sound to me

Electrical wires aside, there was a lot of interesting sounds in Jozi that were new to me.

One gem of a place that I found was an ordinary public square, nothing special about it, except the fact that the floor tiles weren't fixed properly which made them wobble a bit when you walked on them.

The underlying construction must have been hollow of some sort, because it sounded amazing when you crossed the square. It was like a proper musical instrument.

My time in Johannesburg had a great impact on me and my subsequent field studies.

Image nr.3

Link to video Civic centre Braamfontein

Or scan the QR-code

The University of Johannesburg was very accommodating and they assigned two 4th year students, Nthati and Jo, to show me around the city.

Without them I don't know what would have happened to my investigation. I could have been too courageous and ventured too far, walked in the wrong place at the wrong time and perhaps gotten myself in some hairy situations.

Or, maybe, I would have just cowered in my hotel room and then I never would have had the amazing experience that I did have.

After experiencing Johannesburg, Mexico City didn't intimidate me one bit.

Tokyo

Tokyo was different from all other places I went to. Not so much because it is so far away both in distance and in culture, but because it is so over the top.

A guide at the Edo Museum told me: *"[We] the Japanese are masters at acquiring technology and not only making it their own, but excelling at it."*

With those words in mind, it is no wonder that Tokyo is filled with what I would almost label as experimental architecture. While on the one hand it has very modern, state of the art, groundbreaking technology, much of it still has parts of the old city layout left. It is not "on the grid" as one might put it.

I therefore, mistakingly, thought that due to its topography and, in general, relatively low and narrow typography it would have some of the audial qualities that I had found in Rome.

Instead, Tokyo is probably one of the noisiest cities I have ever been to. However, this was not due to the fact that there are so many people living there.

HUNTER
AROUND THE WORLD

Los Angeles

I chose to visit Los Angeles because I had a feeling that it could be a useful example of all the no-no's of how to design aural environments.

I was not wrong, but to my delight I did find a few places that were quite interesting and beautiful.
It is of course always a matter of context. Perhaps after a week of sonic abuse, my ears were desperate to find something enjoyable to listen to.

There are a lot of people living in the Los Angeles area, but that is true for all of the cities that I've visited, so it doesn't really count as an excuse for poor noise design.

The major problem is the layout of the city/ies. A normal grid with huge boulevards spanning at most over a dozen lanes makes it virtually impossible to improve sonic qualities.

Add to that a low rise typography of buildings(except in downtown where they apparently removed any and all height restrictions) in a hilly topography and it all becomes a thick mass of noise.

In most parts of L.A one could categorize the sonic environment as homophonic, it pretty much sounds the same everywhere you go due to the massive masking effect of car noise.

However, they cleverly mask that mask with the sound of huge fountains.

Image nr.5

Link to video in the QR-code

Mexico City

Even though Mexico City is huge, gigantic even, it had a much more varies soundscape than L.A. It has huge highways, lots and lots of cars driving fast and honking their horns.

But it also has the more natural layout, offering soundpockets or sonically calm spots. Even the noise is nicer in Mexico City because it has variety and highs and lows. The noise of M.C felt much more "natural" to me than the noise in L.A.

For instance, much of the commerce in the city is done by street vendors. Street after street with people buzzing, eating tacos and shopping.

Even though humans can be very loud and noisy, it is still a natural sound that as a listener I interpret them as an acceptable or even pleasurable noise.

It might seem counterintuitive but in this setting it works quite nicely. One example of the scizoponia in this city is from a spot where a huge business district meets a park and a highway. Note the mariachi band tuning their guitars in the middle of it.

Image nr.6

Link to video in the QR-code

New York

Last stop, New York City.
I can't help but compare it to my previous stops, both as a whole city, but also the details. I find that New York incorporates many qualities that I liked from other cities. A mixed layout offering both noisy traffic as well as more intimate narrow streets and parks.

However, it is not the perfect mix for me. It doesn't really have those soundpockets that Rome has, it doesn't have the same ease like Mexico City, and gentrification has taken away some of the charm and a more varied palette of sounds.

Harlem was one of my favourite spots in the city, because I heard the most children there. There was a domestic feel to it that didn't imbue the high-end, well off commerce of downtown Manhattan.

Image nr.7

Link to video in the QR-code

In general, pedestrian activity was very organized and subdued; in the subway, or at the huge Shibuya Crossing. Even though a massive amount of people were swiftly navigating their way between each other it never felt messy or chaotic.

The problem with the noise levels was mainly caused by speakers. They were pretty much everywhere, and all playing different music, broadcasting commercials or information.

Image nr.4

Link to video in the QR-code

CHAPTER II

RECORDING

SEQUENCING

Recording

In the following pages I have chosen to show different sonic spaces from my case studies.

They were chosen on the basis that they represent what I think are key factors of the soundscapes[2] in question, but also to what a general urban soundscape usually consists of.

I have included video clips for some of the descriptions and they are of poor quality but serve well as both a reminder to myself but also as a way to add information that is difficult to translate into writing.

When we record something it is usually done with some type of digital equipment or by pen and paper. Usually, a recording is done and played back in sequential order.

Our minds are attracted to rhythm, patterns and sequences. Even if there is no apparent pattern, we somehow invent one. It is our mind's way of organizing data so that it is faster and easier to analyze and interpret the information.

Sequencing

Sergei Eisenstein was a Soviet filmmaker and by many movie buffs considered a genius. Even if you're not a movie buff you will probably recognize the title of one his most famous films *Battleship Potemkin.*

"In 1925, after having published his first article on theories of editing in the review Lef "[...] in place of the static reflection of an event, expressed by a logical unfolding of the action, he proposed a new form: the "montage of attractions"—in which arbitrarily chosen images, independent of the action, would be presented not in chronological sequence but in whatever way would create the maximum psychological impact."[3]

Why do I want to talk about Eisenstein? What relationship could he, or any other filmmaker, have to the subject of aural architecture and how to draw it?

Film is one of the mediums that depend greatly on sound and, more importantly, sound *design*. As an experiment I would tell you to conduct an experiment: try muting the sound of a horror movie. It will not be anywhere near as scary as it is with the sound on.

Try it the other way around too; close your eyes and try and imagine what the spaces in the film look like, only based on the sound that you hear. It might not work the first time, but after some training you'll notice that your hearing sharpens and with it your ability to imagine the spaces.

The sound design of a film adds not only spatial depth to the images but it also provides a psychological impact of the story that is told. And this I think is basically the same idea that we can use when we design architectural, urban environments.

We must acknowledge the fact that we do design the aural space, conscious or not, and that it is very difficult or expensive to alter a sonic quality after it has been built.

Eisenstein was very meticulous in planning his films and as you could see in the image on the previous page, he carefully timed the images with the music and sound.

The architectural equivalent to timing is perhaps program or spatial activation of spaces in a 24 hour period.

The montage equivalent in architectural design would be what is called 'programme': to plan, foresee and anticipate the activities of a place.

Mise-en-scéne

If montage is the equivalent of programme then mise-en-scéne is the equivalent of tectonics, or the architectural expression of a building or a place in which the programme takes place.

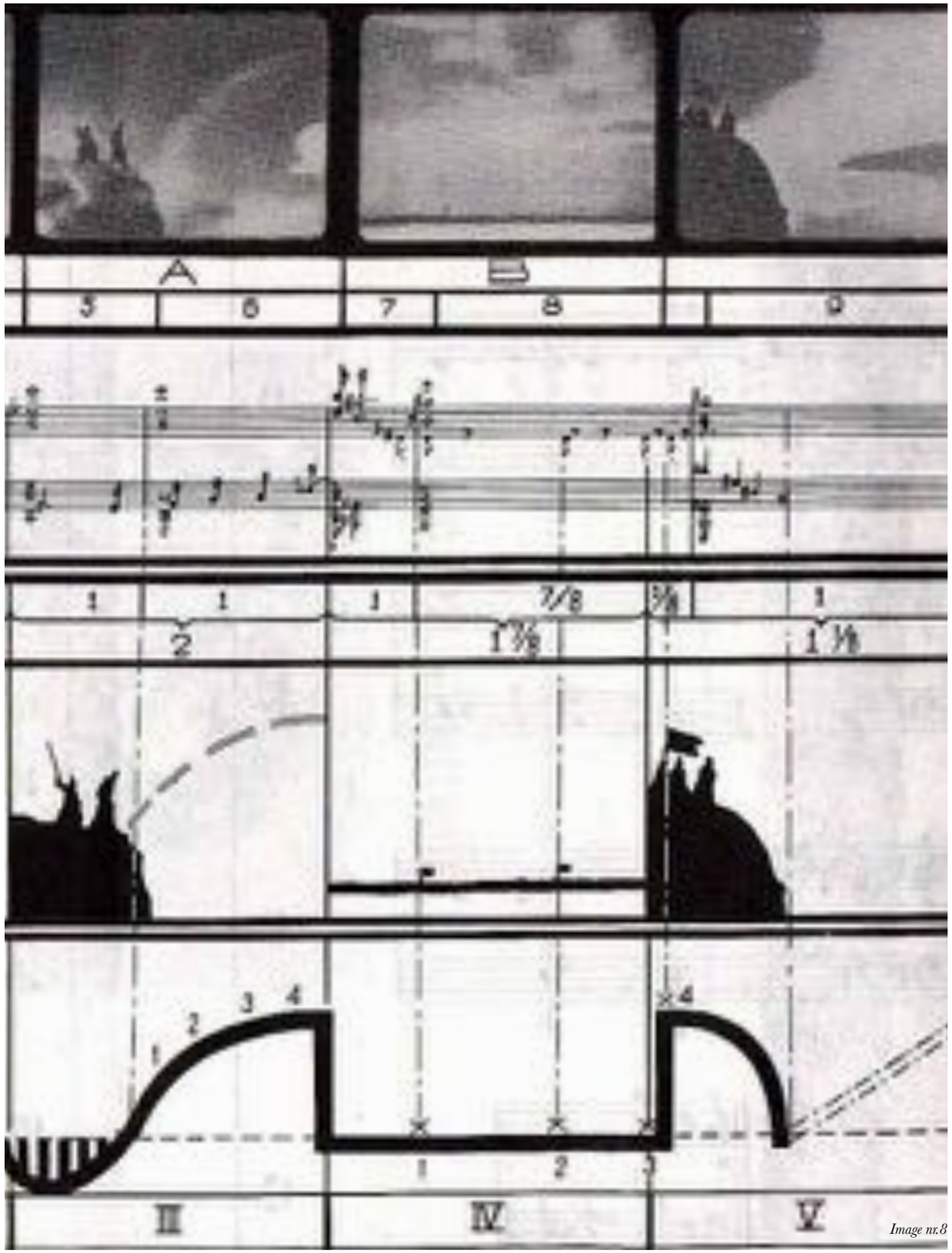


Image nr.8

2 - **Soundscape:** the sonic environment, Schaefer M. (1976)

3 - Quote from Encyclopædia Britannica https://www.britannica.com/biography/Sergey-Eisenstein 2020-04-15

Image nr.9

Image nr.10

Image nr.11

Soundscape

It was a 30-45 minute walk to the city centre from my hotel. I paused a few times to take pictures, record sound with my Zoom and just generally tried to get a feel of the ambient soundscape.

The zig-zagging and seemingly random pattern of my walks are actually a strategy of mine. In order to fully discover a place, one must do just that, discover.

The general layout of Rome is very fortuitous in that sense, because even if you walk a predetermined path, you will inevitably have to zig-zag a little bit.

The organic grid of Rome is a result of what I call ant-trails[4], and that made it very easy to investigate and enjoy many different sites in a relatively short period of time.

I used my ears more than my vision when navigating through Rome, and when recalling my time there the sound comes first and the image second.

Link to video:
https://vimeo.com/412409594

Or scan the QR-code

Soundblock

I walked from my hotel, located in Trastevere, and crossed the River Tiber in to the city.

I did, admittedly, get a little bit tired of all the scooters and horns honking after an hour or two of walking. I sort of zigzagged my way in to the city and the difference in sound pressure (dB) was very noticeable when I went into the narrow back-alleys.

The distinct drop in volume, only a few meters from the main road, was probably because most of the crossing streets met the main street in a diagonal causing the sound waves from the busy road were efficiently reduced.

I went quite far in to the more intimate blocks surrounding the road called Corso Vittorio Emanuele and I tried my best to cover as much ground as possible, so as not to miss any vital sonic environments.

Soundpockets

I was walking along Corso Vittorio Emanuele II, a trafficked road in central Rome, and on a whim I decided to take a little detour to see, or hear, what the spaces that were close to the road sounded like.

And there it was, this tiny little square, a sonic refuge in the middle of a busy downtown block. The word sound pocket[5] popped into my head, because the physical enclosure made it feel like I was in a sound proof space of sorts.

It was an immediate relief for my ears. I had been listening to the soundscape for an hour or more, so the sonic ”void” was like a palette cleanser before trekking further into the back-alleys in the vicinity of Corso Vittorio.

I had no intention of inventing new words for this thesis, but this one came in early and stuck with me in the subsequent case studies.

It stuck with me in the sense that every sub-sequent place I went to I hoped, but tried to stay as open-minded as possible, to find another example of this ”phenomenon”.

4 - **Ant trails:** the seemingly random pattern of movement in a landscape (urban or rural alike) and diagonal paths chosen for optimization of path of least resistance

5 - **Sound pocket:** an urban space in which a Hi-Fi environment can exist, inside a landscape of Lo-Fi environments, due to physical enclosure (tall buildings, walls, earth mounds etc.)

Image nr.12

Image nr.13

Image nr.14

Green fill

There are many little squares that feel like you're in somebody's private garden, and plants growing in and out of buildings. They provide shade and they add a subtle sound to the space when the wind rustles the leaves.

Even if they have little to no sound absorbing properties in an acoustical sense, the green plants do have a psychological effect that cannot be disregarded.

They also block some of the reflected waves of sound that can be of concern in spaces with parallel or very closely standing walls.

Shopping

There are plenty of shopping streets in the business districts of Rome with high-end commodities, but everyday shopping or touristing is almost never further than half a block away.

The open-air markets draw small crowds and there is a pleasant, soft and reassuring sound of muffled voices when the commerce is on.

I really appreciated this sort of informal meetings between people, because it makes a space come to life and gives me a sense of security.[6]

What I personally fear most is empty urban spaces with buildings that have no windows facing the street and no activity after regular office-hours.

Link to video:
https://vimeo.com/412412741

Or scan the QR-code

Street life

The street-life in Rome seemed to be just that; life happens outdoors and the street curb is a little bit like an extended living room.

I almost never came across an empty, silent street, back-alley or residential courtyard. I can't claim to have intimate knowledge of the entire city, that would be an enormous investigation.

But I did walk around the city for at least 8 hours a day for a full week so maybe I do have some sense of what it is like.

There were a lot of people, usually local Italian men, just hanging out on a street corner in the middle of the day. (With my superficial knowledge on Swedish drug-trafficking in the city-centre or streets I didn't see any noticeable signs of criminal activities in that sense being the reason for the 'hanging-around' behaviour.)

The street life of Rome sets the tone for the soundscape because of human activities such as; voices chattering, foot steps patting the cobble, and restaurants buzzing.

These sounds are of a fleeting nature and not built-in to the fabric of the brick, but more of consequence formed by climate and social culture.

6 - "The trust of a city street is formed over time from many, many little public sidewalk contacts."
Jane Jacobs. *The Urban Design Reader (2010) p.83*

Image nr.15

Image nr.16

Image nr.17

Parking spaces

Parking wherever there is an available spot. It can seem a little disorganized and ad hoc, but I think it works quite well. The tightly knitted fabric of urban spaces in Rome more or less forces people to drive smaller cars, which in turn uses less fuel, has smaller engines and thus makes less noise.

On the other hand, the need for a speedy, yet small and affordable means of transportation, means that there is a ridiculous amount of scooters (vespas) running around the city. (More on the scooter noise in the paragraph Signals.)

What's interesting about parking spaces is that they are a subject of much debate in any city.

Is it a civil right to have a parking space? Should there be parking spaces to allow for everyone to take their car in to work in the city centre?

Parking lots, garages and buildings take up a lot of valuable land in a city and for me at least the street parking rules are sometimes very confusing.

Fighting noise with noise

There are so many fountains in Rome. I lost count of them and after a while I didn't get exited when I saw a fountain.

There are the big and famous fountains that have an aesthetic value and in some sense they also act as sound screens as well as coolers when the sun is too hot.

When they act as a sound screen they have a masking[7] effect.

Then there are small, drinking fountains called Nasoni which are of a more practical purpose. (Picture in the Sound Hunter section.)

The River Tiber could also have a local masking effect in some spots where it runs faster, but this might be cancelled out by sound amplification and reflection on water surfaces.

The fountains are in this case much more active and efficient masking agents with both vertical drop distance and fast flow of water causing noise.

Signals

I decided to label the sound of scooters and honking horns as signal[8] sounds in the Roman setting, but they could perhaps be sorted into ambient background noises, or perhaps even keynotes, because of their consistent and pressing presence.

But since my ears were not accustomed to these signals, at least not to that extent, they are signal sounds to me. One might think that the horns loose their capacity as warning calls if used too often and too much.

In a way, to me it seemed, that the honking was more like a ritual rather than a practical action.

The sound of the vespas is difficult to describe with words, but they are more agitating than cars. With a higher pitch and a ra-ta-ta-ta noise they are very difficult to ignore or grow accustomed to.

Link to video:
https://vimeo.com/412402169

Or scan the QR-code

7 - **Masking**: the process by which the threshold of hearing for one sound is raised by the presence of another sound.

8 - **Signal**: foreground sound, listened to consciously. i.e: bells, whistles, sirens.

Image nr.18

Image nr.19

Pedestrian life

There are lots of shared spaces where the distinction between street and sidewalk are completely blurred. Cars and scooters have to move around on the pedestrians terms. It felt like the streets belonged more to people than to vehicles. I liked that, it made the city feel much more intimate and easier to get to know.

The communication between pedestrians and drivers seemed to work well, even if looked chaotic on the surface. At least for me, who is used to a more strict traffic rules and physical separation between vehicular and pedestrian paths.

Even though the grid is irregular and organic I never felt lost or like it slowed me down having to move in a more irregular pattern. On the contrary, I liked it and it didn't fell like I was being pushed towards a place I didn't want to go. And I could divert from the main arteries whenever I felt like it, without ending up in a dead-end.

Rome was like a maze of both streets and sounds.

Aural architecture

The Pantheon was a really amazing building, not just visually, but aurally. A perfect example of aural architecture at its best.

I did try to avoid the usual tourist-spots, but when I stumbled upon famous and great architecture like this I just couldn't ignore it.

When I went in, I stood right in the middle with my eyes closed and listened to all the sounds that washed over me. Pantheon is rounded so, acoustically, you get the rotunda-effect[9].

Link to video:
https://vimeo.com/412814498

Or scan the QR-code

9 - **Rotunda effect**; sound waves are carried from one side to another with the use of guided reflection. Also known as whispering-gallery effect.

Case-specific sounds

SOUND

Soundpocket
an urban space in which a Hi-Fi environment can exist due to physical enclosure (tall buildings, walls, earth mounds, etc.)

Fountain
(the 'f' in the middle stands for fortissimo - strong sound)

Shared space
Where traffic and pedestrians move in the same space

Horns
e.g. car horns

Church bells

Aural architecture/building (Pantheon)
A building or urban space that has a sound quality of exceptional character

SIGN

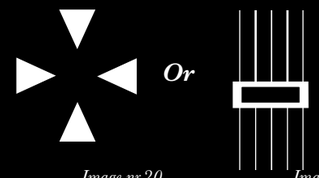


Image nr.20 *Image nr.21*

Image nr.22

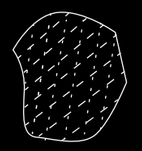


Image nr.23

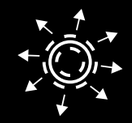


Image nr.24

Image nr.25

Image nr.26

Image nr.27

Image nr.28

Image nr.29

Soundscape

The overall soundscape of Johannesburg is difficult to describe.
I wasn't able to walk around as freely as I would have wanted to.

My experience of the soundscape is fragmented and consists more of very local environments that I visited. Much of my experience in traveling the city was done by car, with the windows up because of the risk of someone reaching in and robbing us.

The official city blocks were more or less divided into 'safe' areas and 'dangerous' areas.
The most dangerous area that we went to was a shanty town, and I could not record any sound only take some photos with my cellphone.

It was interesting to visit the shanty town, but it was perhaps more interesting to observer the invisible lines of sharply cut-off sound environments that were sharply sequenced in safe and dangerous areas.

Link to video:
https://vimeo.com/411499957

Or scan the QR-code

Soundblock

I had read about the Ponte Tower and fortunately one of the girls I was hanging out with knew a guy who lived there.

The building had a gated entrance with armed guards and we had to be vouched for by the person that we were there to meet.
When we got inside, it was absolutely mind blowing and an experience that I have stored in my sound library.

Originally built as an office tower, but abandoned due to financial issues, it became a vacant tower, occupied by squatters. The middle of the ground floor was covered in a huge pile of trash (the tower is hollow in the middle all the way down to the parking garage). Later on the tower was cleaned up and now only inhabited by paying residents.

The acoustic space in that round void was amazing and the light pouring down the shaft was also very beautiful.

Link to video:
https://vimeo.com/357783147

Or scan the QR-code

Business opportunities

When I first saw this I couldn't really understand what I was looking at. Was it just a ram-shack squat? Was it an illegal activity?

There are people all around Johannesburg making a living out of collecting and sorting trash, such as plastic, metal, wood and such. And they needed someplace to bring it, sort it and store it. Apparently they also specialize in specific trash.

This was one such sorting station. A roof claimed by squatters that provide not only a place for work, but also for shelter.

In Sweden, most roof-top activities are either organized businesses such as cafés and restaurants. Or, it is someone's private outdoor space.

In Johannesburg, many rooftops were used as outdoor bars and hangouts, but they were also being used by squatters. And they seemed to be allowed to go about their business as long as they didn't bother anyone.

Image nr.30

Image nr.31

Image nr.32

The pedestrian life

You only walk on the streets that you are familiar with, a wrong turn can be very dangerous. Mostly you travel in your own car, Gautrain, by ”taxi buses” or minivans.

I was amazed at how well my guides knew their city and that there were invisible lines that should not be crossed.

In Stockholm, I can easily identify which streets to avoid at certain times of night. I base my strategy primarily on sound.

If a street in the middle of the city is deserted and quiet on a dark night I absolutely do not go there unless I really have to. If there are people moving around, chatting and perhaps a bar or restaurant is open then I feel safe enough to walk there. This is probably because I’m female.

The biggest threat to me as a woman (in Stockholm) isn’t that I could get beat up or mugged, it is that I could get raped. But in Johannesburg all of these threats suddenly became a possible issue.

Link to video:
https://vimeo.com/411496990
Or scan the QR-code

Parking spaces

In general, you don’t park on the street in Johannesburg, because of the risk of having your car stolen. Unless there are ”parking guards” (a couple of guys standing in the street waiting for people to park their car, and you agree to pay them a reasonable amount for watching your car.)

We went to a part of town to visit a pop-up market (in a parking garage that functioned as a garage at night, but at day it was a market and restaurant) and the street that we parked in was almost completely deserted and silent. Inside the parking garage there was a lively buzz and chatter. And there, just across the street was the shanty town with people, kids, working men (extracting gold flakes from the sand using a hand wheeled machine). The men who stood just outside the shanty town were chatty and cat-called on Nthati.

Link to video:
https://vimeo.com/411494817

Or scan the QR-code

Soundpockets

I would say that Jozi has a lot of aural voids[10], but I would not really call them soundpockets. Mostly the silence covered a much larger area, say a block or two, and the silence was not caused by physical enclosure.

Here we have a derelict building in a eerily quiet street. A couple of boys were hanging out there. They weren’t really goofing around, playing. They were more just sitting there, relatively quiet.

If our guide from the Ponte Tower hadn’t approached them I could have missed them if it wasn’t for the building itself that caught my eye (no my ears).

In the more well-off neighbourhoods, the same kind of quiet existed, but on top of that silence was the prickling noise of electrical fences that sit on top of the walled-in properties.

Link to video:
https://vimeo.com/415185736

Or scan the QR-code

10 - **Aural voids**: places that are void of sound because of social, rather than physical, mechanisms.

Image nr.33

Image nr.34

Image nr.35

Green fill

I didn't see many parks in Jozi. And the ones I did see were more red than green. In the shanty towns, the ground was covered in litter or toxic waste from home-fashioned gold sifting. And the river was filled with plastic garbage.

This particular park, located near the Ponte Tower, in the image above was littered with garbage and there was really nothing to do there. So it was another sound void that was definitely not a sound pocket in the way that I think of them.

Link to video:
https://vimeo.com/411500946

Or scan the QR-code

Shopping

There are plenty of little markets, pop-up stores and restaurants. Usually security is quite rigorous when entering a safe area, and sometimes even just getting into a residential building is a tedious and lengthy process.

Link to video:
https://vimeo.com/411498830

Or scan the QR-code

Street life

You have to be very careful when moving in the streets of Jozi. A wrong turn can get you killed.

Mostly, of course, people are friendly and sometimes perhaps even more scared of you than you are of them. In fact, I first thought that everyone was scared of me. But I soon realized that they were scared ***for*** me. Scared that I might get myself into an awkward situation.

After a couple of days the fear calmed down and I was 'allowed' to go about myself, taking the semi-legal minivans and riding the Gautrain. It actually felt a lot safer than being alone in a taxi. I only took a taxi three times, to and from the hotel when I arrived at the airport and my first visit to the University.

After having an argument (that ended well, fortunately) with the taxi-driver to the university, I decided that taxis were not for me.
I also wanted to be around people doing their every-day business, and listen to the every-day sounds.

I think it is when you travel a city that you get to experience it, and from the backseat of a taxi you don't really experience anything.

Image nr.36

Image nr.37

Fighting noise with noise

Jozi isn't exactly noisy, instead it has sound voids which are mostly caused by fencing, route blockage or social mechanisms.

Here we see a derelict and abandoned building that is occupied by squatters. They themselves have put up the barbed wire to keep out other squatters from taking over their squat.

Link to video:
https://vimeo.com/412811025

Or scan the QR-code

Aural architecture

The square outside the Civic centre of Braamfontein is either cleverly designed or a happy mistake.

The tiles didn't really sit right so when we walked on them they would shift their position and wiggle a little. There must have been a hollowness under the tiles that enhanced the sounds.

When the tile fell back into place they made a little clickety sound, as if you were walking with cobble shoes on.

Link to video:
https://vimeo.com/110311844

Or scan the QR-code

Case-specific sounds

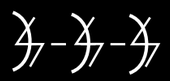
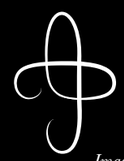
Sound	Sign
Sound voids	 *Image nr.38*
Electrical fences	 *Image nr.39*
Acoustic space/accidental aural space	 *Image nr.40*
Aural architecture/building (Ponte Tower)	 *Image nr.41*

Image nr. 42

Image nr. 43

Image nr. 44

Soundscape

Japan was my third stop on my trip and the long journey from Johannesburg definitely had an impact on me.

When you go from one very distinct soundscape to another, the differences between them becomes ever so sharp. In Tokyo I could ride the Metro and walk to my hotel, taking in the sounds without much anything else to think about than my research.

I got an abrupt wake-up call in the morning after I arrived, when the city exploded in sounds. Or at least that's what it felt for my unaccustomed ears.

The use of speakers was actually not something I had thought would make such a sonic impact. But, they were everywhere, and trying to drown each other out on a high volume.

Speakers aside, I was fascinated how quiet it could still be. On the metro I was a little startled when a massive flood of people suddenly appeared out of nowhere and with little warning because they were so quiet.

They swooshed by me in a fast-paced but orderly manner and when they were gone, the passageway was as still as quiet as it was before.

Soundblock

I decided to stay in Shibuya, the hip shopping district of Tokyo. I chose it mainly because it was the only place in Tokyo that I was somewhat familiar with. I didn't spend all my time there though, because I wanted to get a much wider knowledge of Tokyo.

There were excellent communications to other parts of Tokyo from Shibuya and that too influenced my choice of stay.

I did spend some time hanging out at the crossing in Shibuya. It had the same tendencies as my experience in the metro.

When everyone was waiting for the light to switch, you could have closed your eyes and not even realized that there were hundreds of people just standing there, quietly, patiently waiting for the green light. Speakers all around the crossing of course also worked as masking agents to drown out any human noise.

Link to video:
https://vimeo.com/410189154

Or scan the QR-code

Pedestrian life

I was hugely impressed with how effortless and efficiently people moved when crossing the street or flowing in the subway. I use the word flow, because it felt like a water tap that went from closed to open and then closed again.

As i described in Soundblock, the Shibuya crossing was an interesting experience with a lot of things happening simultaneously and therefore a bit complicated to analyze.

The freedom of walking around wherever I wanted was something that I realized is not to be taken for granted.

In Tokyo I had no guides, no one seemed to be scared that I couldn't handle myself.

I was comfortably inconspicuous and if I stood in a street with my zoom, camera and phone recording peoples movements no one seemed to even notice.

Link to video:
https://vimeo.com/416305663

Or scan the QR-code

Image nr. 45

Image nr. 46

Image nr. 47

Sound pockets

Urban space is never, or rarely, left unused in Tokyo. And with the excessive use of speakers it is difficult to find soundpockets.

At least the were difficult to identify by my definition of the term which hinges, more or less, on the soundscape being as 'natural' as possible (sounds from people, cars, animals etc.).

I found myself searching for something that I could classify as a soundpocket and I tried to stop that, because it was distracting me from having an open mind (and open ears)!

That was an important lesson for me, to try and stop that urge of looking for something instead of experiencing what was actually there.

Parking spaces

Parking wherever there is an available spot. In Tokyo, no piece of land is left unused or uninhabited. And the buildings, especially residential, are really tailored to their setting.

I had a long conversation with a guide at the Edo Museum, and he told me that the layout of Tokyo was pretty much the same as it had been several hundred years ago.

In old Tokyo the buildings were made out of wood and fires would destroy them 'regularly'. If they were destroyed, they built a new building in the same spot as the old.

Tokyo is also prone to earthquakes which also has consequences to the architecture. The constructions must be stable, but flexible not hard otherwise they would break from the vibrations.

Shopping

Shibuya, the trendy place to be, eat and shop. There are plenty of tucked away places everywhere and you can buy anything at any time.

I did find this shopping culture to be a bit terrifying, both morally (my own moral), environmentally and the enormous sound pollution that it caused. The speakers and screens were shouting at you all the time, urging you to buy something.

This extreme situation was something that I had expected to see, or hear, but I didn't think that I would dislike it as much as I did.

Again, maybe I was still under the influence not only from my personal background but from the place I had just come from (Johannesburg).

Link to video:
https://vimeo.com/416307040

Or scan the QR-code

Image nr.48

Image nr.49

Image nr.50

Signals

The extensive use of speakers in public areas was something that I didn't expect. I went to Tokyo after I had been in Johannesburg and I realized that I had gone the "wrong way", meaning I was terribly jet-lagged after the long journey to the east.

I was awakened by a morning phys. ed, with the teachers voice booming from speakers 'Ich, ni, san, chi' (One, two, three, four) in a middle-school yard, located just outside my hotel. When that ended another noise, in the form of a procession, started.

They had cymbals, drums and speakers. I went out from my hotel room and followed the procession for a bit.

It was fun to watch, but I really started to feel that I needed a little rest for my ears. That's when I decided that I should venture out to Little Edo, under an hour's train ride from Tokyo center.

According to the guide at the Edo Museum, Little Edo was more like the 'old' Tokyo. More on that in the section called 'My Favourite Spot'.

Fighting noise with noise

The Tokyo Subway has been plagued with suicides. In an attempt to thwart this development they have, in some stations, placed speakers that play bird song. Apparently, this effort has helped alleviate the problem with jumpers in the subway.

As previously stated in the section called 'Soundblock', my guess is that this excessive use of speakers is a wish to cancel out, or mask, the 'natural' suburban noise.
However, I see this is a 'medicine' that alleviates the symptoms and not the illness. The problem lies within the built structure, anthropologically as well as morphologically. By this I mean that humans move and behave in ways that the built environments allow/force them too.
The movement of people and transportation causes the most sound/noise in a city. The built structures themselves can also function as enhancers or dampeners for the sound that is caused by movement through them.

Link to video:
https://vimeo.com/358009126

Or scan the QR-code

Green fill

Even if Tokyo is a massive city, it has plenty of recreational parks. Gardens are important in Japan and this was evident even in densely populated residential areas of central Tokyo.

There are huge parks in the middle of Tokyo, but I preferred the smaller, more private places of green in Little Edo.

In Little Edo there was plenty of natural, or natural-like, little parks with real birds singing in the trees.

Link to video:
https://vimeo.com/415945180

Or scan the QR-code

Image nr.51

Image nr.52

Street life

The layout of Tokyo is very unpredictable and the topography varies a lot. One must be careful when walking around since you never know if a vehicle will be coming around the corner when and where you least expect it.

Apparently, the Japanese don't like crossings that are regular. I remember asking the guide at the Edo Museum about this and he told me that, in general, no streets should meet at a right angle.

The word that he used for it is lost to me now, but there was much evidence in Tokyo that the Western right-angled grid was not a predominant feature.

I didn't experience the same 'hanging-out-on-a-street-corner' kind of vibe. Mostly, it felt like people were busy going somewhere.

I met a guy at the train station as I was about to leave Tokyo for Los Angeles. He was originally from Canada and he had been living in Tokyo for five years, and he told me that if you wanted to work day or night or both, Tokyo was the city to be.

I could fully understand that after spending just a week in Tokyo.

Aural architecture

A guide at the Tokyo museum told me to go to Little Edo if I wanted to get an idea of what old Tokyo looked like.

So I did.

It was great to see a piece of the old Japan, mixed of course with the modern too. Little Edo isn't a museum, it is a small town with all the modern essentials but, relatively, free from the same kind of sound pollution as inner city Tokyo.

I went to a little park where there were real-life birds singing, and a little temple and a traditional teahouse.

As a whole, my Tokyo experience was dual. Both in terms of culture but also sonically. I find it very hard to put my finger on the Japanese soundscape.

And perhaps that is just what it is, elusive and dual. One that is soft and meditative and the other that is wildly modern and over the top.

Case-specific sounds

Sound	Sign
Speakers (above listener, below listener, ear level)	 Image nr. 53
	 Image nr.54
	 Image nr.55
Fake natural sound (birdsong in the subway)	 Image nr.56

Image nr.57

Image nr.58

Image nr.59

Soundscape

I arrived in Los Angeles at LAX and my first impression was that there was no conscious aural design whatsoever.

I took a taxi from the airport to my hotel and even inside the comfort of a car, I was annoyed. The highway seemed to be built with concrete slabs that had these small gaps between the edges, causing a monotonous, beating sound when the car ran over them.

It was very difficult for me to get a grasp of the scale of Los Angeles. I would look at the map and go, 'okay, I'll just walk a few blocks and then I'm there'. No. A block in Los Angeles is huge.

Of course that didn't stop me from walking for hours and hours every day.

One day I decided to try and walk to the beach. And after six hours of walking I could almost see the ocean, but there was no way of getting there unless you were in a car. There were no pedestrian or bicycling routes. So, I hopped on a bus an rode back to my hotel. The next day instead, I took the bus to the ocean.

The vistas and boulevard seemed endless, if you were in a car. If you were traveling by foot, the sidewalk could just come to an end with no way to any further.

Soundblock

I have chosen to show you a 'typical' block of Los Angeles, portraying the urban sprawl.

It doesn't look that intimidating when you see it in a tiny picture such as this. But each block is approximately 125 meters wide (at the short end), and approximately 200 meters deep.

Almost double the width of a typical block in the inner city of Stockholm.

The consequence of this is that you're almost forced to have a car if you live in L.A, and the speed limits are considerably higher than in Stockholm.

The metro and buses stop working early in the night, but they aren't really that helpful even when they are running because the stops are few and far between.

I make a point out of going by metro in every city I go to (in Johannesburg I wasn't 'allowed' to ride the metro but I did use the Gautrain, which is more like a commuter train).

Metro culture is very fascinating and so different in every country, and the sound of them is also very distinct even though they share a lot of the same elements.

Street life

When I saw how many people were living in the streets of Los Angeles, I could not help but wonder what the cause for this was.

It is probably a mix of many issues and to go into that is a whole other kind of thesis, but from a sonic point of view I can say this: the noise from the cars made the homeless feel far away, distant or dislocated from oneself.

I could barely hear them at all even though I passed them on the opposite side of the street. The sound barrier created a **sonic, fourth wall**[11] through which I could see, but not hear the homeless.

This sonic wall, created by vehicular noise, was everywhere I turned. The buildings were so low and far apart from each other that they could not contain the noise.

11 - **The fourth wall**: a performance convention in which an invisible, imagined wall separates actors from the audience.

Image nr.60

Image nr.61

Image nr.62

Pedestrian life

As I walked around L.A I realised that a street could go on for miles, and it seemed they never ended.

In the section called 'Soundscape' I told you about my failed attempt to walk to the beach. When I had been walking for four hours or so, I stopped and asked for directions to the beach.

They looked at me and laughed when I told them I was walking to the beach. I replied:'It's okay, I'm European.' Meaning that where I come from we walk to where we are going unless there is good reason not to.
In Los Angeles, it is the other way around.

Link to video:
https://vimeo.com/411002272

Or scan the QR-code

Parking spaces

Parking takes up a lot of space in L.A. Some lots that I saw were bigger than the footprints of the adjacent buildings.

The urban sprawl is deeply embedded in every aspect of the urban fabric. Distances are enormous and one/two storey buildings are the norm.
Except in down town, where they lifted the height restrictions and the skyscrapers are incredibly tall.

I once thought of re-designing Los Angeles, as a purely intellectual exercise of course, just to see what it would be like if you stacked all those low storey buildings on top of each other. Scaled down the streets and played around with the grid a little bit to create a more diverse urban soundscape.
The effect of this would also be that a lot of land would be left untouched or available for farming.

The sprawl has more consequences than just sonically, the environmental impact is extremely negative with pollution and droughts.

The River, which once used to overflow and give the land nourishment is now contained inside concrete to stem the overflow and push the water to the ocean. Causing the effects of drought to be even more severe than ever.

3 - Shopping

It was tricky to walk to the store in L.A.
I felt like the odd one out as I entered the shopping grounds on foot and not by car, because there was rarely a designated walkway from the large sidewalk and to the store front.

I didn't do any serious shopping like shopping for clothes or anything. I just wanted to buy food, or find a decent cup of coffee. In one of the more famous coffee shop franchises the café was packed and they had even better Wi-Fi than my hotel, I noticed.

People would use it as a home away from home or as an office.

I didn't pry or anything, but from what I could tell, and hear, there were many playwrights sitting there hoping to make it in Hollywood.

Backlot[12] is a term used in the movie industry and that is exactly what Los Angeles felt like - one big backlot. And it does look good on camera, even the concrete tub that is now the River looks amazing on film.

But in real-life it is not that dreamy. At least not if you are walking through it.

12 - **Backlot**: an area behind or adjoining a movie studio, containing permanent or temporary exterior buildings for outdoor scenes in filmmaking production.

Image nr.63

Image nr.64

Image nr.65

Green fill

California is home to 77,500 farms (Wikipedia) but in central Los Angeles, there is little evidence of that.

There are parks and recreational areas and stadiums and lakes. But where people actually live their day-to-day lives or go to work there is little to no soft, green spaces. There are plenty of narrow, fenced in back yards, but the ratio between green fill and tarmac is very disproportionate for a city of this size.

As I said earlier, the urban sprawl has negative effects, not just on the soundscape but also environmentally. If we would focus on building cities that were sustainable and healthy in terms of sound pollution I think that environmental issues would also be resolved in a better way.

Fighting noise with noise

This fountain was so loud that it masked the car noise quite well. I assumed that this was intentional and I could appreciate the intention, but the reason for it made me sad.

There were more fountains like this one, usually placed right between the front entrance to a building and the street just outside it.

Link to video:
https://vimeo.com/410999891

Or scan the QR-code

Signals

A siren cuts through the vehicular noise. It has a higher pitch than the Low Frequency Noise that is omnipresent in the soundscape of Los Angeles.

I can't really remember any other signals, or foreground sounds, from Los Angeles. It feels strange to admit it and surely I may have missed something. But I guess if I didn't notice any other signals than sirens then maybe there aren't any.

Image nr.66

Image nr.67

Soundpockets

The disappointment almost made me cry when I entered that which I thought might be a little sonic refuge or soundpocket.
The hedges first made me think it was a little park, but it turned out to be just another parking lot. And the sound of the street was very present even when I stepped into the parking lot.

By this time I had walked many miles, and I just wanted to sit down and relax somewhere without having to drink another cup of coffee.

The residential areas, with their backyards could possible be spots for quiet relaxation, given that the house facing the street could act as a sound buffer. But I didn't know anyone who lived there, so I never got the chance to test that assumption.

I did walk around in residential areas a lot, in particular one that was located very near the Golden State Freeway.

It was not a place that I would have chosen to live in. The freeway could be heard very clearly even though some measures have been taken to put commercial buildings and green space between the residential area and the freeway.

Aural architecture

There are many bridges that span across the River. When cars drive over them and you stand underneath it, it "sings" with the vibrations and the dried up river bed below creates a very interesting acoustic space.

This particular bridge is the Hyperion bridge, and I was very happy to have found it. To me, this was the best spot in Los Angeles that I found.

Link to video:
https://vimeo.com/358036301

Or scan the QR-code

Case-specific sounds

Sound

Low Frequency Noise area
Low Frequency Noise is typically caused by traffic

Roads (listener walks on or next to it, the road is above listener, road is below listener)

River

Ambience field
A constant background noise convolutes the area, e.g. a noisy ventilation fan in an office, open space adjacent to highway, etc.

Sign

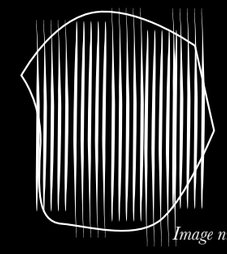


Image nr.68

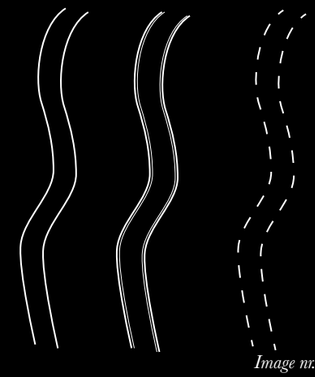


Image nr.69

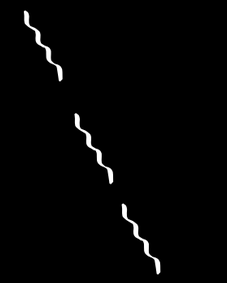


Image nr.70

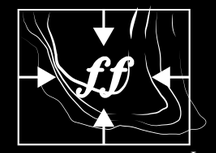


Image nr.71

Image nr.72

Image nr.73

Image nr.74

Soundscape

Mexico City has a very diverse soundscape, with huge roads, narrow streets and a grid that is a mix between the right angle and organic. They co-exist somehow and I think it works quite well.

There are residential areas, commercial areas and lots of mixes between the two.

Soundblock

This is the area in which I traveled, or walked around, most. My hotel is marked with the red box. The big road that marks the line between buildings and the park was very busy, but the smaller streets south of it was more or less pedestrian.

There were street vendors, cafés, shops, buses, metro and just about everything you could think of or need was really not more than a few blocks away.

The buildings vary a lot in height, size and use. The park was not my favourite park, mostly because it was so planned out and left very little to the imagination. It was also too small to provide refuge from the noise of the big, busy streets surrounding it.

In another park, not too far from where I was staying, I saw these guys playing something that I think is a version of Pelota. This was a park that I did enjoy. It was more informal and even though it wasn't really bigger than the park I mentioned earlier, it felt more shielded from a sonic point of view.

Signals

Traffic lights, horns, music playing inside cars, traffic police, stalls with taquerias, clothes and other stuff for sale lining the streets.

There were plenty of signals competing for attention in the soundscape, but not to the point that I found it exhausting.

Image nr.75

Image nr.76

Image nr.77

The pedestrian life

In Mexico City you'll find huge roads that serve, for example, the financial districts with their sky-scrapers. But, since I mostly travelled by foot, I found that Mexico City had very pleasant smaller roads cutting through the grid like ant-trails.

There were buses everywhere, even if I didn't always know exactly where they went.

Link to video:
https://vimeo.com/411032085
Or scan the QR-code

The metro was also easy to find and un-intimidating to be in. Instead of birdsong, like in Japan, they played music. It was great to visit a country that loves music so much.

Link to video:
https://vimeo.com/411033632

Or scan the QR-code

Parking spaces

I wasn't really looking for parking options, but in general it seemed like parking was what I would call 'normal'. There were parking garages in the central city and in the residential areas, parking was available on the street or outside the house.

Aural architecture

Perhaps not so much a physical place, but an event instead.

I soon discovered that I had come to Mexico City in the middle of rain season. I was sitting in my hotel room, when all of a sudden the sky opened and rain poured down and with it flashes and thunder.

I have always loved the rain, I even lived in Glasgow for a year so heavy rain and thunder doesn't scare me. It actually makes me feel more at home.

But this rain was unlike any other that I have experienced. It also came so sudden and left just as sudden. In the morning the streets were almost dried up, but at night the rain came back. And this scene would be played again.

Link to video:
https://vimeo.com/410619493

Or scan the QR-code

Image nr.78

Image nr.79

Image nr.80

Green fill

There are a lot of parks in Mexico City, of different sizes and uses. A large city requires large green areas for recreation, water handling and trees. They also serve as calm spots for all residents, homeless or not.

The parks were carefully planned and well maintained. Some were placed very well and could be shielded from the busy, adjacent streets.

This image is from Alameda Central, Mexico City's oldest municipal park. Oldest, but certainly not the largest. The largest green area I visited was Bosque Chapultepec, where the Mexico City Anthropological Museum is located.

Although it felt like a huge forest, it is actually smaller than Central Park in New York. Chapultepec is approximately 686 ha, and Central Park is 843 ha.

The sound effect was still pretty much the same, or even better, in Chapultepec because of its shape. Central Park in New York City is formed as a rectangle and Chapultepec is more like a hexagon, meaning that if you're in the heart of Chapultepec it is quite some distance between you and surrounding traffic noise. While in Central Park, the width of the park is more limited.

Shopping

There were many, many streets with vendors covering both sides with their individual stalls. There you can buy anything from clothes, phones or amazingly tasty tacos for 7 pesos.

The vendors fought for attention by shouting out their merchandise.

Link to video:
https://vimeo.com/358265223

Or scan the QR-code

Fighting noise with noise

I was on my way to Chapultepec and the Anthropological museum when I stumbled across this scene: a mariachi band tuning their guitars right in the middle of a very busy highway exit and a demonstration.

But there they were, tuning their guitars in an almost rebellious manor.

This made me think that perhaps people will fight to find a way to be heard even in such noisy environments.

I really can't say that this has anything to do with a citywide strategy in the fight against noise pollution. (There weren't any such evident strategies that I heard. At least not as evident as in Rome or Tokyo.)

Perhaps the one thing that could fit in to this category and something that I was very fond of was the music that was played either from shops or cars.

Link to video:
https://vimeo.com/358272952

Or scan the QR-code

Image nr.81

Image nr.82

Street life

I had been warned about the dangers in Mexico City. I even had an offer to be driven in a private taxi from ar friend of a friend.

I declined, both because I thought that the best way of investigating a soundscape is by being immersed in it, day and night, and that meant that I'd have to be out on the streets.
My other reason was actually that I thought that that would possibly risk making me an even bigger target, riding in a fancy car.

It was only to and from the airport that I took a taxi, otherwise I utilized the metro or buses. But mostly I walked. I even walked at night, but that was admittedly a little scary at times.

I took a wrong turn from the metro one night and there could have been an incident, but thankfully I managed to get away without any hassle.

In the image above we see the construction workers when they make a part of the street their own space for rest.

I walked around in the financial district one night and there were piles of workers sleeping on the sidewalk. I didn't want to take my camera out at that particular time though so unfortunately I don't have a photo of that.

Soundpockets

There are a lot of little tucked away courtyards, squares and green patches in Mexico City.

Some are quiet, just like the tiny square in Rome. Some are more simply a place where human and animal activities are the prevalent sounds.

Link to video:
https://vimeo.com/358270206

Or scan the QR-code

Case-specific sounds

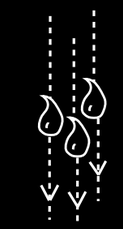
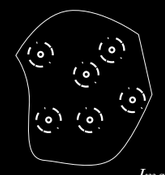
Sound	Sign
Rain (heavy)	 *Image nr.83*
Green fill (forest)	 *Image nr.84*
Marketplaces	 *Image nr.85*

Image nr.86

Image nr.87

Image nr.88

Soundscape

New York City was my last stop and I thought that it felt like a 'complete' city. It has the old, the new, the right-angled grid which has been carved out by finer, organic lines. it has vegetation, or green fill, and it has a lively relationship between pedestrians and vehicles.

But it also has softer notes and 'natural' sounds. One might say that is has a more complete set of instruments in the orchestra than many of the other cities that I visited on this journey.

My investigation of New York is limited to Manhattan Island even if I did do some excursions to Brooklyn. This was not a deliberate move on my part. It was more due to time constraints and the fact that Manhattan is so diverse and interesting from a sonic point of view.

Link to video:
https://vimeo.com/411019785

Or scan the QR-code

Soundblock

This is the Columbus Circle Subway (apparently, in New York it is never called the Metro) station, on the southwest corner of Central Park. I stayed at the West Side YMCA so it was very close to my daily point of origin.

The round circle is where the entrance to the subway is. To the right you see ventilation grids of sorts, through which the sound of the trains spills out onto the street.

The square surrounding it was usually packed with people coming or going. Street vendors, musicians, taxis waiting, lots of cars driving in all directions.

It is a busy place, but when you cross the street towards the green all that noise fades away when you go deeper in to the park. (For a better idea of what the place looks like see the image in the previous section 'Soundscape'.)

Link to video:
https://vimeo.com/358750031

Or scan the QR-code

Parking spaces

Where land is expensive, you learn not to waste too much of it on parking or storage. Clever solutions that go vertical instead of horizontal are invented out of necessity.

Stacking, or maximizing land use is cost-effective as well as alleviate the negative consequences of urban sprawl.

Image nr.89

Image nr.90

Image nr.91

Signals

The wailing sirens is for some reason one of the first sounds that I think of when I think about New York. I don't know if I experienced sirens to be as predominant as they are portrayed in movies. There could be a dilemma here, my real-life memory and memories of films set in New York.

I would think, however, that sirens is something that many associate New York with. That makes it ambiguous for me when categorizing this sound.

It is clearly meant to make pedestrians and drivers aware that an ambulance or other similar vehicle is approaching and you need to get out of its way. On the other hand, if a noise is used too frequently, people tend to ignore it more.

So the signal risks becoming a keynote. I use the word risk, because if something that is supposed to warn you becomes something that you ignore that's not a good thing.

Link to video:
https://vimeo.com/411024225

Or scan the QR-code

The pedestrian life

Even if I didn't see that many officially mixed zones people and cars seem to have a working understanding of each other, vehicular speed is naturally slower than L.A since you never know if somebody decides to take a shortcut all of a sudden.

Link to video:
https://vimeo.com/411020271

Or scan the QR-code

Green fill

Central Park is a wonderful place of course. But one problem that I think it has is that you have to go there and if you go in too deep it takes a while to get out.
I think the High Line is the perfect contrast, or supplement, to it.

Located above and in between the buildings it becomes a part of the city but it sits on top of the city instead of in it. Almost like the old idea of the physical separation of people and vehicles.

When I lived in Glasgow, the railway would often be lifted up and ran on bridges between and over the street life. I think that when it comes to railway or green spaces, this idea of separating and lifting up works quite well, both logistically as well as sonically.

Link to video:
https://vimeo.com/358753693

Or scan the QR-code

Image nr.92

Image nr.93

Image nr.94

Fighting noise with noise

New York subway is poorly constructed both sound wise as well as when it comes to safety concerns. Both sound and sight travel freely in the space. I love the fact that this drummer didn't just play on the buckets, he used the metal bin behind him as a part of his performance.

Link to video:
https://vimeo.com/410660499

Or scan the QR-code

Shopping

You can buy anything you want, whenever you want to. But what does N.Y. City really sell the most of? It sells the ***idea*** of what New York is; attitude, history, fashion, fame and money.

In the 60's and 70's the gentrification[13] hadn't fully taken its hold on Manhattan, and buildings such as the Chelsea Hotel could house a variety of people.

I would like to do a study on how gentrification and soundscape are connected. My thoughts on it is that gentrified areas tend to slow down and quiet down. (And, as you may have understood already, I am not advocating for the soundscape to go quiet.)

I remember areas in Stockholm that I used to hang out a lot in when I was a teenager. They became 'fashionable' hipster hangouts and slowly, but surely, our favourite places became more expensive or we just didn't feel at home anymore.

This is a part of what the modern city's metabolism looks like with the way city planning is formulated.
The big problem is: what happens to those who get dispersed when it happens?

Soundpockets

New York being 'old', not by European standards but by American standards, it has a lot of interesting spaces that are remnants of what used to be, what might be and something in between.

I was surprised to find as many soundpockets as I did. I had expected New York to be in a 'worse' state than Los Angeles but it was a completely faulty assumption.

When old structures remain, be it not in their original capacity, shape or size, little creases are made and we get what I call soundpockets. In a way soundpockets has a lot in common with S.L.O.A.Ps (Spaces Left Over After Planning).

So it is no wonder that I am so fascinated with these aural mishaps, because I absolutely love S.L.O.A.Ps. Most would regard them as flaws or ugly places, but to me that is where there is true potential for a city.
I really liked Harlem, but it was a little sad to see the gentrification pushing in there too.

Link to video:
https://vimeo.com/358276513

Or scan the QR-code

13 - **Gentrification**: a process of changing the character of a neighbourhood through the influx of more affluent residents and businesses

Image nr.95

Image nr.96

Street life

Homelessness is very visible in the U.S. but mostly the people who have the streets as their home are invisible to those who have a home.

Surely there are many homeless people in Stockholm too, but not to the same degree as in the U.S.

When I was in Los Angeles I wrote on my blog that I had to ask for directions to the bus stop, but no one knew where it was except a homeless man!

The knowledge of the city seem limited to those who have the most money or for some other reason only use a car for transportation.

If you're living on the streets you know them like the back of your hand.

Thinking back I wish I had had the courage to talk to the ones who really knew the city. But it didn't occur to me then.

Aural architecture

Brooklyn Bridge by night was amazing. Great sounds and great views of the city. Since I am from Stockholm, I generally feel more at home in cities that have a close relationship with the sea.

The sound of water is comforting and makes it easier to navigate the city. In Johannesburg I could really sense the absence of open water.

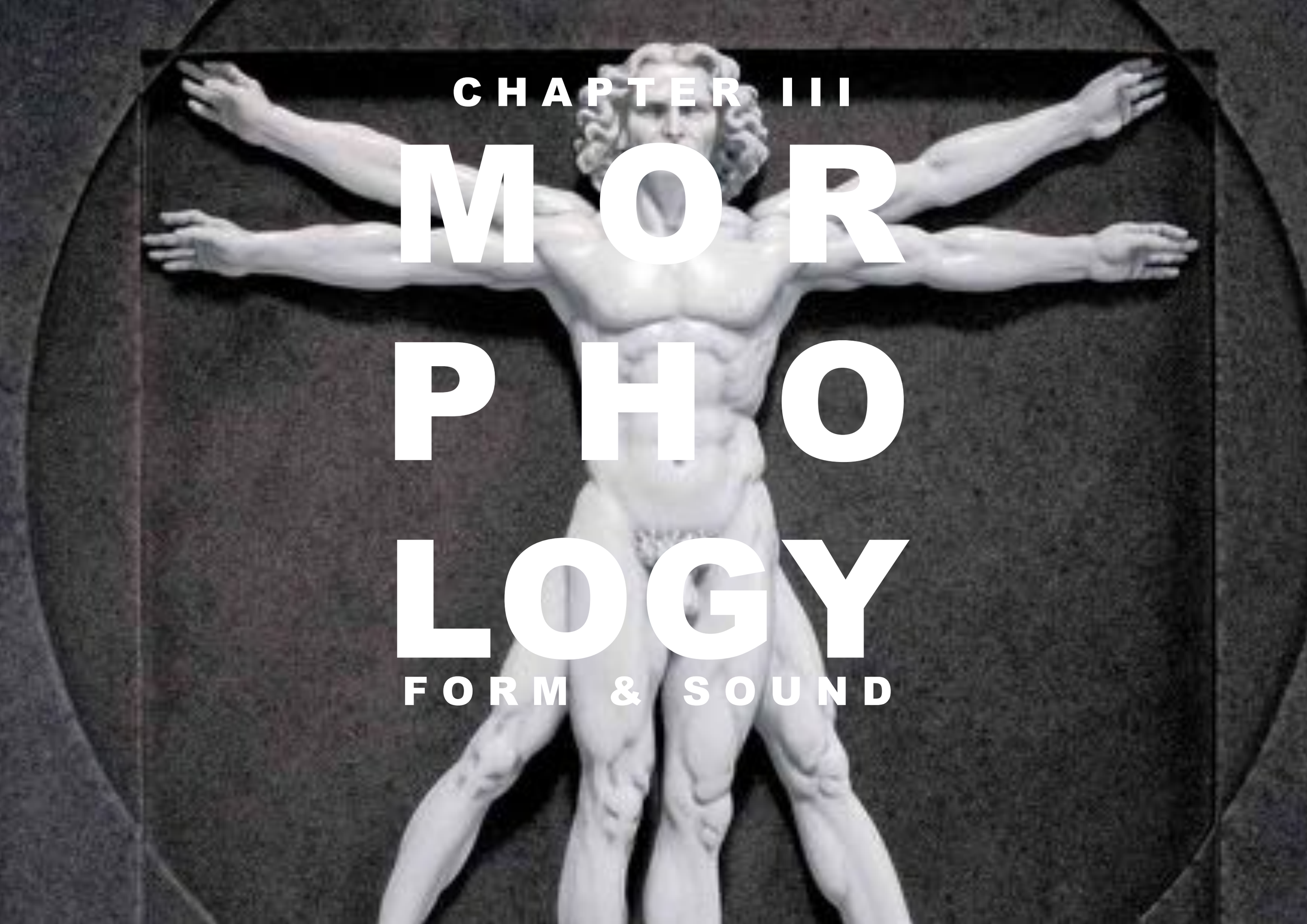
If you listen carefully, you can hear the same 'thumping' sound from the joints in the concrete slabs that I described when I went from LAX to my hotel.

Link to video:
https://vimeo.com/410735683

Or scan the QR-code

Case-specific sounds

Sound	Sign
Siren ***Ambulance, police or similar.***	 *Image nr.97*
Avian animal ***Bird***	 *Image nr.98*
Wind	 *Image nr.99*
Aircraft	 *Image nr.100*
Car/s Exclamation mark indicating strong sound/soundmark	 *Image nr.101*



CHAPTER III

MORPHOLOGY

FORM & SOUND

Form & Sound

The plan, section and arrangement of urban space has a very profound impact on its soundscape. Both in terms of technical acoustics, but also in terms of *psycho*-acoustics[14].

Like a back-of-an-envelope analysis, a quick survey of a city's general layout, or grid, is very useful to understand what a city's keynote[15] ***may*** sound like.

When analyzing a soundscape further we must also take into account the layout, or shape and form, but also the topography of the landscape.
Urban topography will usually be the height of the buildings, roads and green spaces.

The grid, topography and shape of a city also controls the way that people move, ***how*** they move and las, but definitely not least, at what ***speed*** they move.

In general; a regular grid with wide lanes and low buildings will be a very noisy soundscape.
In my opinion a narrow, winding layout with turns in other angles than 90 degrees tends to have a more varied soundscape.

The varied layout utilizes the acoustic properties of sound waves, meaning that they are obstructed by non-parallel walls and absorbed by thick walls or earth mounds.

A gridded urban layout tends to have parallel standing walls, which are excellent for sound to bounce off and in major cities the urbanization density tends to omit green areas with the capacity of absorbing sound. (A flat, open field with low or no vegetation is not capable of sound absorption at a noticeable level.)

Take, for instance, Los Angeles with its rigid grid and huge network of enormous highways set in a mainly flat (former agricultural) landscape, with little to no natural sound shielding in either *topography* (flat landscape) or *typography* (low storey buildings and enormous highways), it is not a huge leap to think that the ambient sound scape will be very noisy.

Compare that with Rome, a large city in its own right, but with narrow, winding roads and a topology that allows for somewhat more natural noise shielding. Buildings are in general a lot taller than in L.A and built very close to each other, cutting off any or all sound from one place to another.

However, one must not stop there and think that the grid will tell you what the soundscape sounds like.
Tokyo has a grid that resembles that of Rome very much, but it is incredibly more noisy. Why that is so, we will discuss further on.

The grid of Los Angeles: long boulevards and right angled junctions

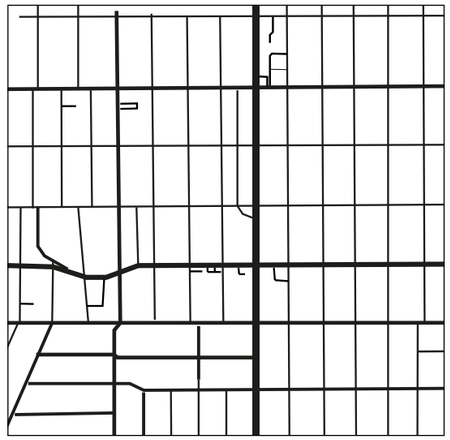


Image nr.102

Close-up of a generic block-layout in Los Angeles.

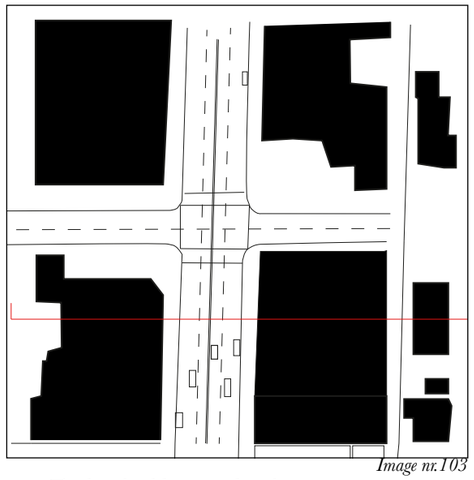


Image nr.103

The low buildings and wide streets provide a noisy soundscape with little possibility of noise absorbtion or dispersing of sound waves.

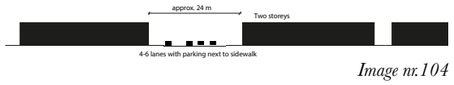


Image nr.104

Conventional mapping

The conventional way to draw a map of a city generally doesn't show the height of the buildings.
There may be curves that indicate *geological heights* (hills, valleys, etcetera), but rarely does it show or denote the actual building heights. The height of the buildings is, in my opinion, of great interest when assessing or designing sonic properties in urban spaces.

Sometimes the addition of shadows from the sun indicate if a building is tall or not. So, for that reason, I have tried to draw contour-maps that include building heights without the use of shadows or shading.

The reason for that is that I think that when I move further along in my drawing such as the tempaural exercises, the conventional way of using shadows to indicate building heights will lead to confusion.

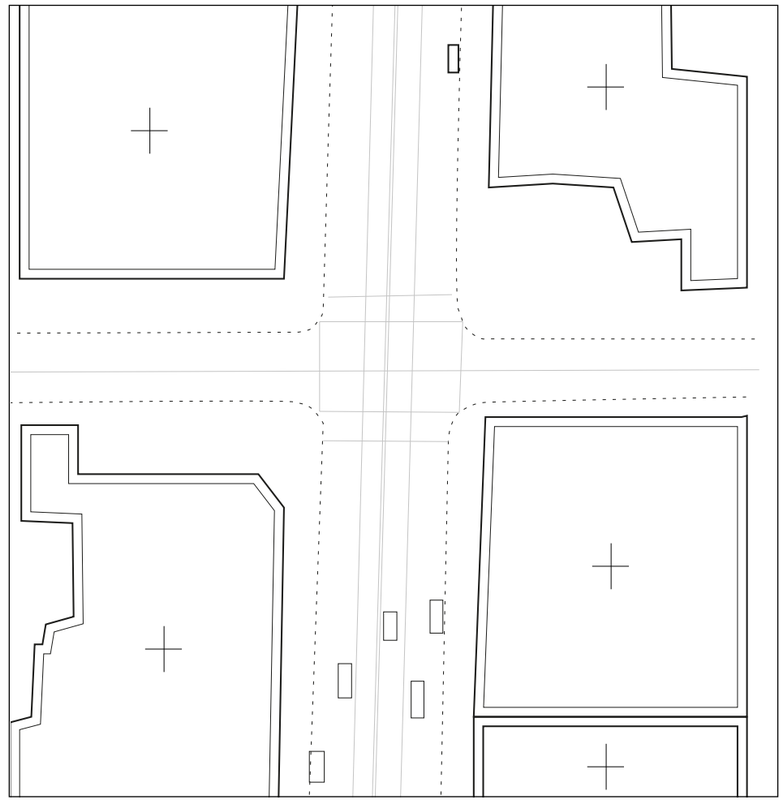


Image nr.105

14 -**Psychoacoustics**: The study of the perception of sound. (Blesser B. 2007)

15 -**Keynote**: The societal background noise to which all other sounds are perceived

Aural topography

”Direction of the sound source is not notated in music as the relationship between it and the listener is determined by the stage-to-seating arrangements of the venue, whereas in landscape the direction of the sound source is a key component of the spatial experience of it.”[16]

When doing an aurological map one might use dB-measurements (Remember that low frequencies are usually not indicated clearly by a dB-meter.

Low Frequency Noise is very difficult to measure, but has a detrimental impact on human health and psychological well-being. *See Appendix I*) to study the strength of sound in different places of the soundscape, such as the *quantitative* Isobel map. See Image nr.106.

Or, one might walk through an area time and time again, during all the hours of the day and then try and do a *qualitative estimate* of what the sonic environment is like.

Since the grids won't tell us all we need to know, we must get down to street level. I have chosen to illustrate a couple of spots in all the cities that I went to on my research trip. I chose them because to me they pinpoint my overall experience of the city. For example Rome, in which I found the angled streets and sound shielded courtyards to be some of the most important findings for my studies from that city. The spot that I have chosen to elaborate on embodies all of those qualities.

This chapter deals with my subjective mapping of the soundscape and its morphology in those specific places.

In this example I have treated the mapping almost like a geological survey, with the *urban topography* as a base and the moving or static sound sources (humans, vehicles, traffic lights) or emitters, also depicted as topographical objects. See image nr.107.

The reason behind this is that sound is a 4-dimensional experience and sound waves spread in three dimensions so a sound emitted from a vehicle on the ground will move to the sides, down and up.

The sound waves is in a way creating little sonic islands or hills (sometimes moving though) so it sort of fits in with the idea of urban, or sonic, topography mapping. If the surrounding buildings aren't tall enough, as in Los Angeles, sound will spread above and across it more easily than if a taller building would have been there to block the sound waves travelling up and out.

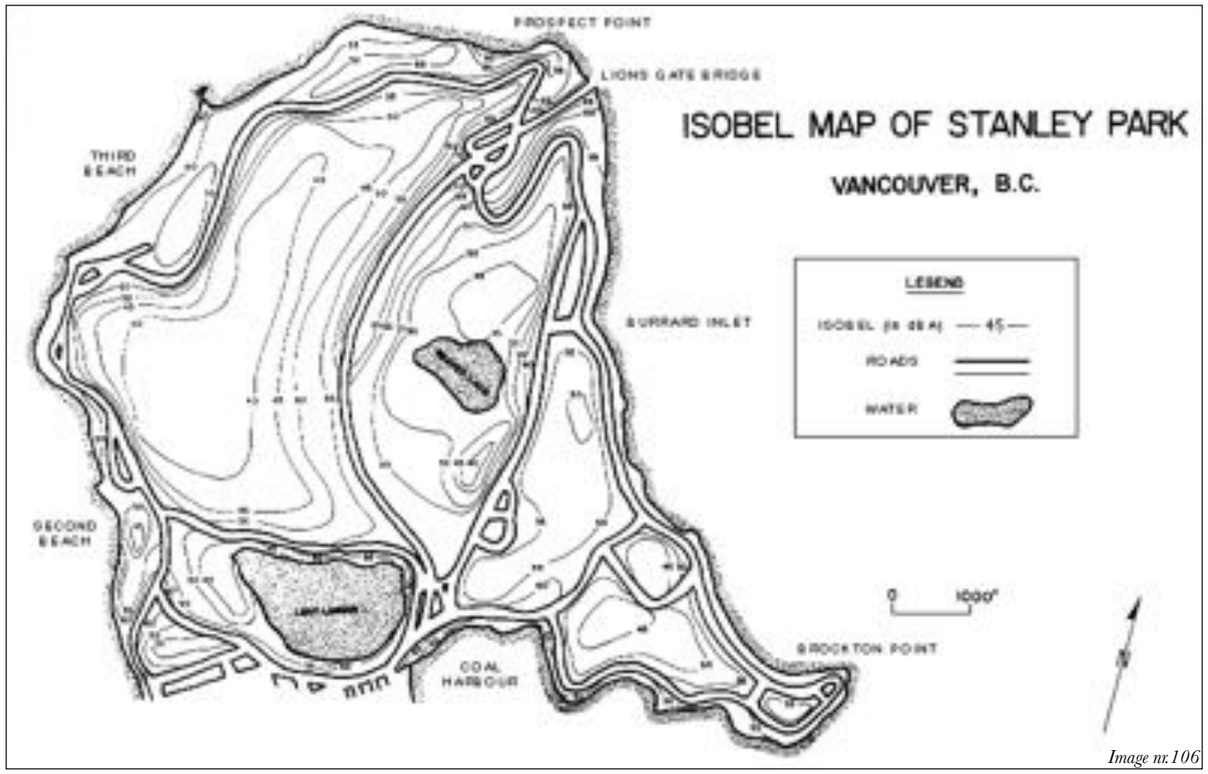


Image nr.106

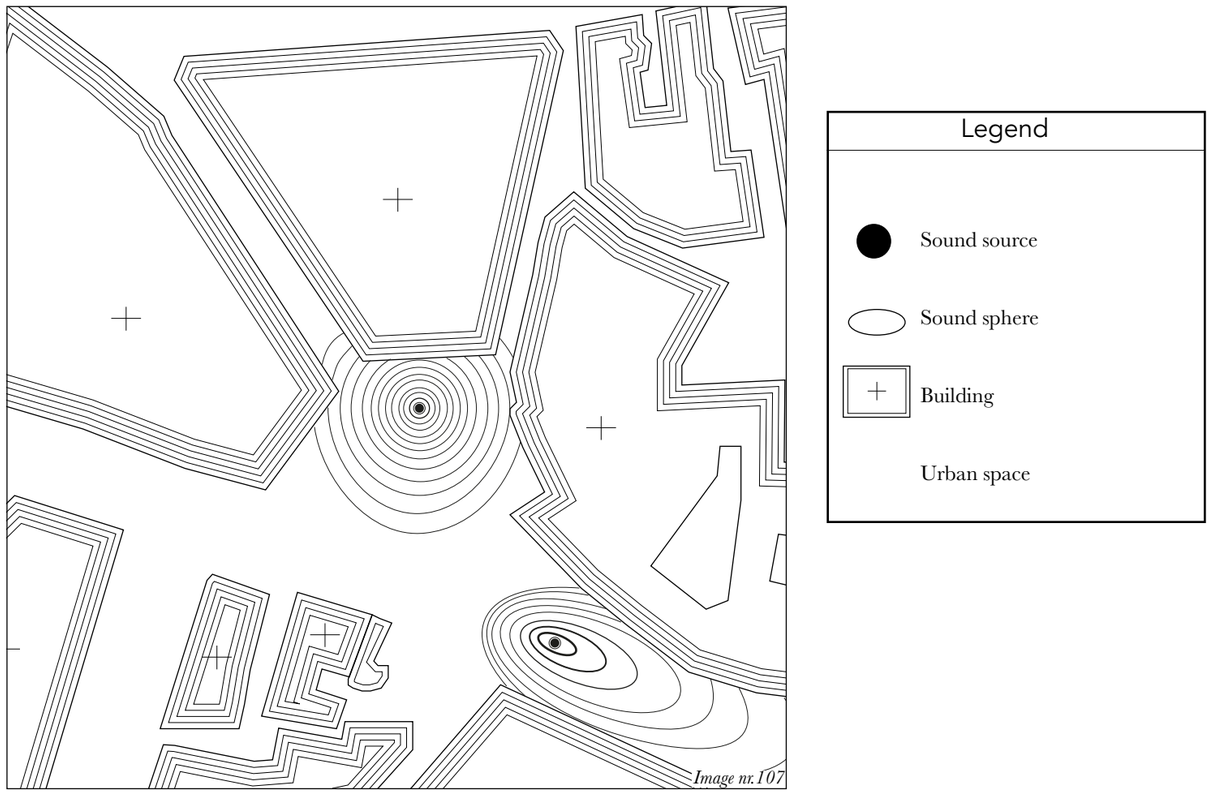


Image nr.107

16 - Buck, David Nicholas. *A musicology for the Landscape*

Tempaural drawing

I have done what I call a tempaural[17] mapping of each site in my case studies and it is a simplified tool to show differences in sound and in some sense also intensity or strength. This is loosely inspired on the Actor - Network Theory (Latour and Wolgar 1986). What I mean by that is that sound and sound artifacts and sonic spaces act in symbiosis and their impact on each other is part of an interactive relationship.

When we move through space, we leave behind a sort of imprint. If we walk past someone, a draft may form, our smell (perfume or au naturel) lingers for a second or two, the sounds of our footsteps lives independently for a brief time after we have passed in the form of reverb and/or echo.

In this map the darker the hue, the quieter it is. Buildings are completely black because of lack of data and/or because what happens inside a building rarely affects the urban space in a substantial way. (Of course, if the windows are open music or voices can spill out into the urban soundscape.

The time it takes for the sound to enter our ears is significantly longer than the time it takes for the image, or the light emitted from an object, to enter our eyes. Therefore, the sound we make as we move through space is perceived as an imprint that follows us.

The more imprints an object leave behind it at a timed interval, the faster it is moving.

The idea of the imprint, of a multi-existence in time and space led me to think about using that as a means of notation when it comes to describing the sonic/aural experience of architecture.

In this type of visualization I let the spaces where the sound is over a certain limit of comfortableness to be light in different ways, depending on type of sound, and the space that are either buildings or ”soundpockets” are black.

Edges of buildings have different line-weights depending on the activation they get.

A (acoustically) reflective stonewall will be thick and white indicating that it is affected by sound waves and thus becomes an emitter of sound itself.

A shielded area will have thin, grey washed lines of walls and black ”floor”.

My aural map of Rome, shows a moment of time in the morning with traffic and pedestrian movement as well as stationary sound sources (fountain in Piazza Navona).

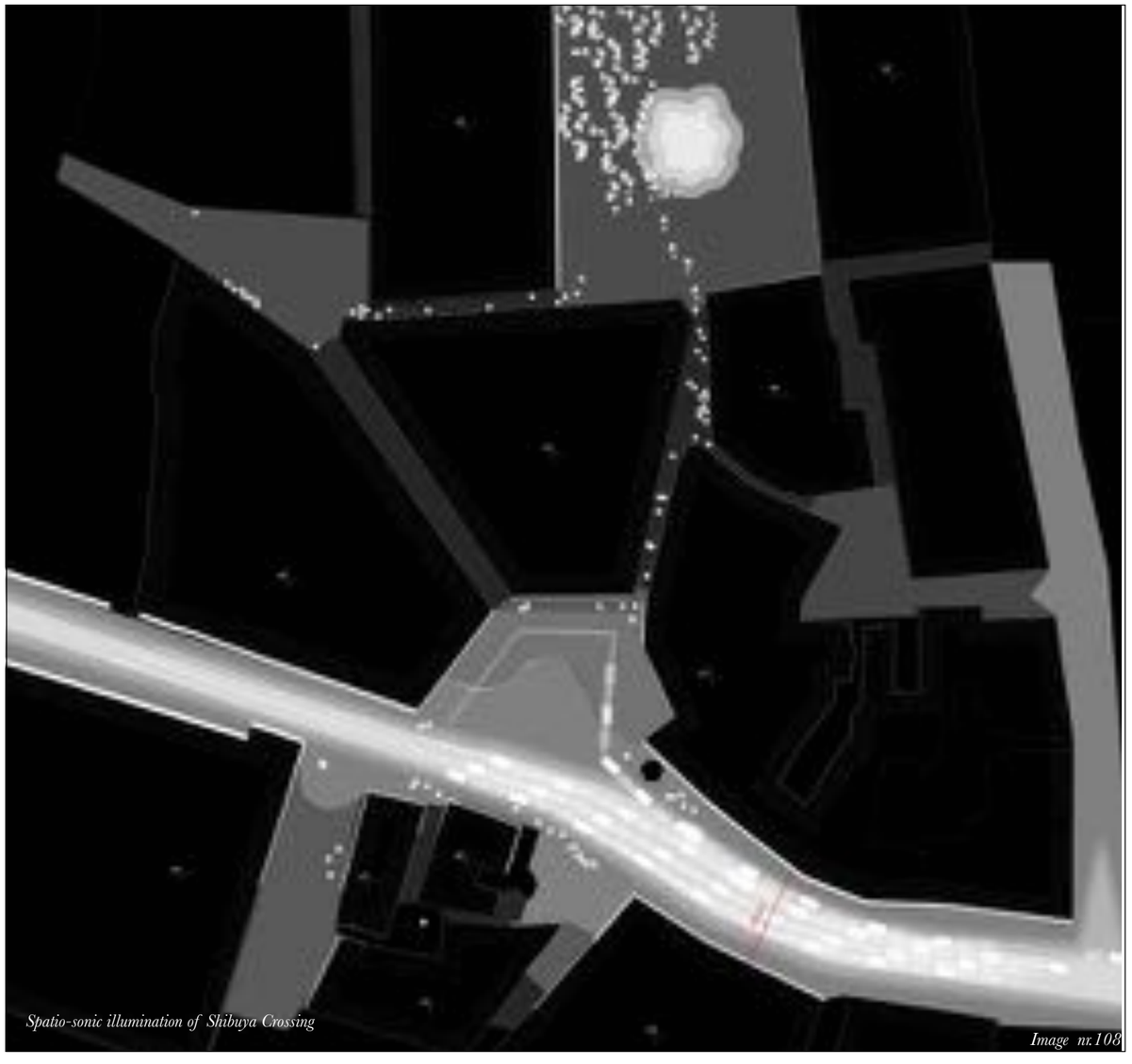
The distance between the rectangular shapes (cars) shows the speed (approximately 50 km/h) and how far they move every second.

The whiter the rectangle is, the more it sounds. So, a car that is turning right and coming to a stop gradually fades into grey, and the distance between the sequenced rectangles is shorter.

When I was there it was 34° C in the morning. I was at Piazza Navona in the afternoon and as it was still quite hot I chose to sit in the shaded area of the square.

And so did almost everyone else there, and so the shaded area was full of life and chatter, and the sunny area was basically empty of people and quiet.

Quite the opposite of what a Swedish summer afternoon would sound like. Usually the temperature will not be that high and the shade will be a bit cold if you’re dressed for a summer day.



Spatio-sonic illumination of Shibuya Crossing

Image nr.108

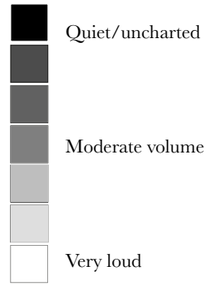
Soundmarks

The soundmark/s of a city play a key role in our perception and memory of it. They are usually quite unique sounds and are therefore difficult to assign a generic sign.
Some cities (such as Johannesburg) lack obvious sound marks and that, which is missing, can also be important for the overall soundscape experience.

User experience

A phrase that I have borrowed from the world of web- or application design. The importance of designing the experience that a user gets when using a website or application is growing more and more.

But, I think, that the same ideas should be applied to our physical lives as well. It becomes even more important in dense urban environments.



17 - **Tempaural**: a play on words (temporal and aural), which describes sonic events in conjunction with the passage of time

Citygrid of Rome

Image nr.109

Rome

Founded: ≈ 753 B.C

Population: ≈ 2,9 million (2018)

Area: 1 285 km2

Weather conditions (during my visit): +30C°, dry

Grid type: organic, ant trails[18]

Keynotes: Pedestrian movement, fountains and crickets.

Soundmarks: church bells

Signals: Vehicle horns

The grid

This map of Rome (partial), demonstrates the organic grid. It has thicker 'veins' which are more trafficked than the thinner ones. There are almost no straight lines, or vistas, and the lines branch out into thinner capillaries as you move further away from the main roads.

User experience

Below you see a simple diagram that illustrates my personal experience of Rome's soundscape.

Sonic experience

The graph shows that I think the traffic is undulating, while still quite strong at its peaks, it is not overwhelming or a constant drone.

When it drops to its lower pressure, soundmarks can be heard as well as conversations.

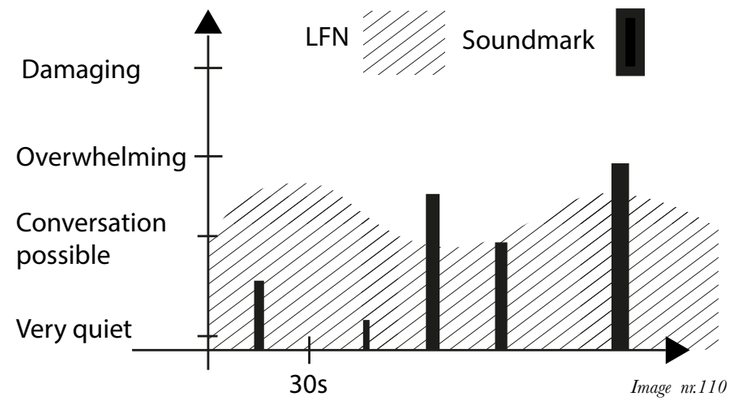


Image nr.110

LFN stands for Low Frequency Noise, usually caused by motorized vehicles. The y-scale indicates loudness, and the x-scale indicate time-intervall.

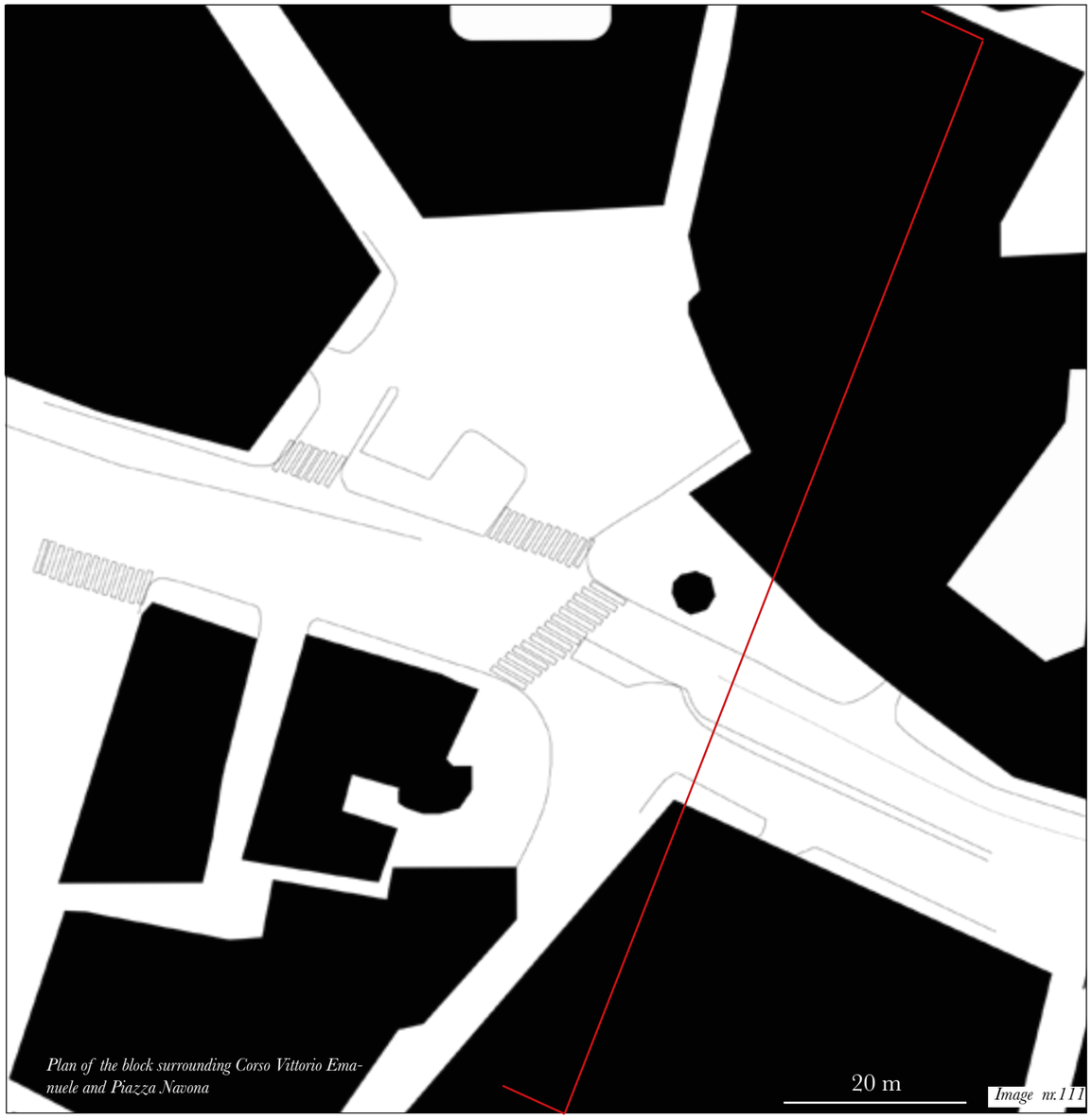
18 - **Ant trails**: the seemingly random pattern of movement in a landscape (urban or rural alike) and diagonal paths chosen for optimization of path of least resistance

Height-to-width ratios

This area is in central Rome, the way into Piazza Navona can be seen in the top right quadrant.

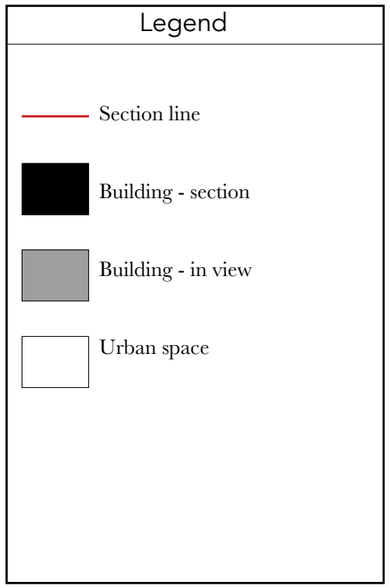
I chose to illustrate this area because it was here that I found evidence for my idea that the organic grid offers a more diverse soundscape. This is also where I came up with the word soundpocket. I also understood the power of morphology and its effects on urban soundscapes.

So, this is a very special place for me as it is so rich in sonic experiences, acoustic properties, psychoacoustics and urban morphology.



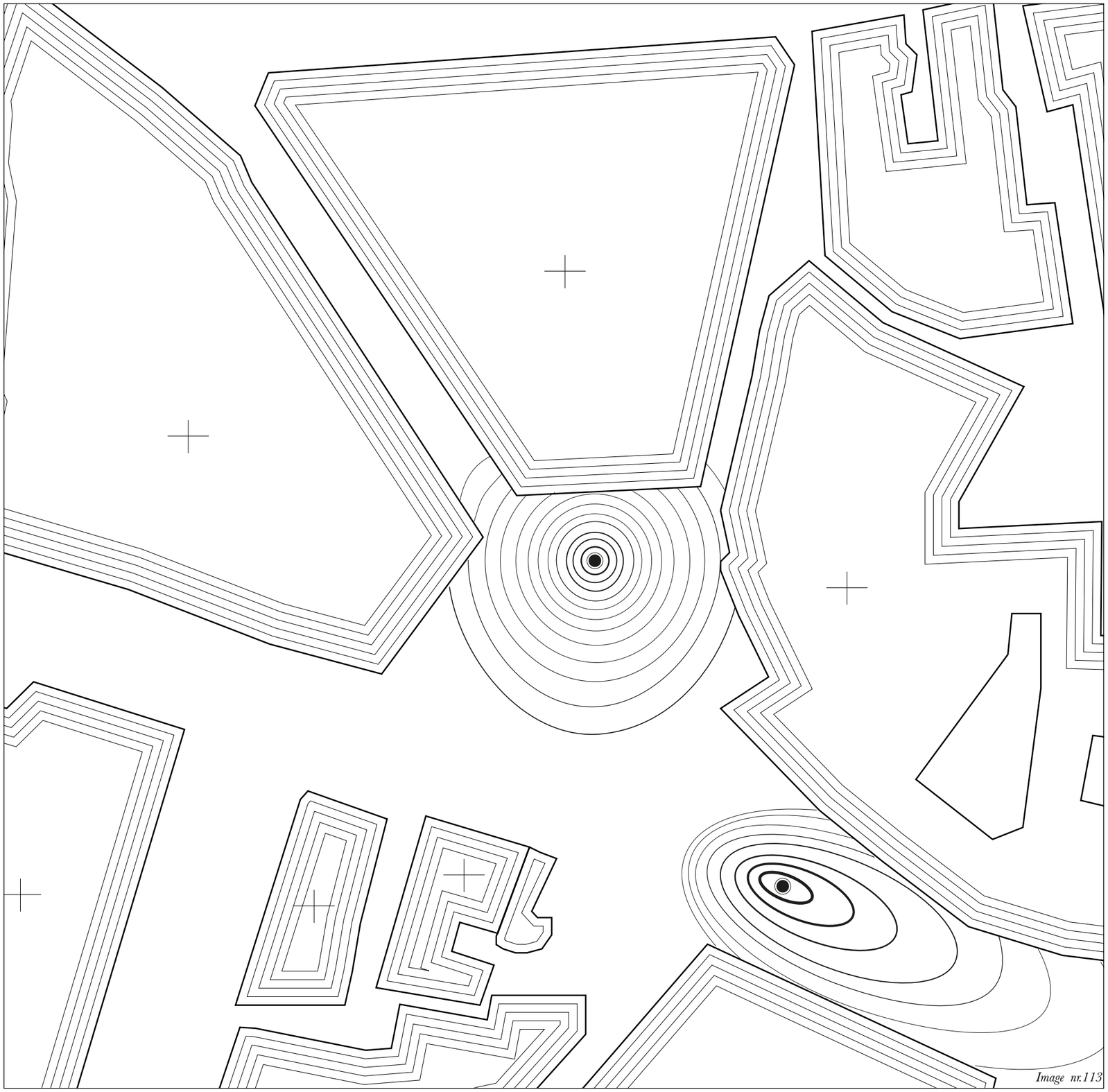
Plan of the block surrounding Corso Vittorio Emanuele and Piazza Navona

Image nr.111



The plan shows primarily the constellation of buildings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings.

Image nr.112



Legend

Sound source

Sound sphere

Building

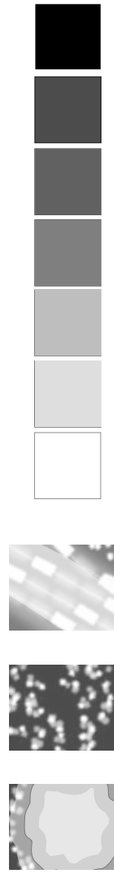
Urban space

Aural topoghraphy

The area shown here is relatively level in terms of building topography. The urban spaces are varied in size and shape and the connections between two larger, open spaces are tight and angled, which prevents sound leaking from one space to the other.

Spatio-sonic illumination of Corso Vittorio Emanuele and Piazza Navona.

Image nr.114



Quiet/uncharted

Moderate volume

Very loud

Vehicles

People

Fountain

Spatio-sonic illumination

In the top of the image you see the busy Piazza Navona and one of its big fountains. At this particular time of day, temperature and sun angle, the crowd gathered on one side to avoid the burning sun.

There is a considerable amount of people in the Piazza, but when they enter or exit it is more like a trickle along 'ant-trails' and not a herd running on the plains.

The alleyways are a thoroughfare but still fairly quiet due to the physical limitations and mitigation of sound. They are also angled away from the main street, effectively cutting off the noise from the cars on the main road.

The plan shows primarily the constellation of buildings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings. The white dots are people and the white rectangles are vehicles. The distance between the dots is approximately 13m which gives a speed of 60km/h.

Shapes

Many buildings in Rome are chamfered at the corners and/or in a tilted angle towards a square or crossing.

The buildings tend to be formed after the urban space, and not the other way around.

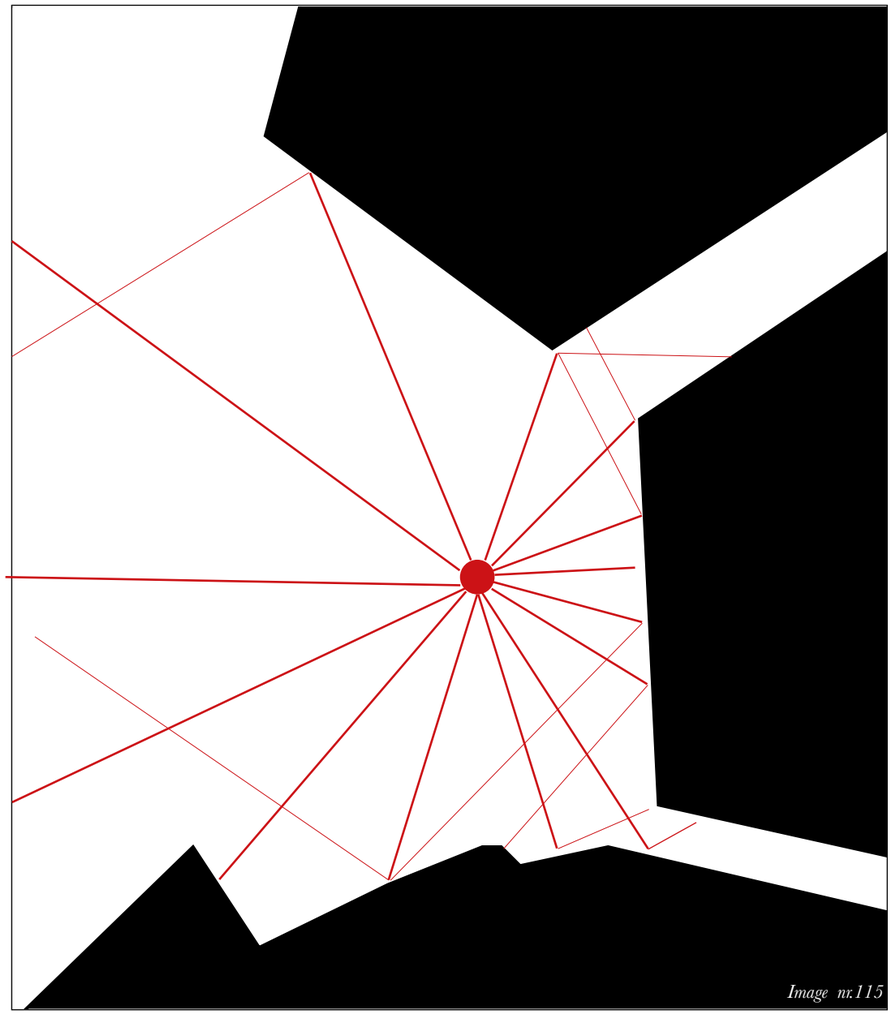


Image nr.115

Shapes - urban space

The urban space in Rome is like branches with twigs growing out of them and on the twigs are even finer, thinner sprouts.

The narrow and angled passages effectively stop a lot of the sound that is emitted from the main road from spreading further into the nearby blocks.

Shapes - buildings

Chamfered or stepped corners and/or placed in a tilted angle towards a square or crossing.

Because the shape of the space is irregular, the acoustic properties helps disperse sound instead of enhancing them between parallel walls.

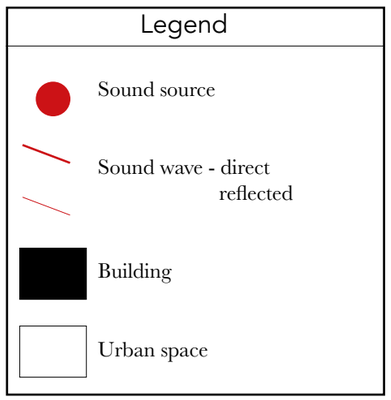


Image nr.116

Shapes - facades

The architectonic 'expression' in Rome is very three-dimensional. The facades are almost never a flat, slick surface. They are heavy, made out of stone and mortar.

The window lintels are heavy and protruding. Pillars are thick and high and the windows are dressed with shutters.

Facades can also be covered with thick, heavy, green climbers. And sometimes sculptures are set into the facade in quite unexpected ways.


Image nr.117


Image nr.118


Image nr.119

Image nr.120


Image nr.121


Image nr.122

Case-specific morphologies

Form	Psychoacoustic properties
Branching streets (going from thick to thin, angled towards main roads)	Sound mitigation by cutting off the sound waves's path.
Chamfered corners	Sound is not amplified as strongly as it would with parallell walls.
Extruded lintels	Helps disperse sound waves a little, on a micro-scale.
Extruded facade (stones)	A little extra dispersion for sound waves on a micro-scale.
Pillars	Retracts the immediate entrance from the street by a few meters.
Window shutters	More beneficial for the interior sound climate than exterior.
Green climber (on surface of facade)	Adds a little bit of extra 'fabric' to the facades, mitigating sound in the higher frequencies.

Citygrid of Johannesburg

Image nr.123

Johannesburg

Founded: 1886 A.D

Population: ≈ 5,6 million (2019)

Area: 1 645 km²

Weather conditions (during my visit): +20C°, no rain

Grid type: right angle, cut-off

Keynotes: Vehicles

Soundmarks: Electrical fences

Signals: Silence

The grid

I labeled the grid type as right-angle and cut-off. That is because the scars of apartheid is not only psychological it is very evident physically and architecturally. It is very difficult to go north-south in Johannesburg, because it was meant to be difficult.
The workers were supposed to get to work, but not frequent any places where they don't belong outside of working hours.

Sonic experience

The diagram of Johannesburg is a bit odd, because sometimes the noise levels drop to almost zero.

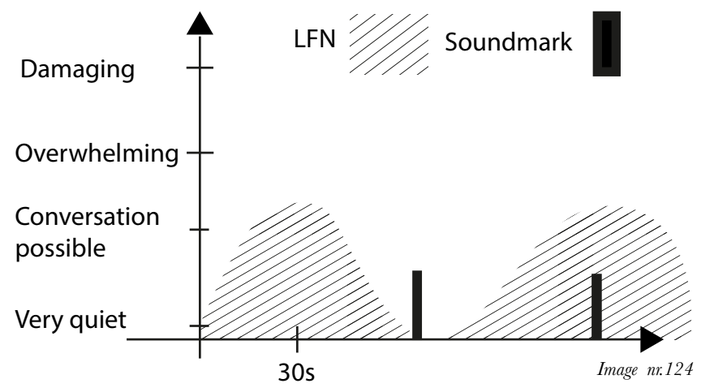


Image nr.124

LFN stands for Low Frequency Noise, usually caused by motorized vehicles. The y-scale indicates loudness, and the x-scale indicate time-intervall.

Height-to-width ratios

This is a residential area called Primrose Terrace in Johannesburg, near the Ponte Tower. It is a relatively 'dangerous' area, but in the right company and time of day it is an interesting place.

At the time of day that I was there it was very quiet and still. I was almost chocked to see the scale of the buildings and urban spaces.

The blocks were enormously tall and densely packed with apartments in pigeon-hole like facades.

And, for some reason, a group of tiny little villas/cottages stood in their shadows.

I thought it was very peculiar with such extreme differences in height in one block. Neither of the two types of buildings would seem to benefit from their own shape, socially or spatially. The landscape, and the sonic landscape in particular, becomes fragmented and prone to aural voids.

The advantage of such tall buildings is that you get a great view of the urban soundscape when you're at the top. On the downside you are very far from the street and this disconnection between urban space and gated buildings makes the streets feel even more dangerous, because there is nowhere to take refuge.

The space between the taller buildings across the street form one another is huge and unwelcoming. The street isn't very busy since it is almost a dead-end, so it feels even more vast because of the aural void. This is probably the direct opposite of Los Angeles both in terms of aural morphology. See section on Los Angeles for further elaboration.

Primrose Terrace, Johannesburg

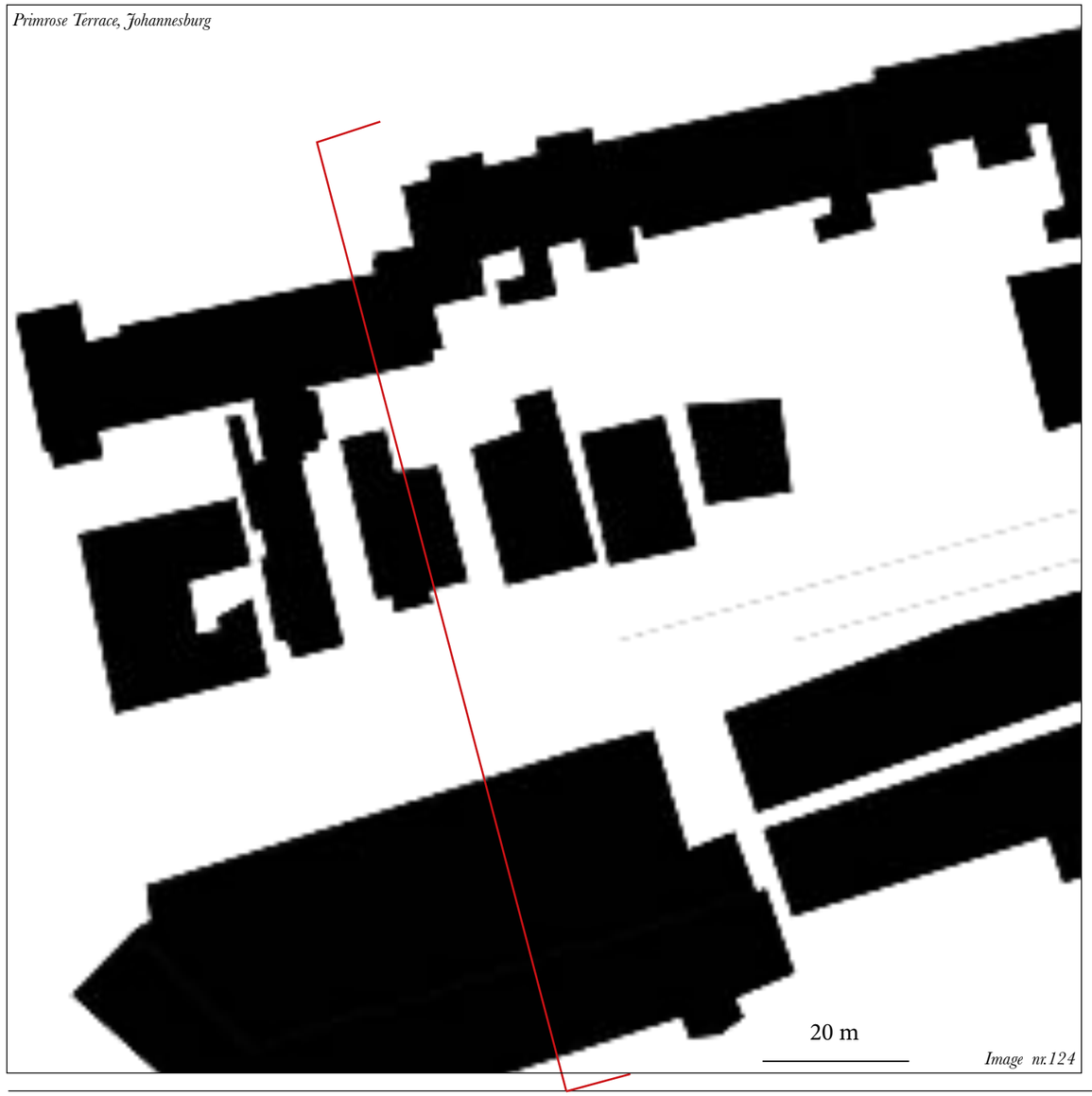
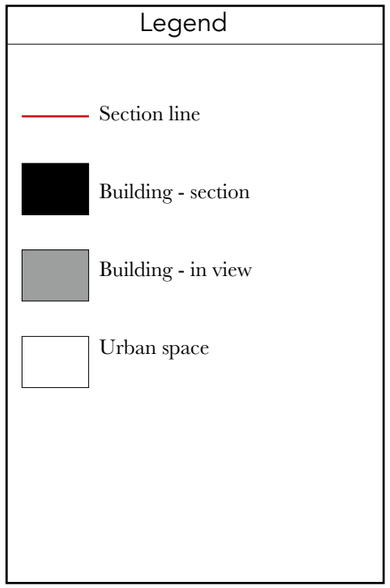


Image nr.124



The plan shows primarily the constellation of buidings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings.

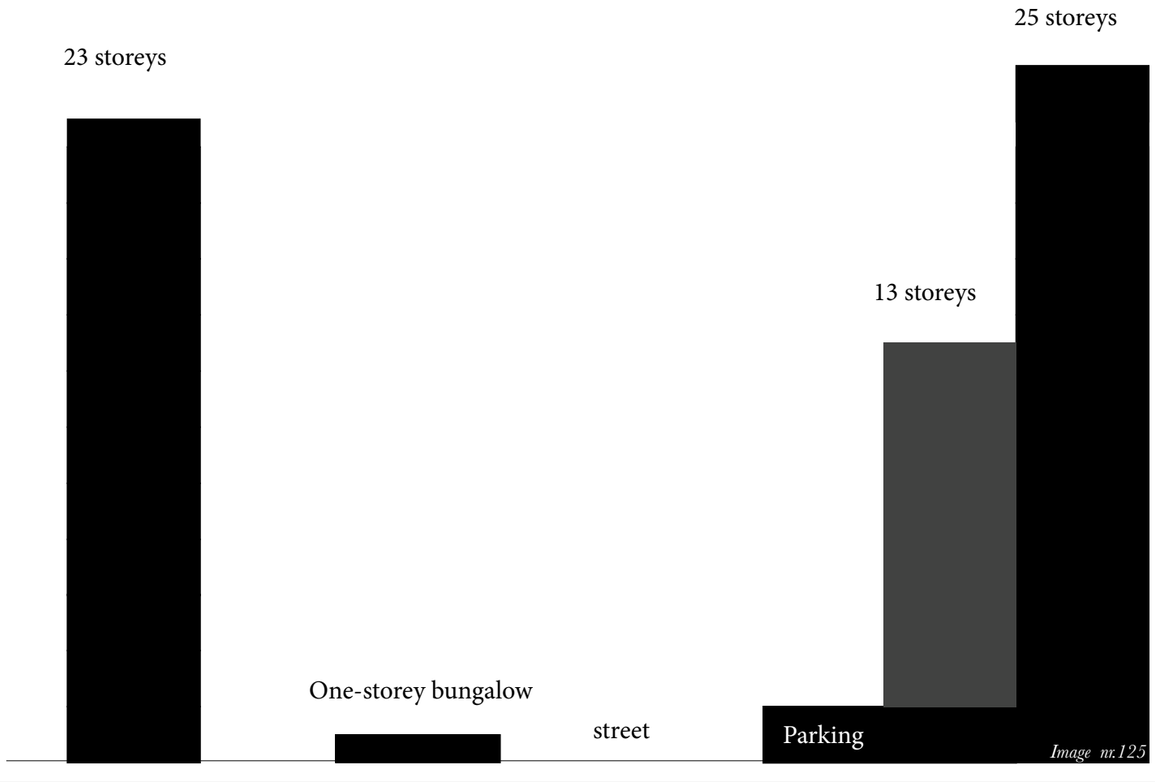
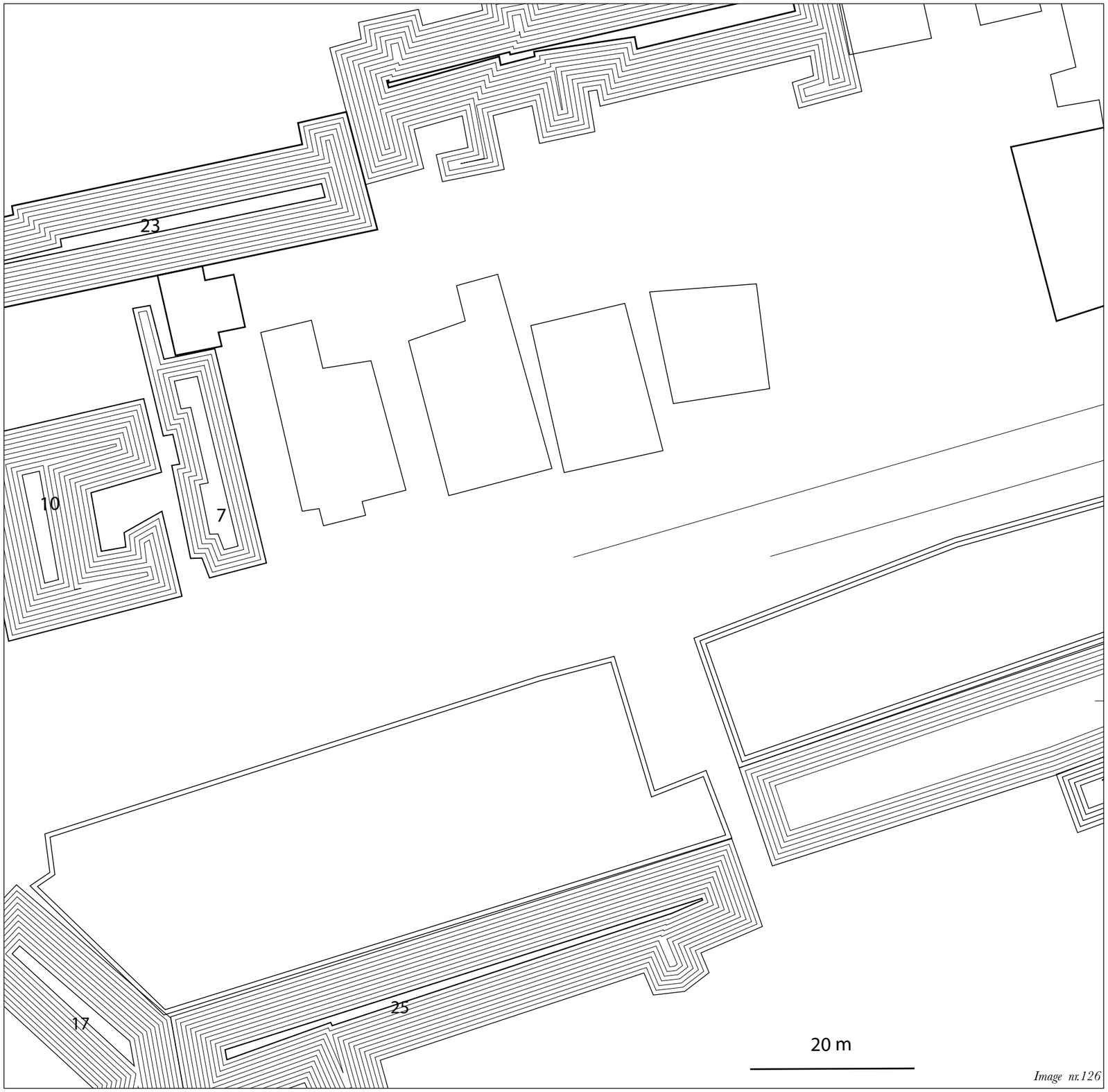


Image nr.125



Legend

Sound source

Sound sphere

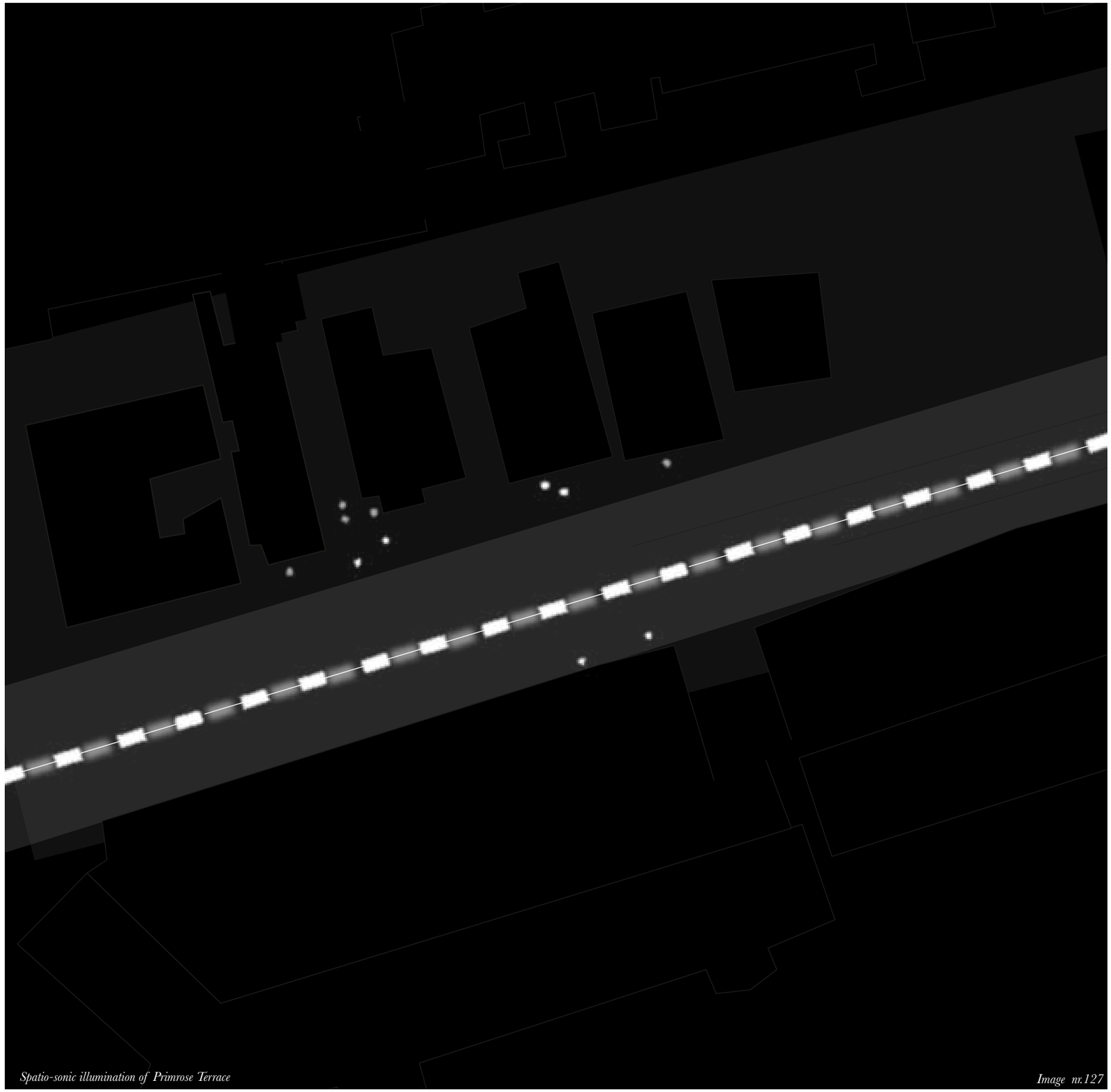
Building

Urban space

Image nr.126

Aural topoghraphy

The buildings are extremely high or low and the urban space is vast and with little to no variation of shape and size. The connections between one space and another are of conventional size and sound spills from one space to the other with ease.



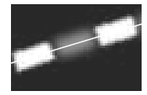
Spatio-sonic illumination of Primrose Terrace

Image nr.127

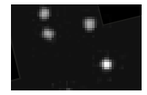
Quiet/uncharted

Moderate volume

Very loud



Vehicle



People

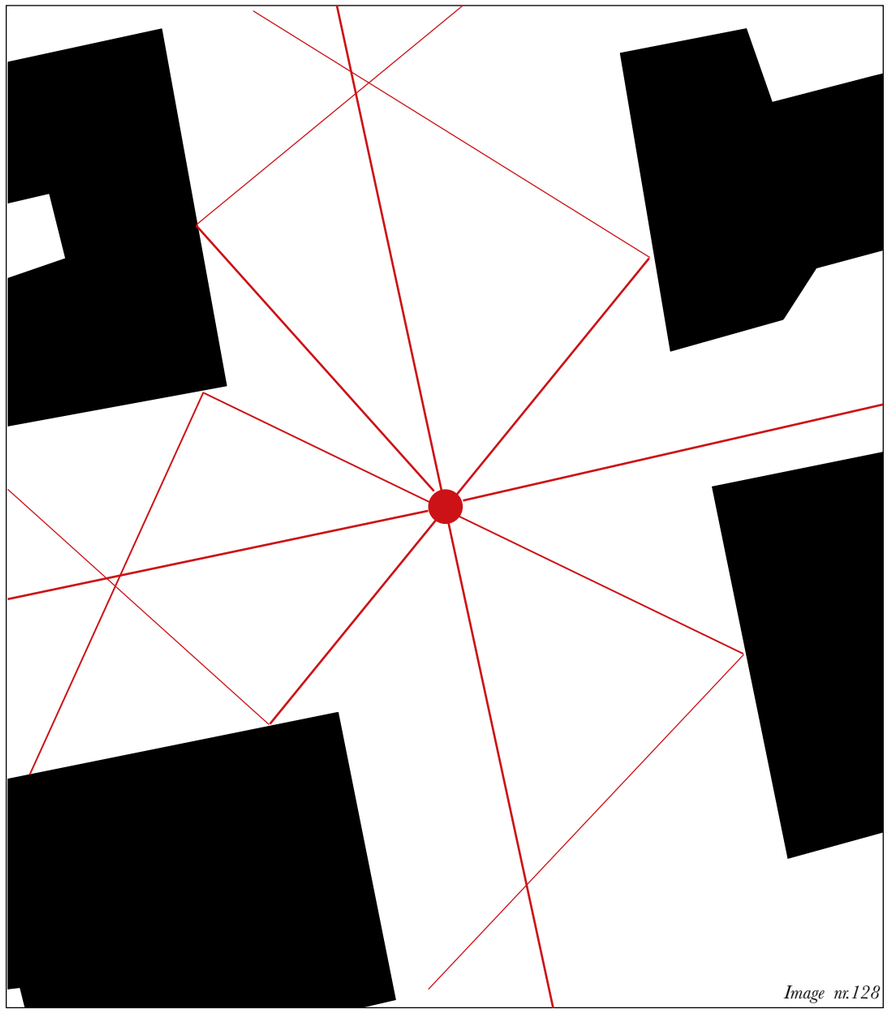
Spatio-sonic illumination

This is the illumination map of the area and it is one of the darkest and greyest maps of all of the case studies.

There was one car, driving slowly because it was heading to the parking garage, that passed us on our walk through the area and there were some people out and about in front of the bungalows, but apart from that it was very quiet and desolate. The aural void was very present and heavy.

Shapes

Many buildings are very tall and skinny, usually with a ground floor for parking.

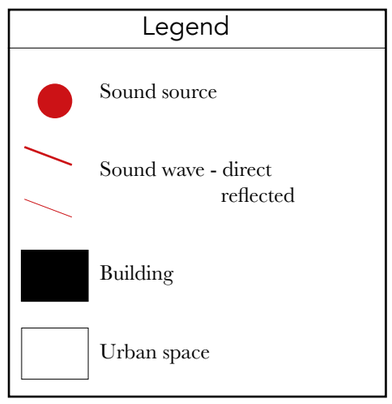


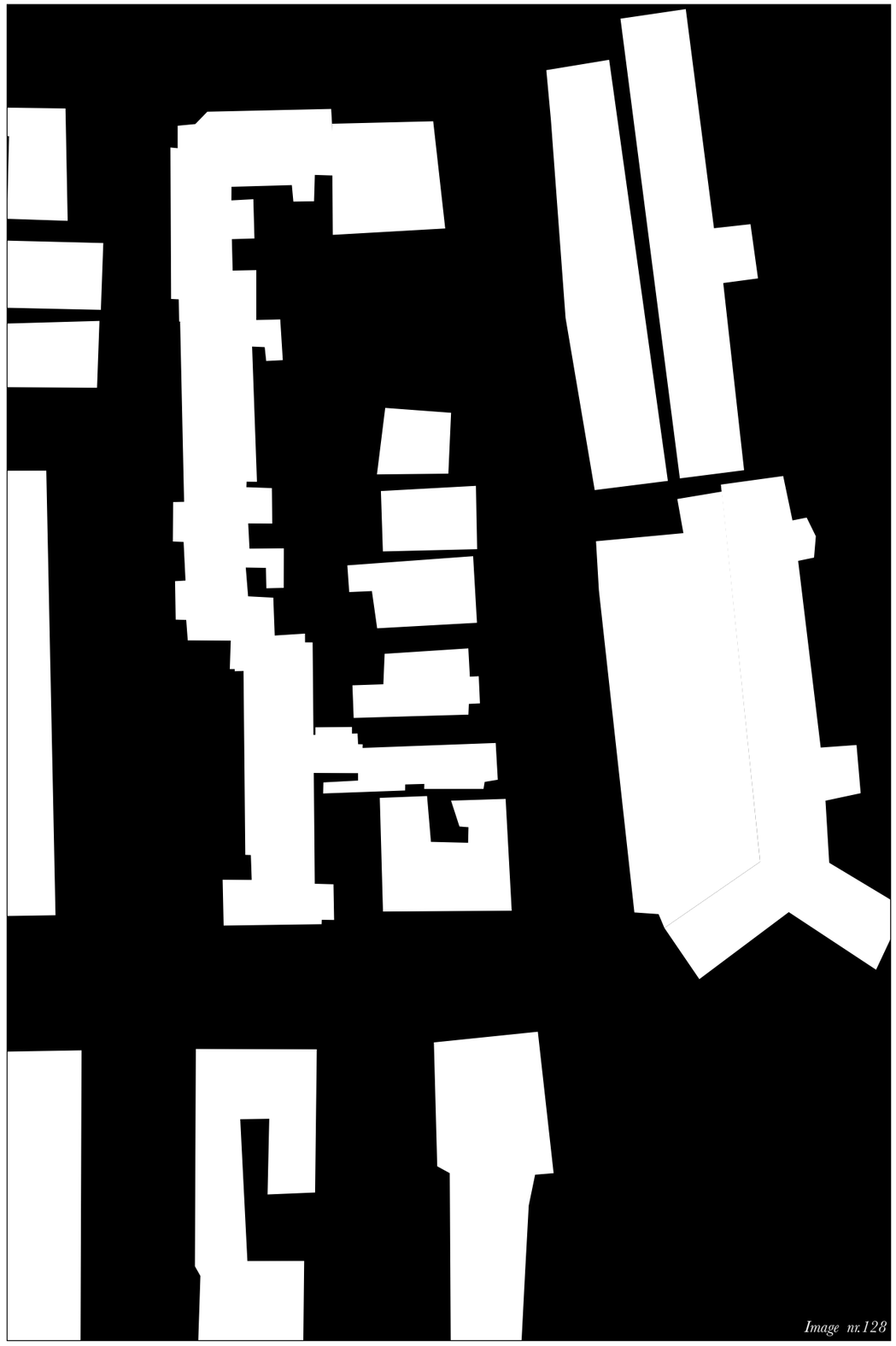
Shapes - urban space

The urban space in Johannesburg looks generous with the very tall and skinny buildings. But the quality of the space is not that inviting and I can't help but think that lower and broader buildings would have been preferred to these 20+ storey residential buildings.

Shapes - buildings

In general, the building corners are shaped "normally", i.e right-angled. They do, however, pull in from the sidewalk, leaving a fenced buffer zone of maybe a meter or two from the public space.





Shapes - facades

The general impression of facades in Johannesburg is that they are basically infilled material in to a structural grid.

There were lots of different colors and sizes of the grids, but they pretty much looked the same.

Image nr.129


Image nr.130


Image nr.131


Image nr.132


Image nr.133


Image nr.134

Image nr.135

Case-specific morphologies

Form	Psychoacoustic properties
Scavenged materials (Plywood, posters, left-over building materials)	Very thin materials, no insulation from weather or sound.
Framed facades (A structural grid filled with light materials)	Tends to create a very cohesive and flat surface, even if there are balconies.
Corrugated material (mostly found in shanty towns)	Very thin materials, no insulation from weather or sound.
Posters for decoration (shanty town)	Purely used for visual decoration.
Facade used as message board	An interesting, unplanned use of facades.
Barbed wire and electrical fences (villas)	A buzzing sound that fills the neighbourhood after dark. A (false) sense of security.
Savannah climate (mild temperatures)	Less prone to extreme shifts in temperature or wind turbulence which can have unwanted acoustic side effects

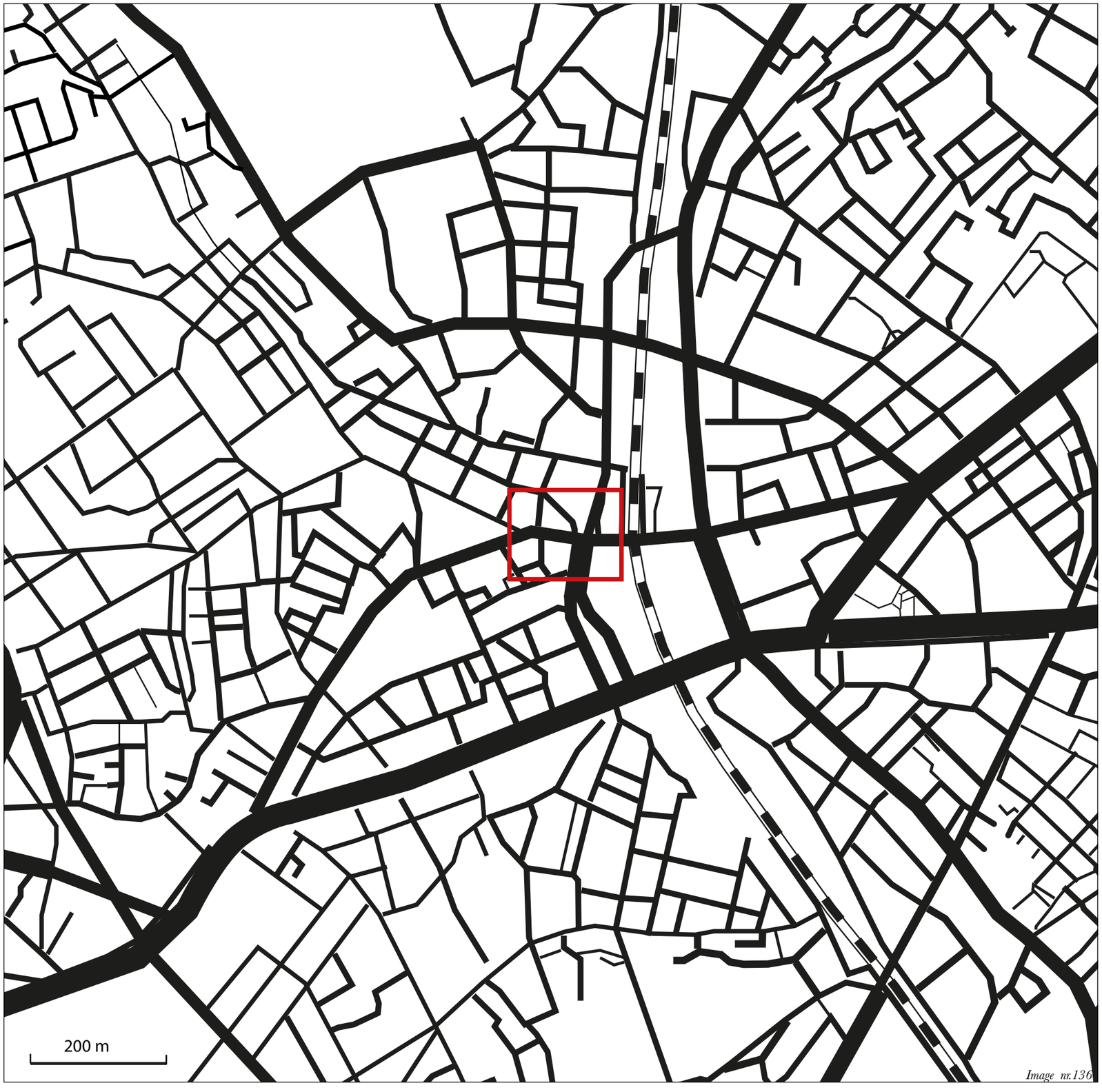


Image nr.136

Tokyo

Founded: 1457 A.D

Population: ≈ 14 million (2019)

Area: 2 193 km²

Weather conditions (during my visit): +20C°, light rain

Grid type: organic, ant trails

Keynotes: Massive crowd movement

Soundmarks: Speakers

Signals:

The grid

This map of Rome (partial), demonstrates the organic grid. It has thicker 'veins' which are more trafficked than the thinner ones. There are almost no straight lines, or vistas, and the lines branch out into thinner capillaries as you move further away from the main roads.

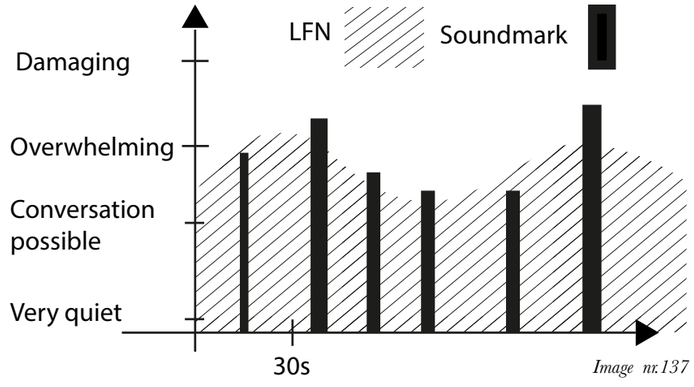


Image nr.137

LFN stands for Low Frequency Noise, usually caused by motorized vehicles. The y-scale indicates loudness, and the x-scale indicate time-intervall.

Height-to-width ratios

This is Shibuya Crossing, where thousands of people cross the street every hour. I was fascinated by the amount of people, cars and the fast intervals with which they moved like a fluent, well-organized stream.

It is of course a noisy place, or at least it is not quiet given that there is so much traffic going on in and around this junction (cars, pedestrians and a very big railway-station).

But what was the loudest, or noisiest thing in this place? It wasn't the cars, it wasn't the mass of pedestrians. It was the loud speakers on every building facade. I don't know if it is intended as masking agents or purely for commercial uses. Some of the speakers only played music and I thought about the recorded birdsong in the subway station and I believe that this too is an attempt to keep the public in good spirits.

For someone who isn't used to it, I found it quite annoying, because it wasn't the same music played everywhere so I just got to hear fragments of songs that shifted both in volume and sonic quality.

I would personally prefer just to have the 'natural' urban sound and if needed I would use headphones and listen to the music of my own choice. This is one of the main reasons why i don't appreciate digital sound modification to urban spaces. The other reason is that I actually enjoy the sound of a city. I like the chatter of people, birds, dogs, and the railways and cars and whatever other sounds that are produced by the urban mechanisms and its users.

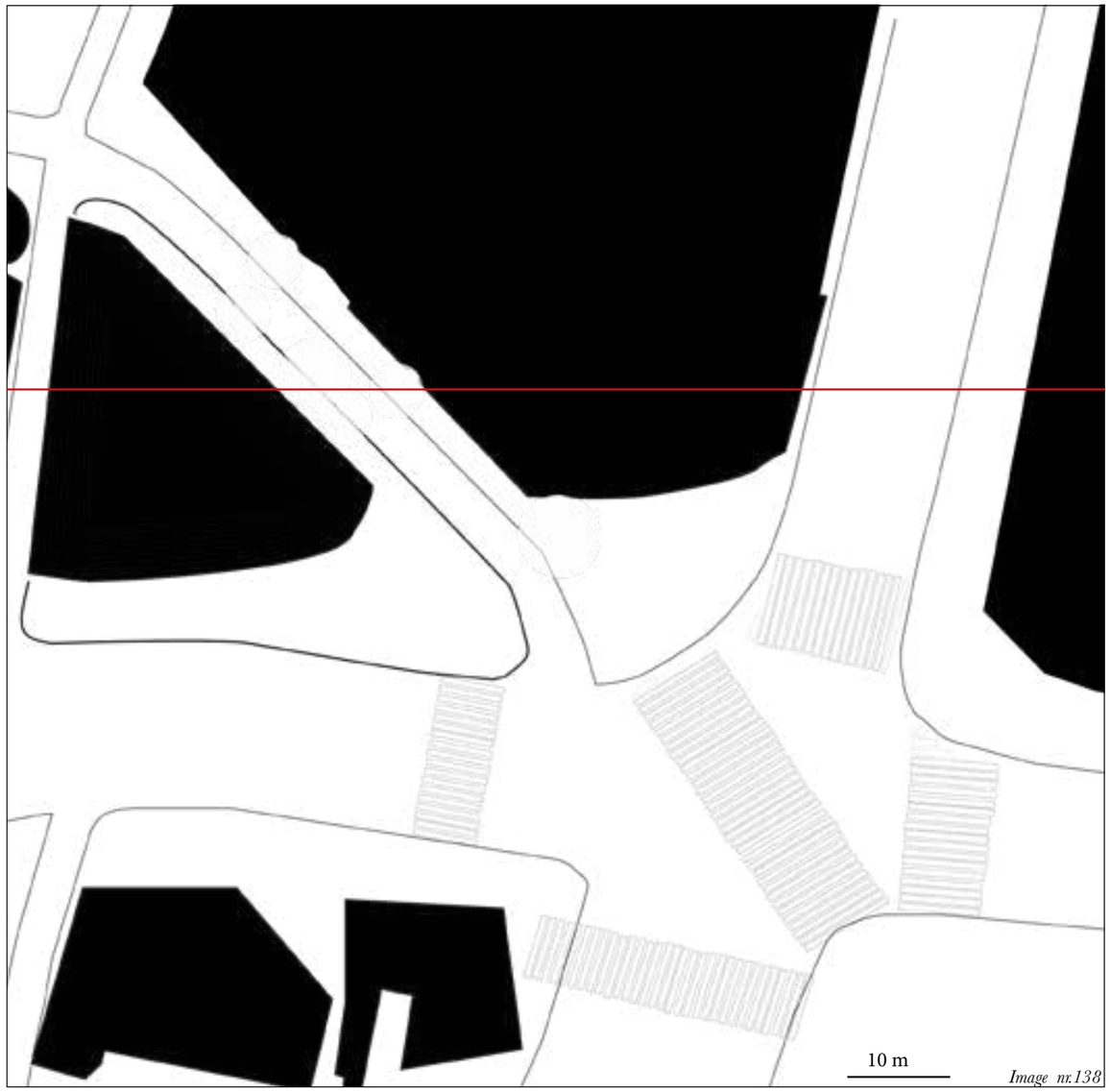
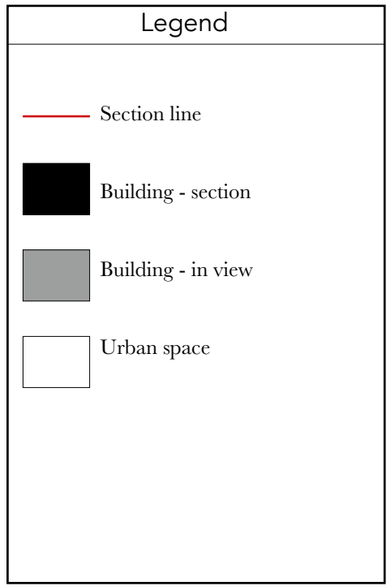
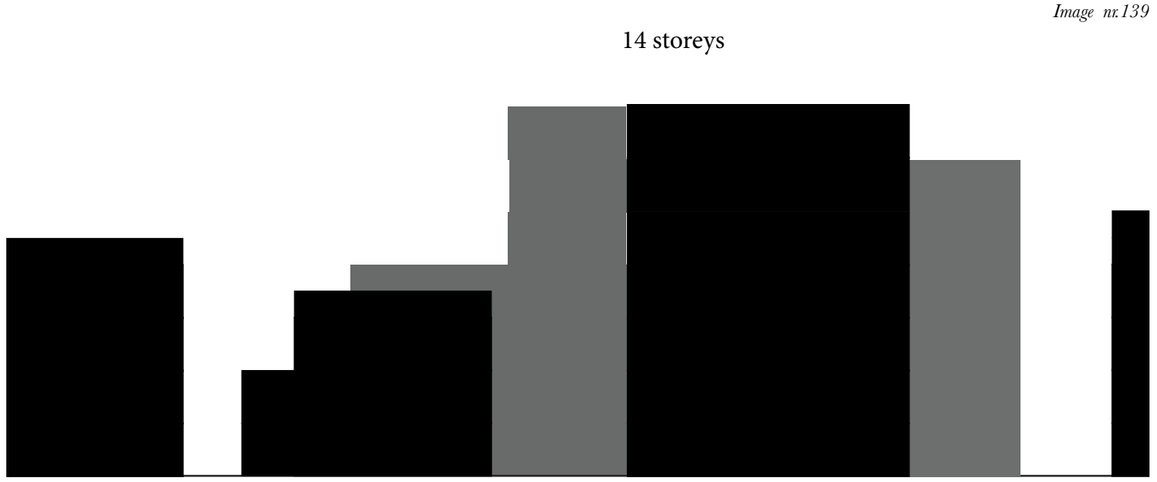


Image nr.138



The plan shows primarily the constellation of buidings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings.

Image nr.139



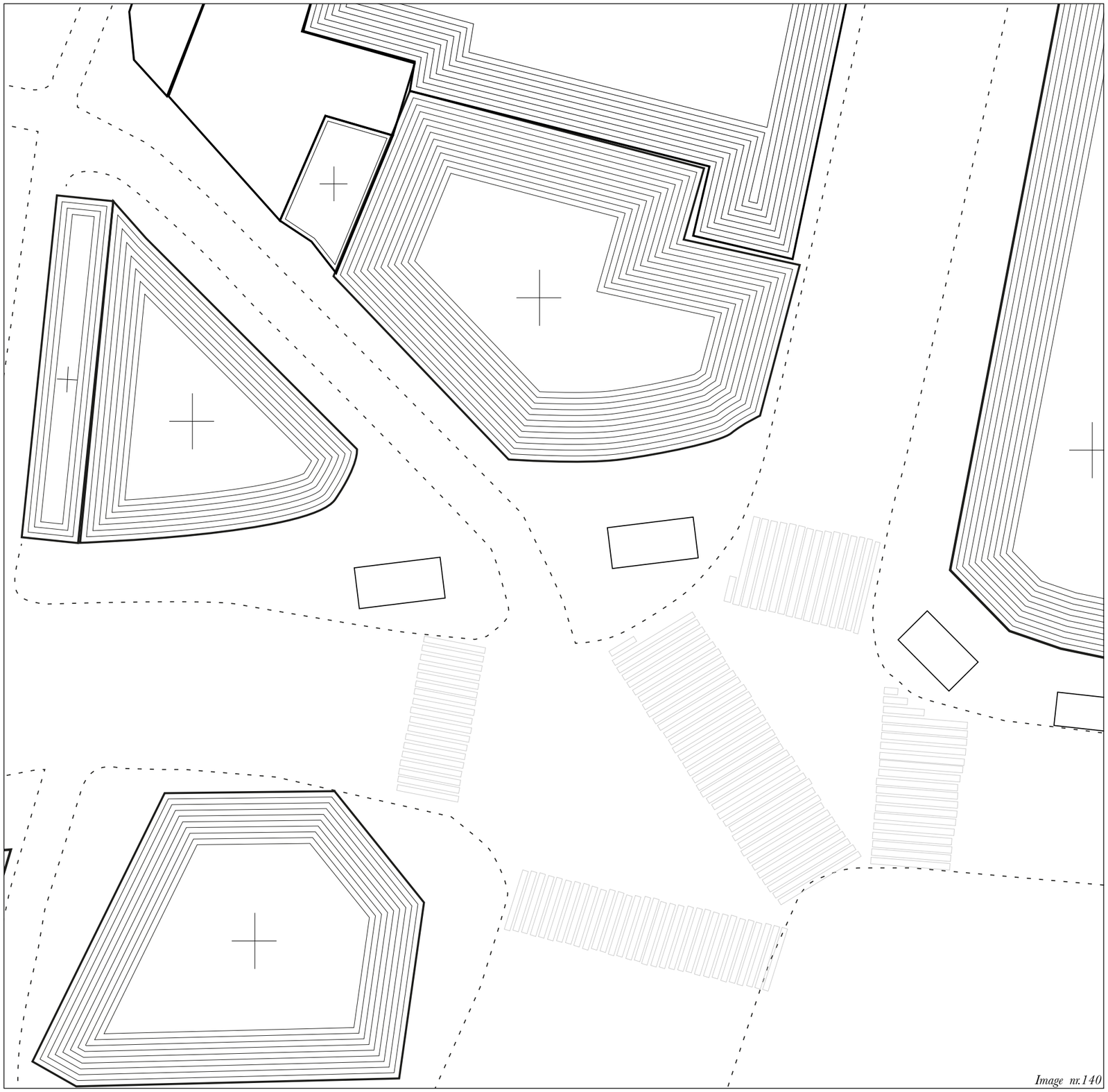


Image nr.140

Legend

- Sound source
- Sound sphere
- Building
- Urban space

Aural topoghraphy

The buildings in Tokyo, and particularly in the area surrounding Shibuya Crossing, are very varied in height and shape. A twelve storey building can have an adjacent building of one or two storeys. The layout is diverse, tightly knitted and the word metabolic is perhaps best used to describe this weave of urban fabric.

The connections between open urban spaces are larger than Romes, but more organic and malleable than in Johannesburg. The connections themselves are more like medium sized urban spaces, with activities and large masses of people, and therefore doesn't produce the same drop in sound pressure as in Rome.

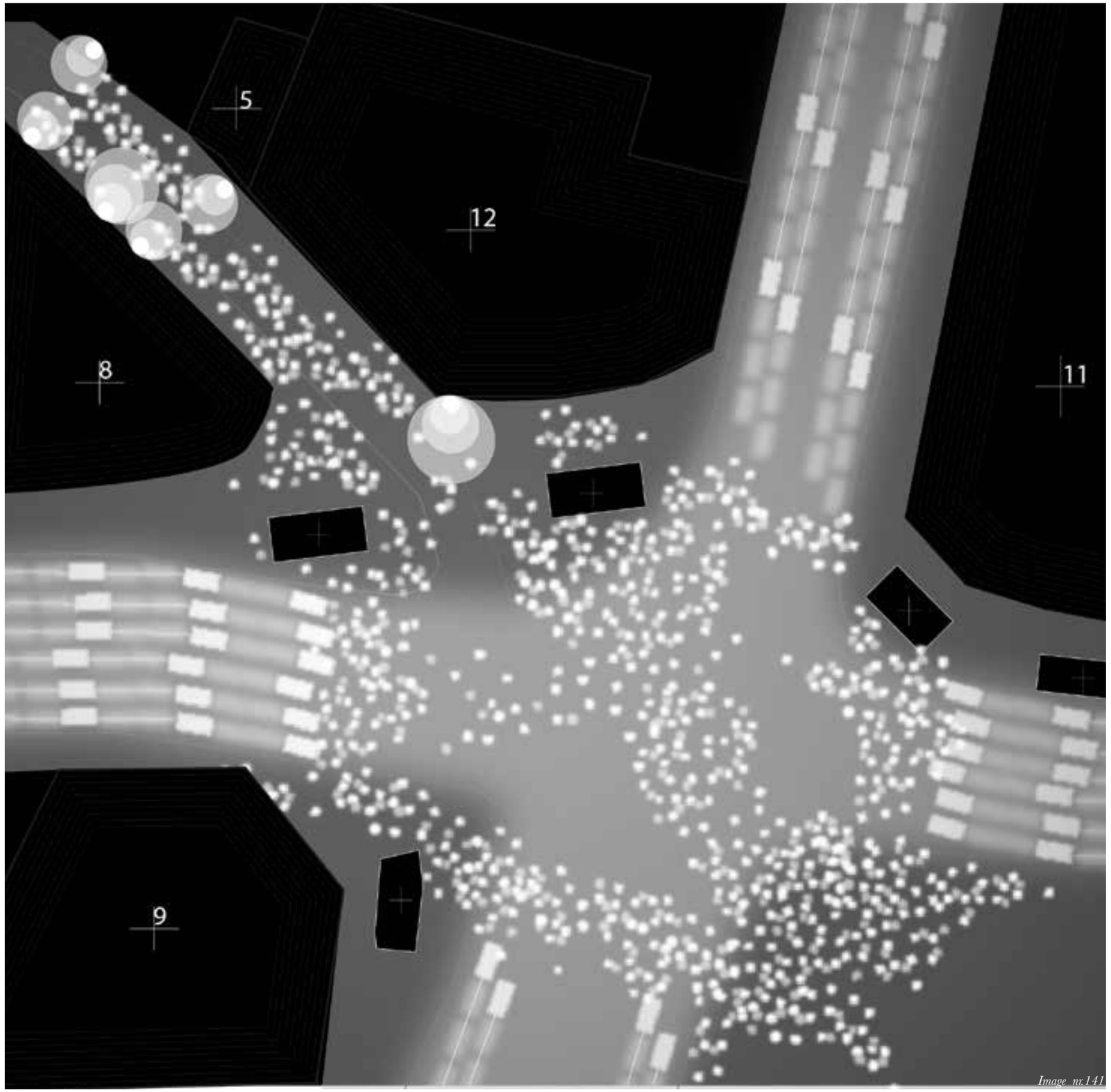


Image nr.141

Quiet/uncharted

Moderate volume

Very loud

Vehicles

People

Loudspeaker

12 Rooftop (number indicates nmber of storeys)

Spatio-sonic illumination

This map shows the incredible mass of movement in Shibuya Crossing, not just pedestrian but also vehicular. Note that there are speakers placed on the buildings. If not for the speakers, the crossing would be surprisingly quiet. The use of car horns were nowhere near the levels of Rome, and people in Japan seem to move more fluently and organized thereby not causing so much noise in terms of noise caused by walking or bicycling.

The plan shows primarily the constellation of buildings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings. The white dots are people and the white rectangles are vehicles. The distance between the dots is approximately 13m which gives a speed of 60km/h.

Shapes

It feels like many of Tokyo's buildings are molded entirely by their context, be it topography or available space between existing buildings. The urban context is organic and metabolic.

Shapes - urban space

The urban space in Tokyo is tightly knit and vary a lot in height, widht and shape.

Shapes - buildings

In general, the building corners are not cut sharply, but rather 'molded' in situ. Sometimes it is difficult to discern where one building ends and another begins.

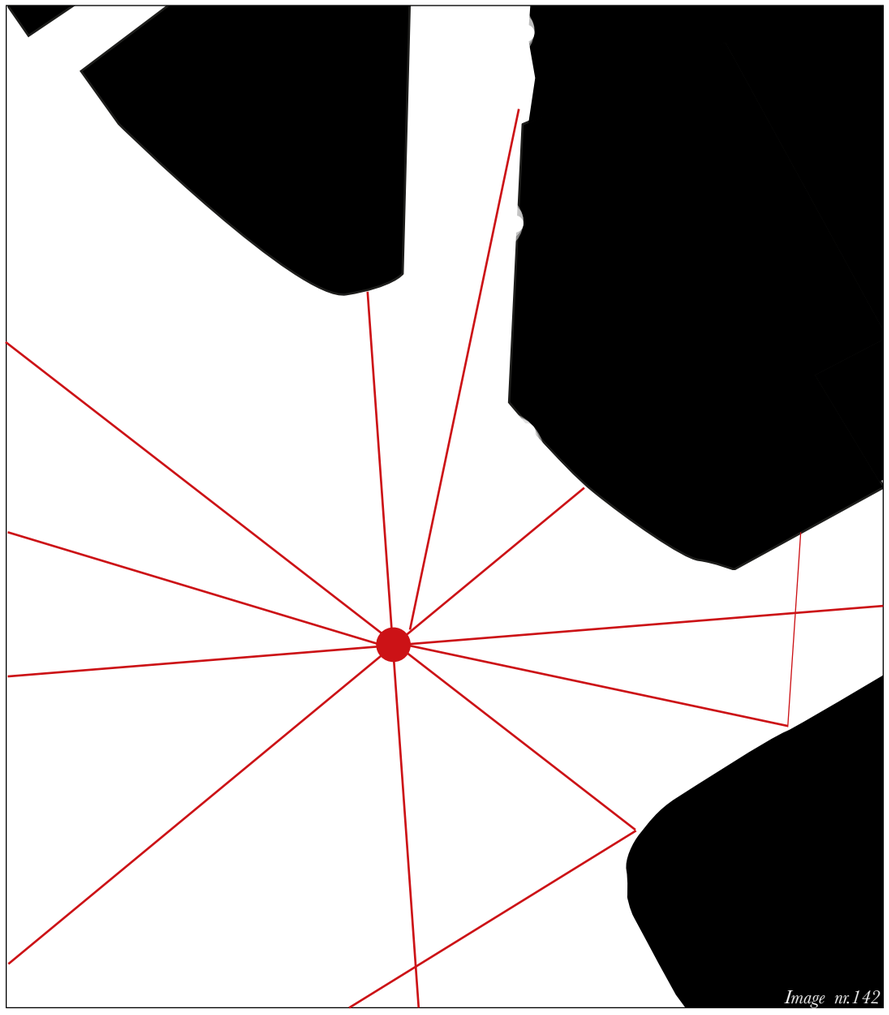


Image nr.142

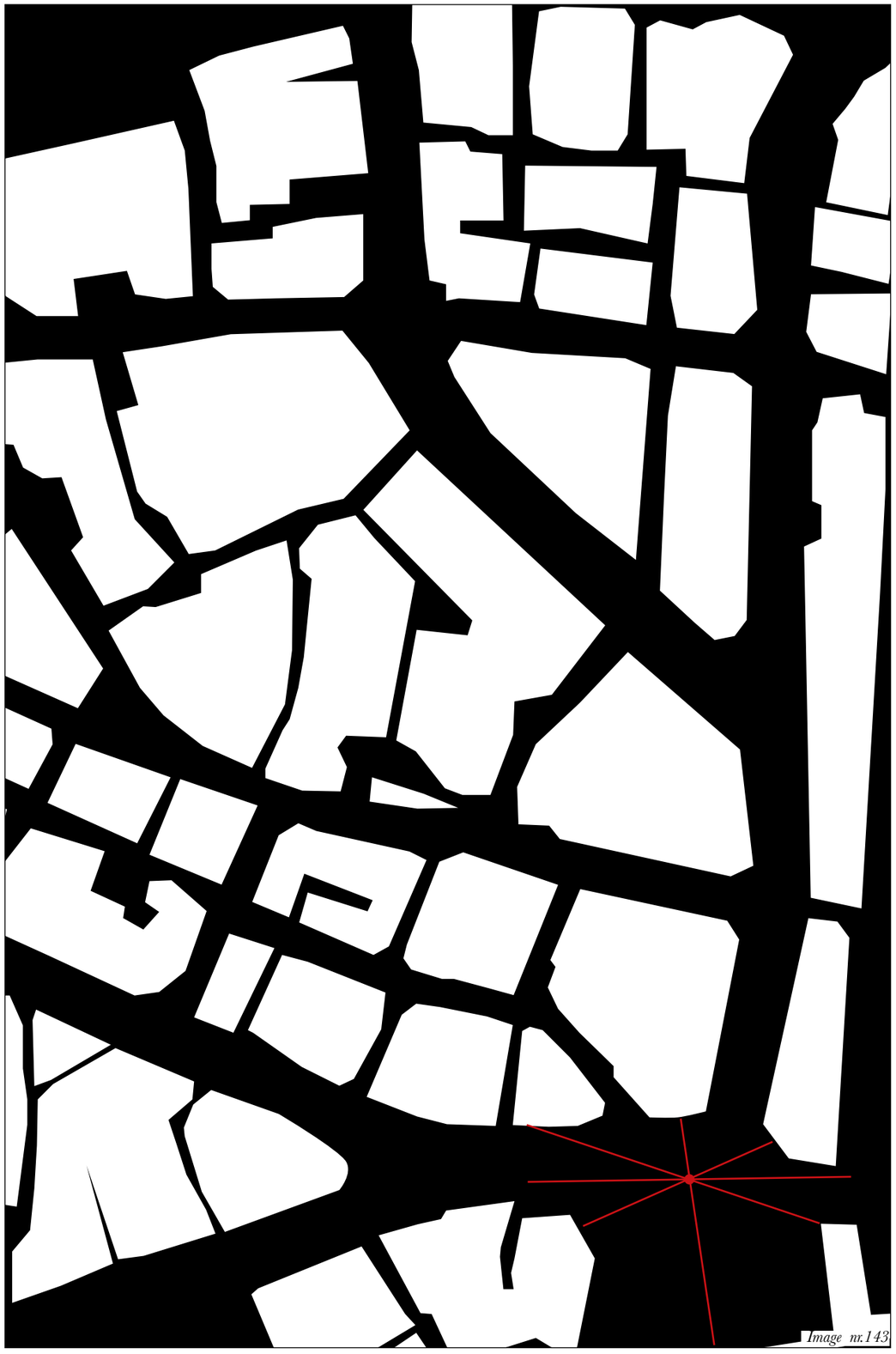


Image nr.143

Shapes - facades

My impression of facades in Tokyo is that they function more as screens than as solid barriers.

They are either used as light shows screens, sales windows or as constructions in which to place speakers. This causes a certain uneasiness for me as I would like to think of facades as a tool to try and remedy noise pollution, not to add even more to it.

Image nr.144

Image nr.145

Image nr.146

Image nr.147

Image nr.148

Case-specific morphologies

Form	Psychoacoustic properties
Screen (facade)	cSreens on the facades produce digital sounds as well as reflected due to flat and hard materials.
Metabolic structure	It resembles stacked matchboxes with protruding windows or openings.
High density	Buildings sit tightly together, noise from balconies or windows spill into the adjacent buildings.

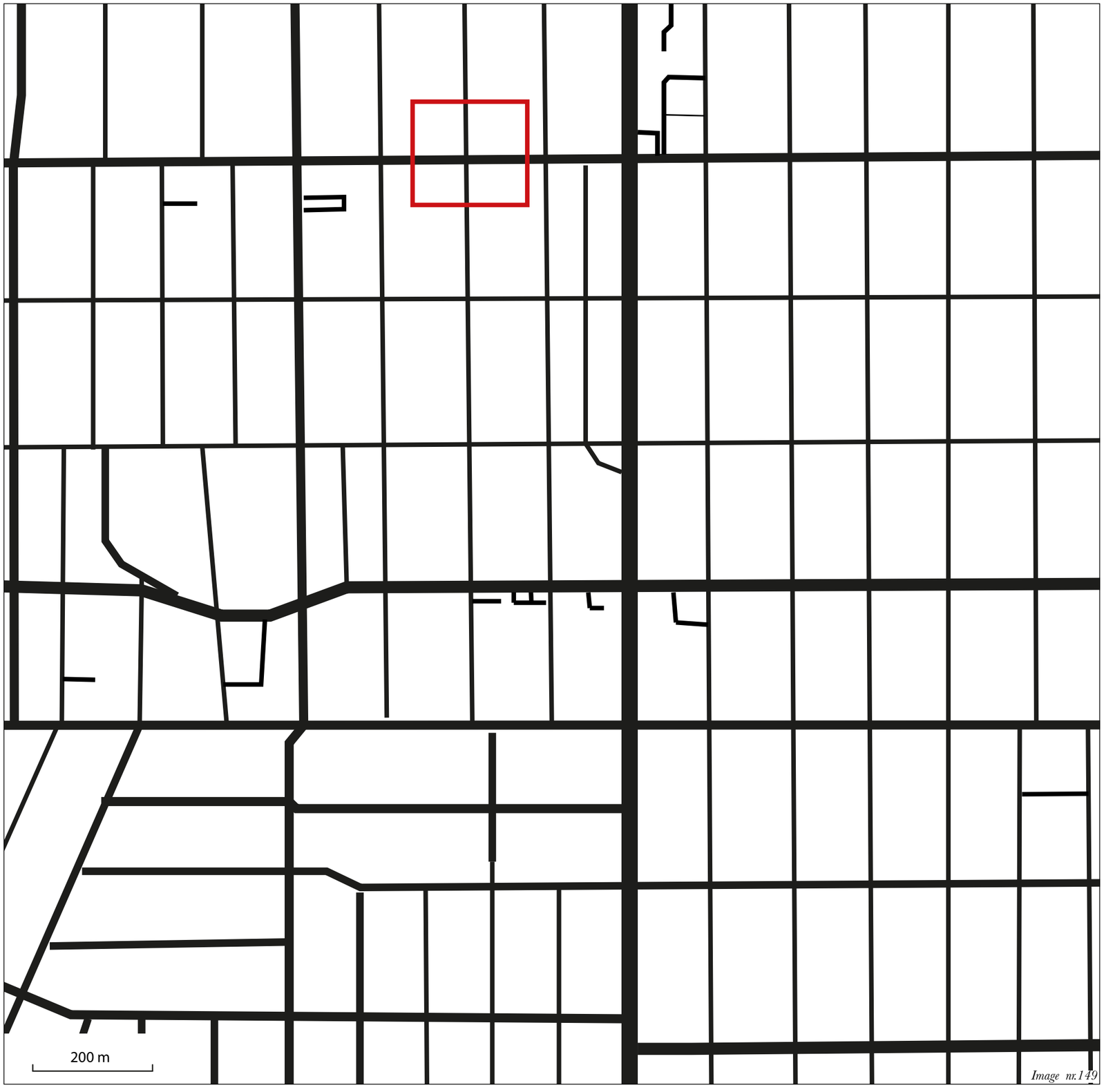


Image nr.149

Los Angeles

(metropolitan area)

Founded: 1781 A.D

Population: ≈ 13,5 million (2019)

Area: 12 562 km²

Weather conditions (during my visit): Hot, drought

Grid type: right angle, sprawl

Keynote: Low Frequency Noise (cars).

Soundmarks: L.A River bridges

Signals: Sirens

The grid

This map of Los Angeles (metropolitan area) clearly shows the rigid, right-angled grid. It is almost impossible to identify specific places, streets or boulevards by looking at the map at this scale.

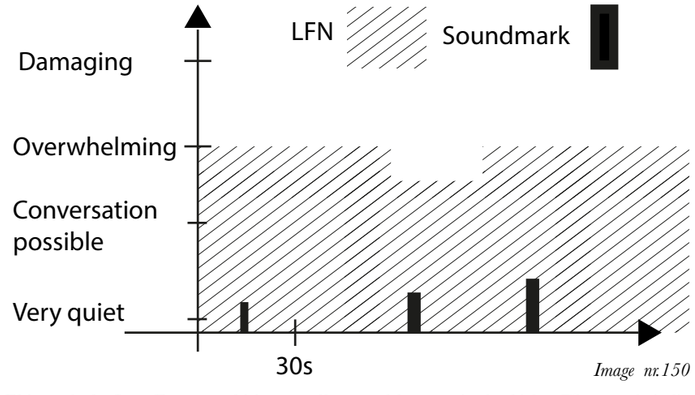


Image nr.150

LFN stands for Low Frequency Noise, usually caused by motorized vehicles. The y-scale indicates loudness, and the x-scale indicate time-intervall.

Height-to-width ratios

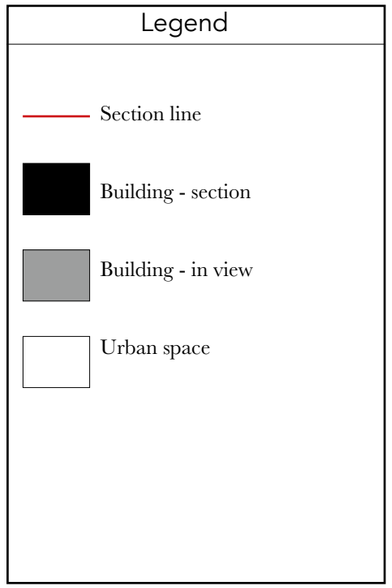
This is a typical scene in Los Angeles metropolitan area (I deliberately chose not to illustrate downtown L.A because it covers a relatively small area and due to lack of height restriction in buildings the sections are exceptionally excessive).

The boulevards and streets meet at right-angled crossings. The height-to-width ratio is extreme and the straight lanes invites for higher speeds than we would normally, with certain exceptions of course, experience in central Stockholm. I even found that the counties can adjust the speed limits to fit with the speed that is used, meaning that if a street has a speed limit of 50 km/h, but mostly people drive at 60 km/h the county can, if they choose, actually change the legal speed limit to 60 km/h. The limit is set by the users and not the other way around!

The height-to-width ratio also allows for sound, or noise, to travel easy and quite a distance.
My experience is that the car noise is like a never-ending stream and little to no signals or soundmarks can be heard or distinguished.

Los Angeles is one of the most extreme Lo-Fi environments I have ever been to. The fact that it is so large and with so little variation makes it one of, or the worst soundscapes of all my case studies.

Image nr.151



The plan shows primarily the constellation of buidings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings.

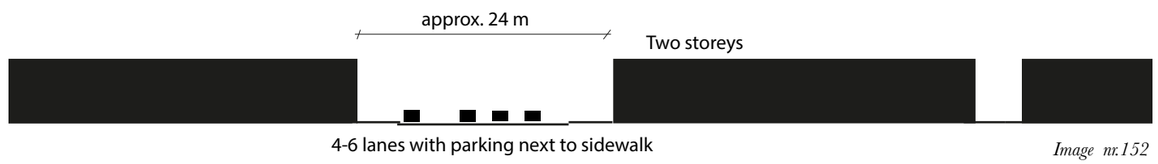
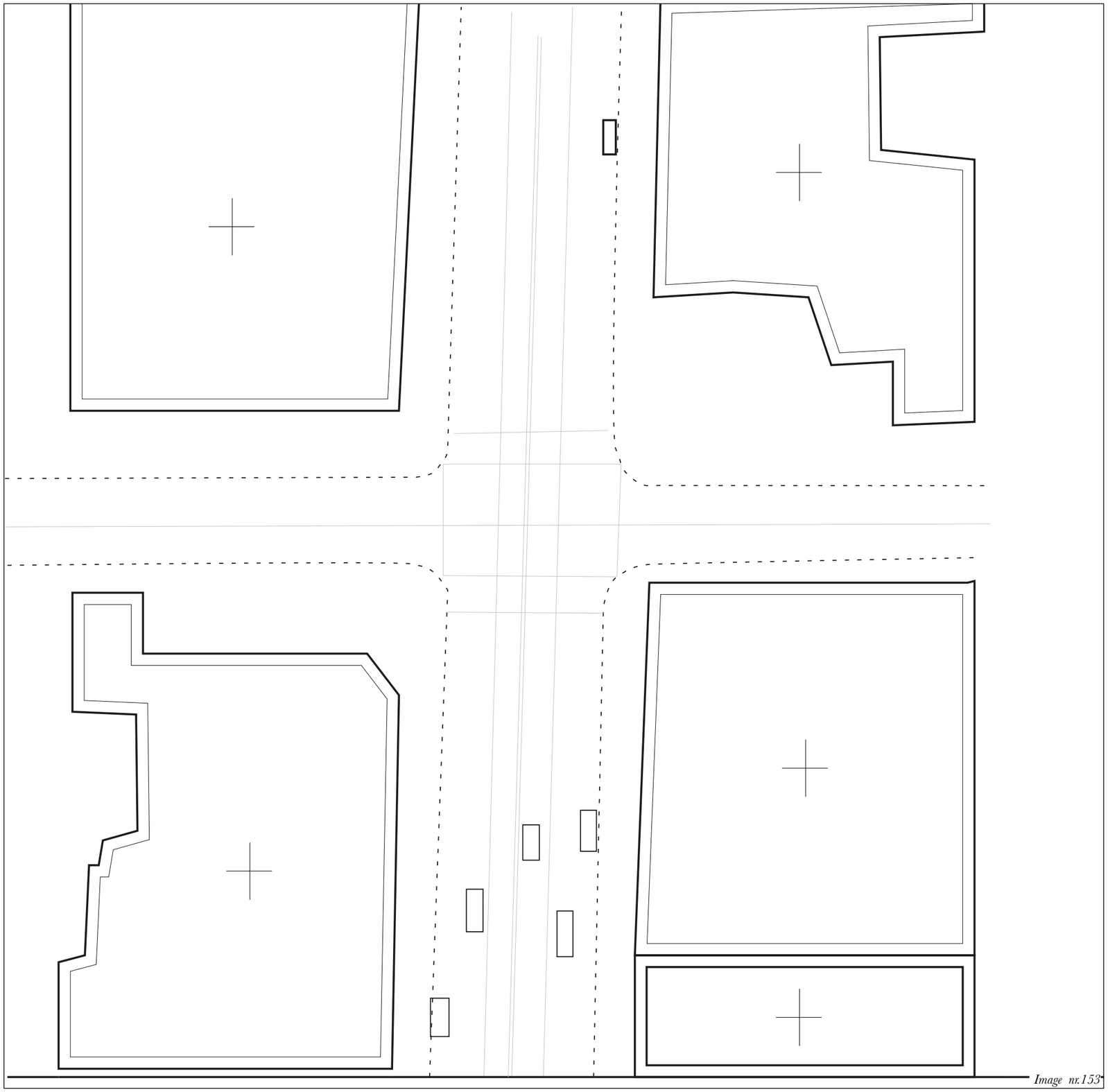


Image nr.152



Legend

Sound source

Sound sphere

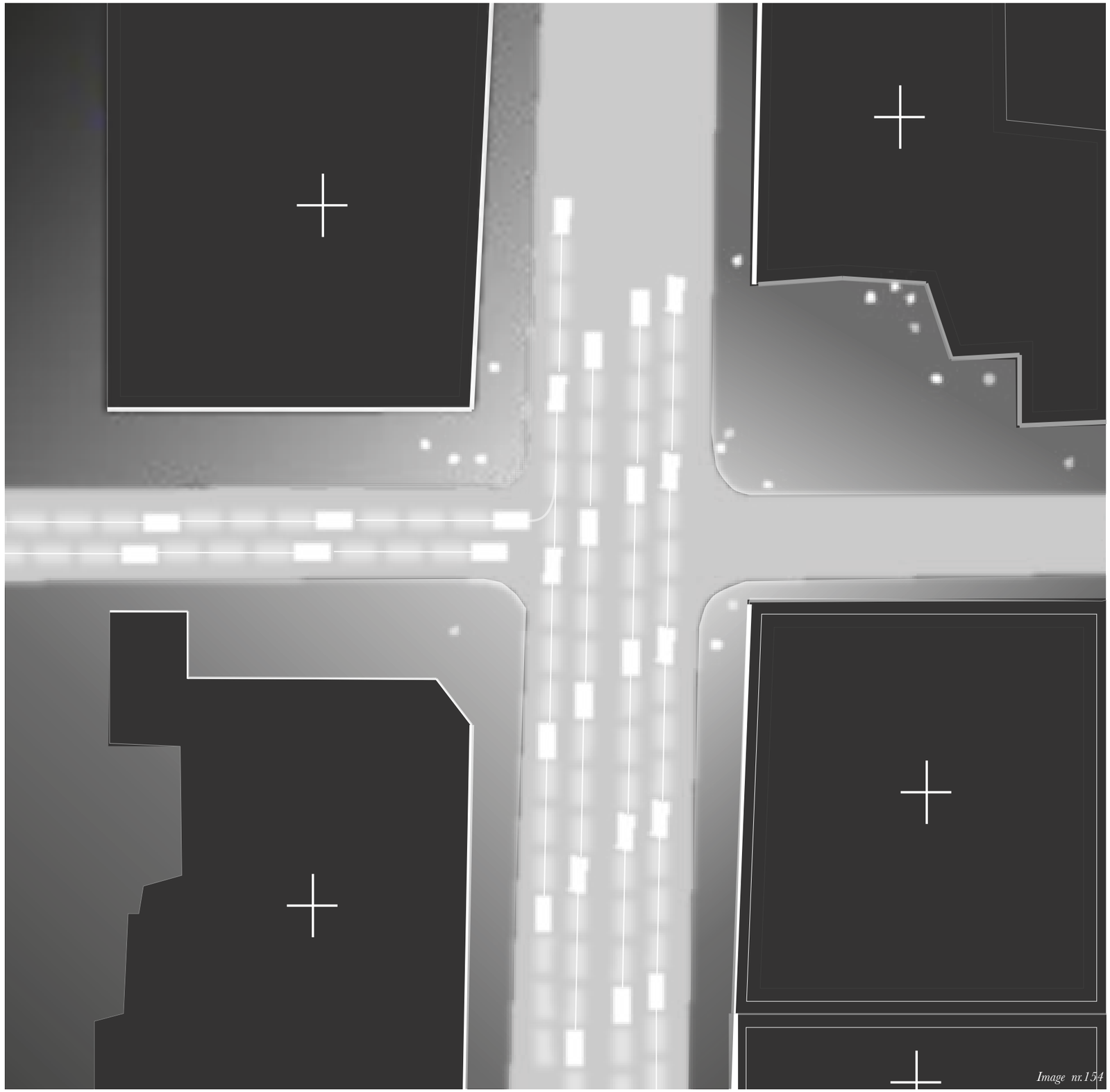
Building

Urban space

Image nr.153

Aural topography

This map of Los Angeles (metropolitan area) clearly shows the rigid, right-angled grid. It is almost impossible to identify specific places, streets or boulevards by looking at the map at this scale.



Quiet/uncharted

Moderate volume

Very loud

Spatio-sonic illumination

This map shows the relation between space for cars and buildings. The sidewalks, which I normally would classify as public space, is rendered uninhabitable by the mass of noise created by the vast amount of cars and the speed with which the pass through the area.

As you may already have noticed, this example is more grey-washed than any of the other illumination maps. This is because I want to illustrate how the noise flows over tha low buildings and becomes a thick layer on top of the whole landscape.

Even the buildings are lighter in colour in part because the walls (at least in those buildings that I stayed in while visiting) are so thin that you can hear the street noise more than in the other cities that I studied, but also because the sound travels over them with ease.

Shapes

Considering the expanse and flatness of the urban sprawl in Los Angeles, I rather think of it as a landscape more than an urban space.

Shapes - urban space

The urban space in Los Angeles is hacked in to rectangular plots where the garden is behind the building, away from the street. It looks like there is a lot of public space, but most of what you see here is private property.

Shapes - buildings

Usually, buildings are right-angled just like the grid, but there is also a lot of parking lots in front of stores. There the building 'pulls in' from the grid and leaves an open space for parking.

It is however not really what I would call a 'public' space because if you go there you're expected to go into the stores and then leave.

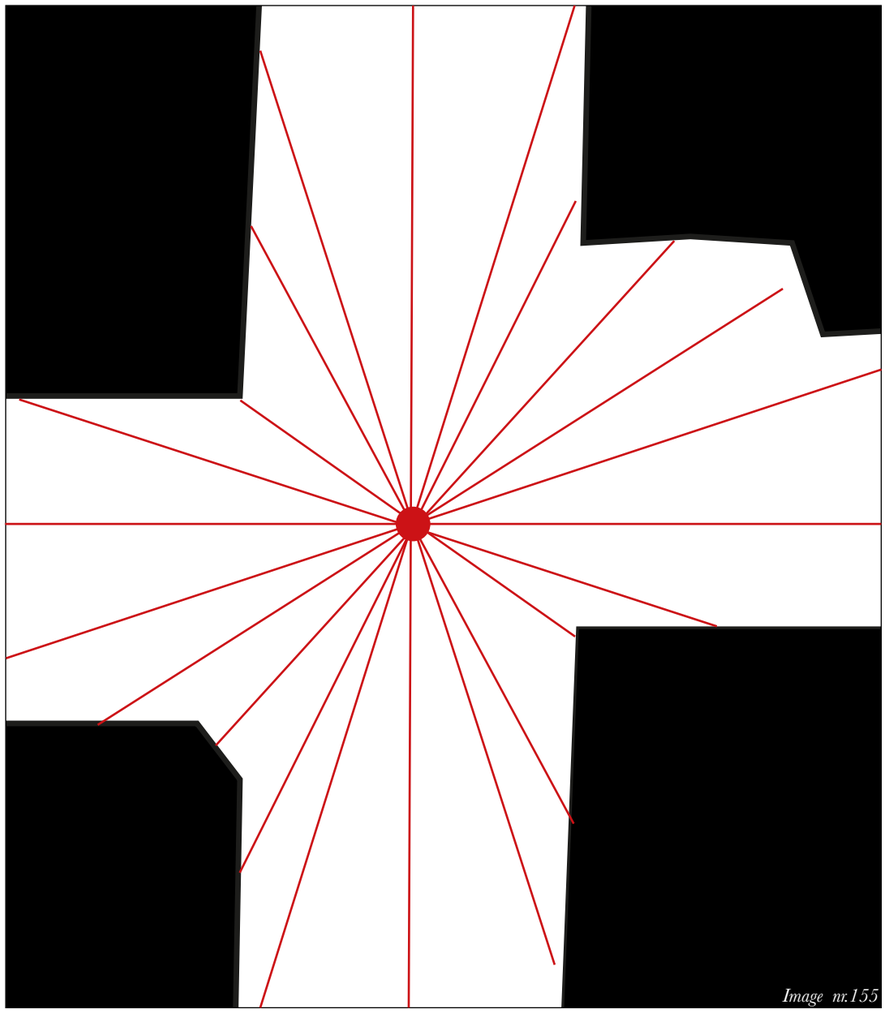


Image nr.155

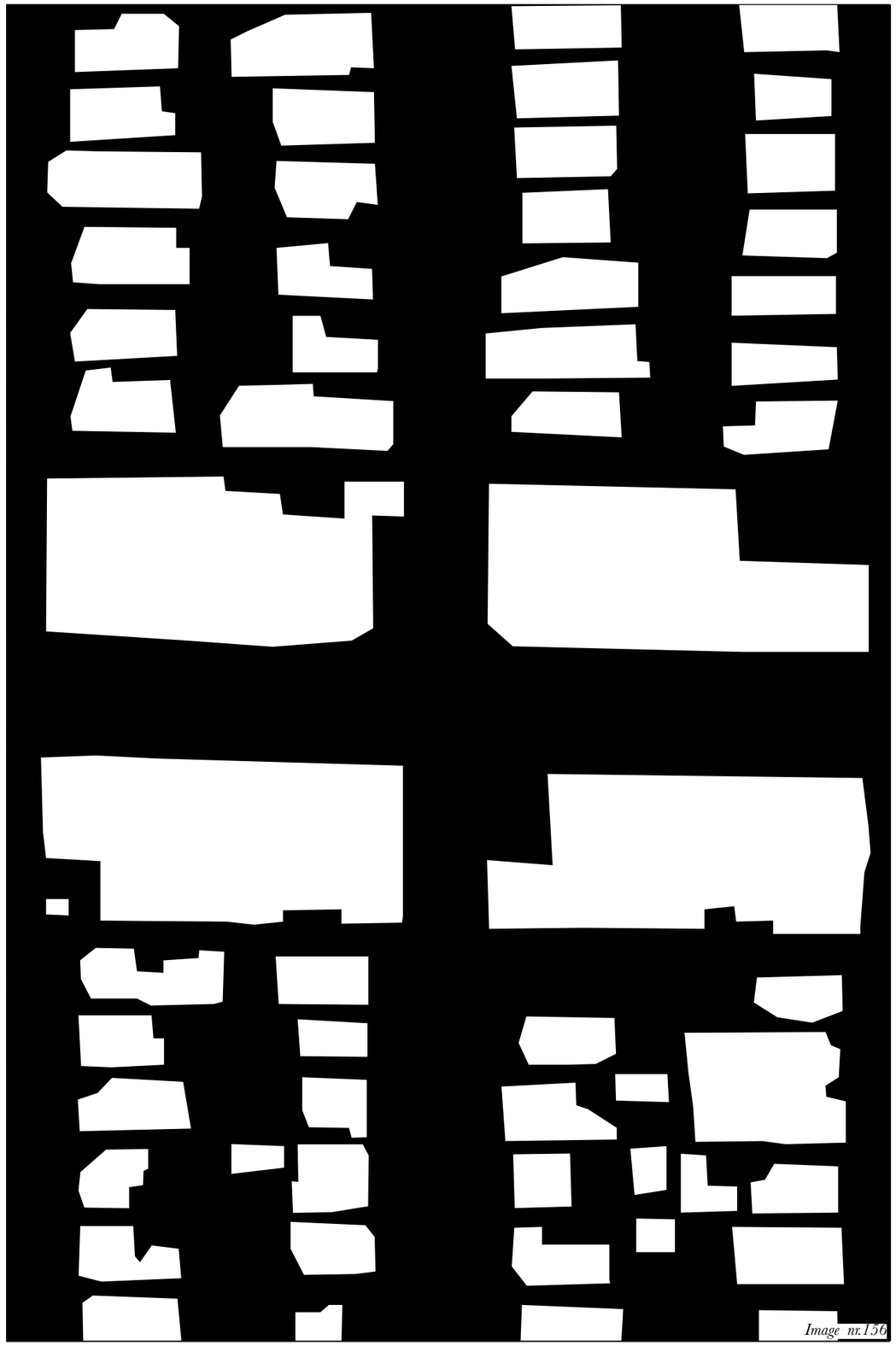


Image nr.156

Shapes - facades

There are lots of different facade types in Los Angeles, especially downtown where 'old' stone buildings are mixed with sheening skyscrapers completely covered in glass.

But I spent most of my time outside of downtown so what I mostly saw were flat, rendered, fake facades. By fake I mean, that they were not made out of solid materials that you would expect when you see a facade that looks like lime-rendered stone but is in fact made out of plaster.

It could be real, but it could be a cheaper material made to look like stone.

Maybe I was under the influence of being in an area mostly known for its movies, but it did feel a little bit like walking around in a backlot or a movie set. The facades facing the street could be very nice looking, but when you turned the corner, you saw raw concrete bricks.


Image nr.157


Image nr.158

Image nr.159


Image nr.160


Image nr.161

Case-specific morphologies

Form	Psychoacoustic properties
Plaster (facade)	Very poor insulation all the noise from the street is constantly heard inside.
Extreme height differences (buildings)	Sound reflected from the tall glass buildings shoot over the lower next to them
Vistas (extremely long boulevards)	Nowhere to hide from the noise or the sight of cars
Urban sprawl (high rate of urban space, very low public space)	Pedestrians confined to sidewalks, very little public space for 'hang-out'.

Image nr.162

Mexico City

Founded: 1521 A.D

Population: ≈ 8,9 million (2015)

Area: 1 485 km^2

Weather conditions (during my visit): Mild to warm temperatures, heavy rain

Grid type: right angle, diagonal cuts

Keynote: Rain

Soundmarks: Markets, music

Signals: Sirens, traffic police whistles

The grid

This map of Rome (partial), demonstrates the organic grid. It has thicker 'veins' which are more trafficked than the thinner ones. There are almost no straight lines, or vistas, and the lines branch out into thinner capillaries as you move further away from the main roads.

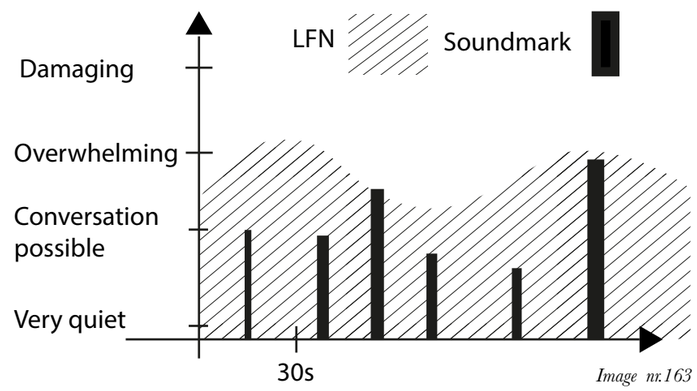


Image nr.163

LFN stands for Low Frequency Noise, usually caused by motorized vehicles. The y-scale indicates loudness, and the x-scale indicate time-intervall.

Height-to-width ratio

This is the corner of Balderas/Av. Juarez in central Mexico City.

A huge park is placed in the top right quadrant and the street vendors fill both sides of the main street on the left side of the image. A busy place, but not overwhelmingly loud or exhausting to be at.

I think that what makes the sound level, or sound ***pressure*** (db(A)), more tolerable than otherwise is the fact that the majority of the sound sources are human, or natural.

The sound sources that are non-human are vehicles of different sorts, speakers and traffic police's whistles. Traffic in general was a lot busier than what I am used to, and there were areas where the space for cars was enormous (see image nr.75, p.29) and unwelcoming to be at as a pedestrian. But, in general, the traffic situation was quite tolerable and I could easily get away from it via smaller and narrower streets leading into calmer blocks.

In general i think that the problem with loud traffic noise is not the noise itself, it is the freedom (or lack there of)as a pedestrian or inhabitant of the city, to be able to get away from it and seek calmer environments when we feel the need for it.

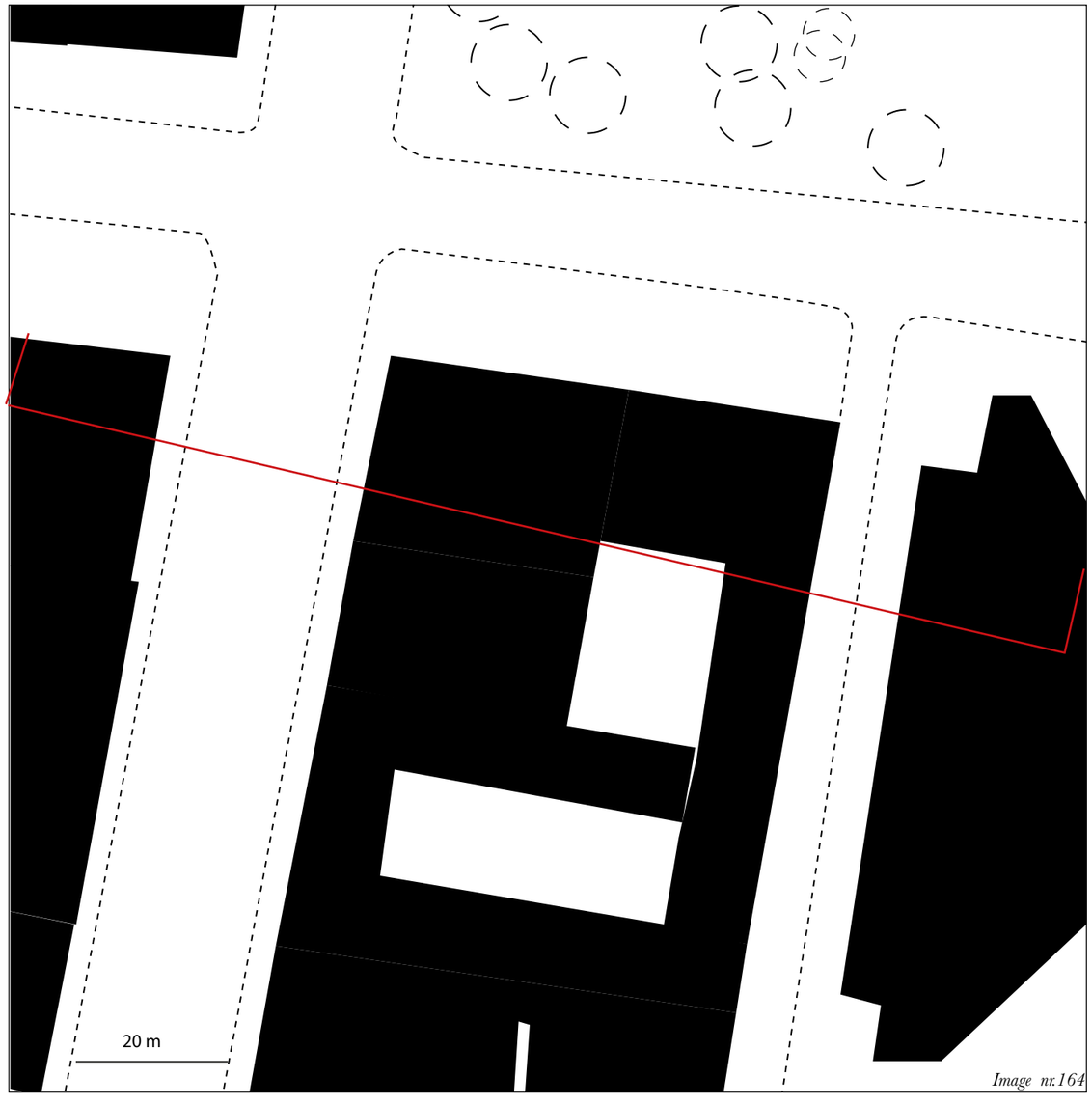
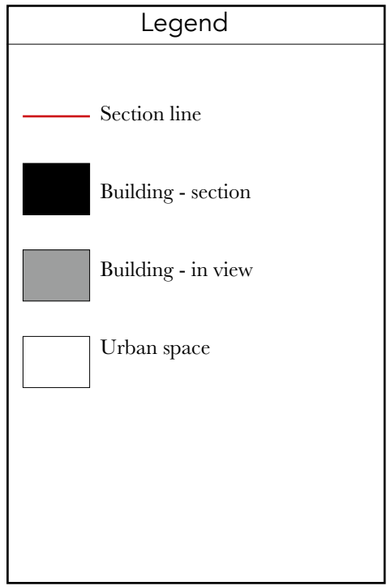


Image nr.164



The plan shows primarily the constellation of buidings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings.

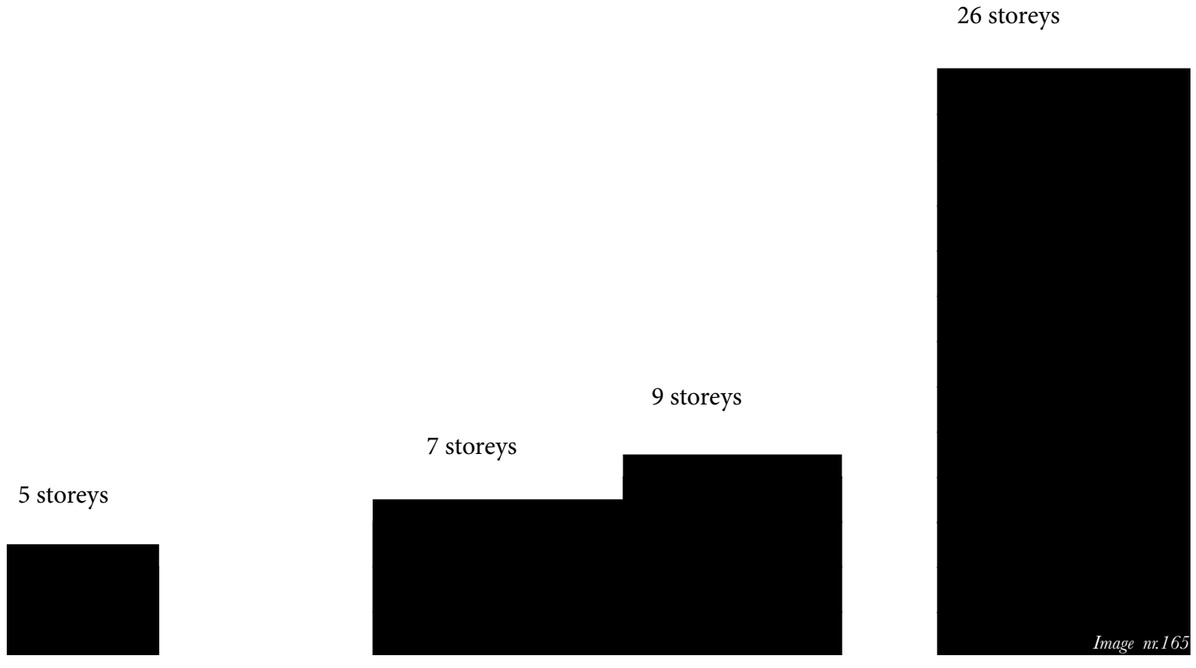


Image nr.165

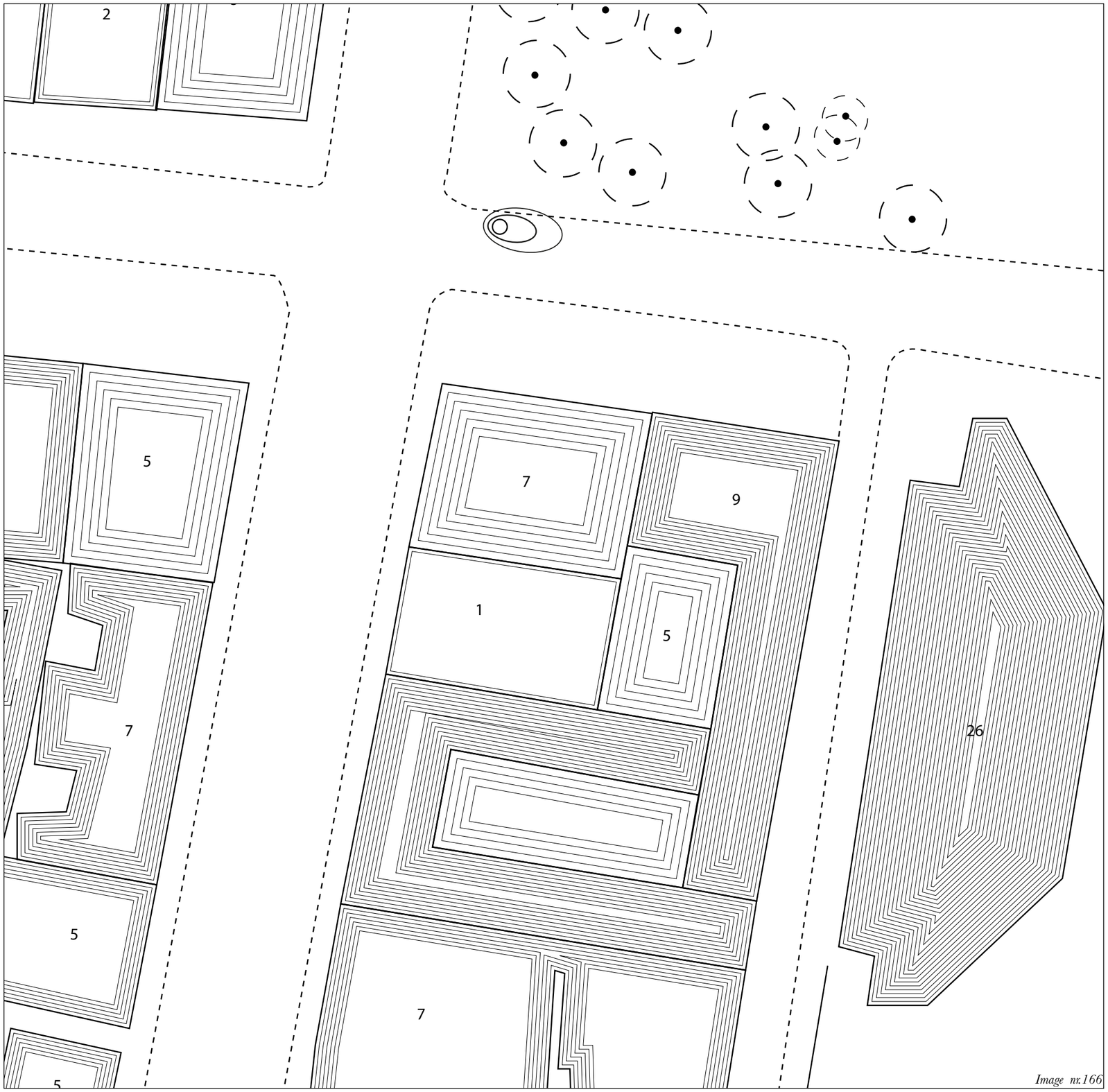


Image nr.166

Legend

Sound source

Sound sphere

Building

Urban space

Aural topography

The building topography in Mexico City is very varied and just like New York it is home to very tall buildings as well as very low. The public space is also very varied with huge parks, small residential community gardens, enormous boulevards and a tightly knit web of neighbourhood blocks and back streets.

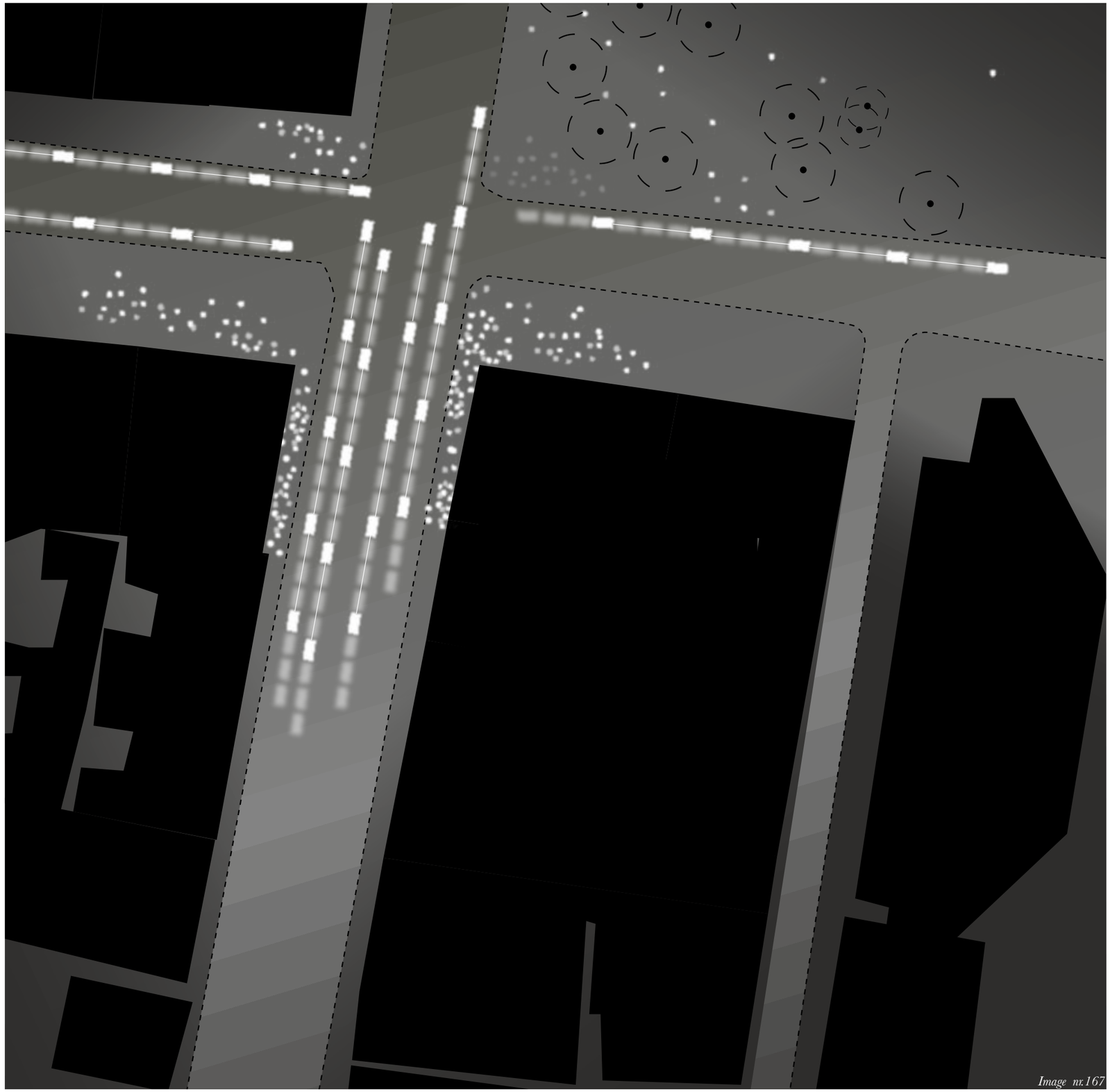


Image nr.167

Quiet/uncharted

Moderate volume

Very loud

Spatio-sonic illumination

The park in the upper right-hand corner is relatively big and when you're in the middle of it, the visual connection to the street is more or less obscured by trees. One can of course hear the traffic, but the psychoacoustic[19] effect is still relatively strong and a nice 'breather' from the busy streets surrounding the park.

19 - **Psychoacoustics**: the study of the perception of sound. (Blesser B. 2007)

Shapes

In Mexico City buildings come in all sizes, shapes and heights. A one-storey building can be squeezed in between two or more very tall buildings.

One other thing that also comes in many forms is public open spaces such as parks, markets etc.

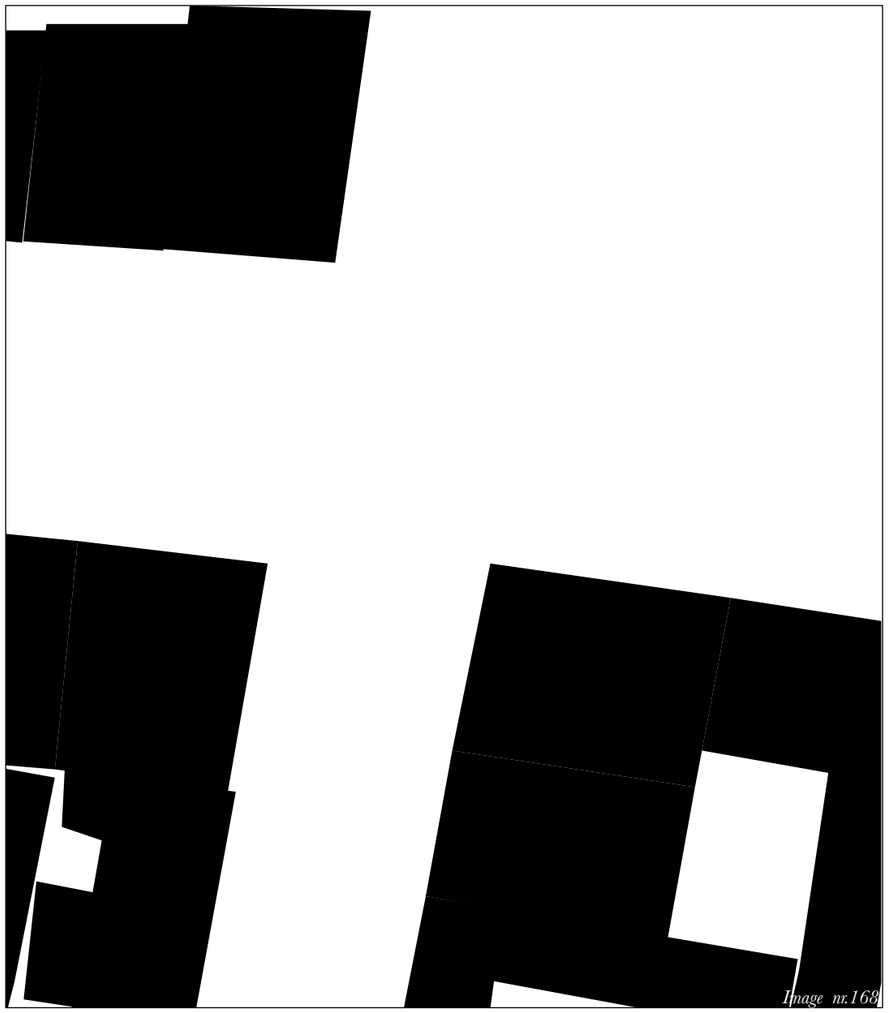


Image nr.168

Shapes - urban space

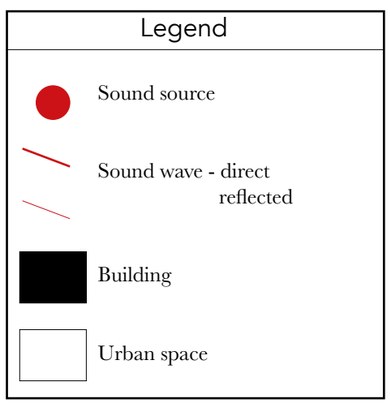
The urban space in Mexico City is very diverse and really goes form one end of the scale to the other.

They are also spaced out nicely in the city so it is never very far from a space where you can have a seat and relax for a bit.

Shapes - buildings

Usually, building corners are right-angled, but a block can be quite dense and the individual buildings in it vary a lot in shape.

It is almost like the buildings of Tokyo were squeezed into a right-angled grid and block.



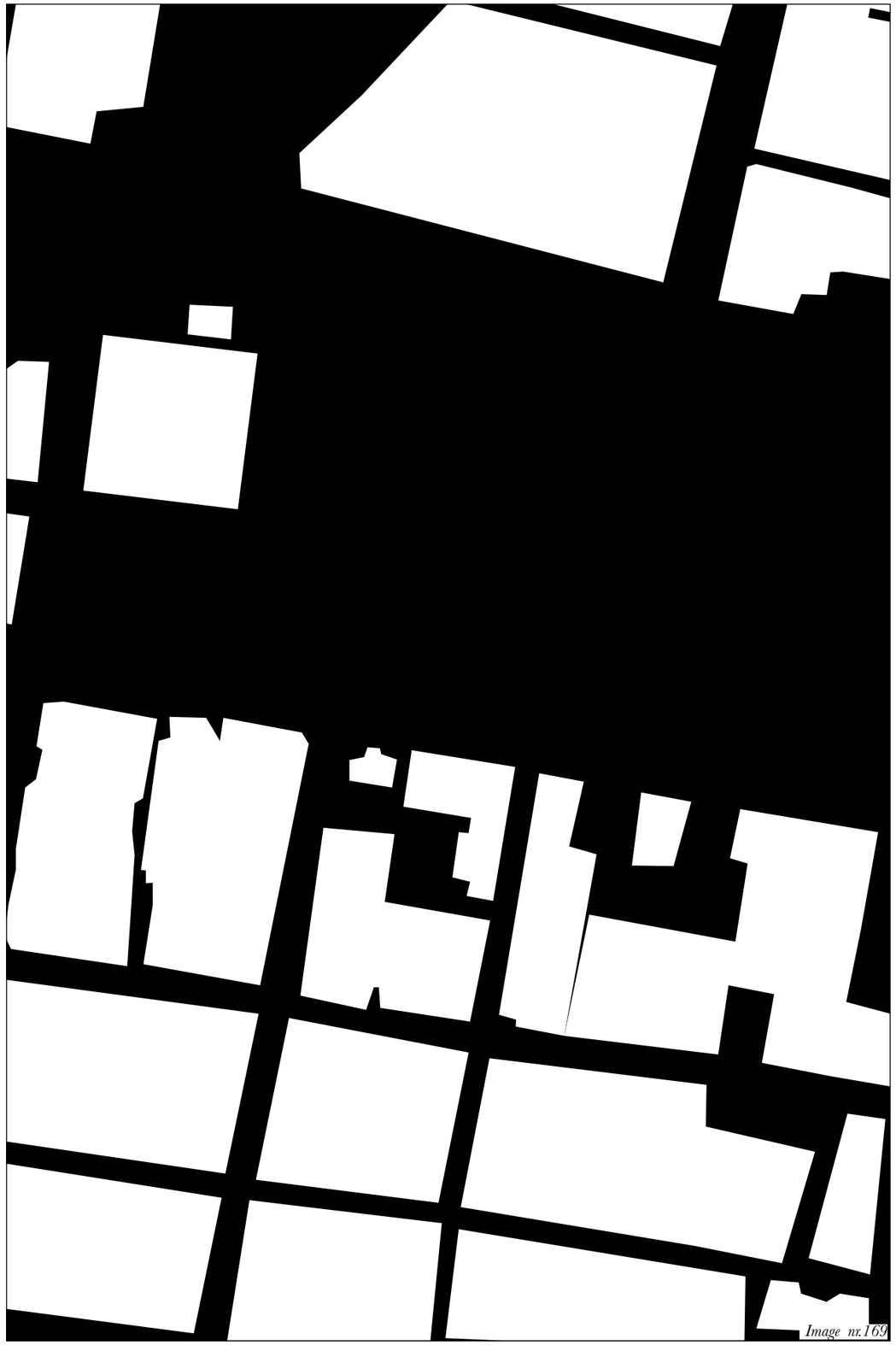


Image nr.169

Shapes - facades

The facades in Mexico City are often colourful or made out of very interesting and different (with European standards) materials such as grass or tiles.

Image nr.170

Image nr.172

Image nr.171

Image nr.173

Image nr.174

Case-specific morphologies

Form	**Psychoacoustic properties**
Plenty of urban and public space	One could always find a spot to relax your feet and ears.
Grass covered facades	Nice to look at, but also acting like a piece of fabric, mitigating some high frequency noise

Image nr.175

New York

(city)

Founded: 1624 A.D

Population: ≈ 8,4 million (2019)

Area: 784 km²

Grid type: regular grid

Keynote: Vehicular and human movement

Soundmarks: Subway trains, car horns

Signals: Sirens

The grid

This map of Rome (partial), demonstrates the organic grid. It has thicker 'veins' which are more trafficked than the thinner ones. There are almost no straight lines, or vistas, and the lines branch out into thinner capillaries as you move further away from the main roads.

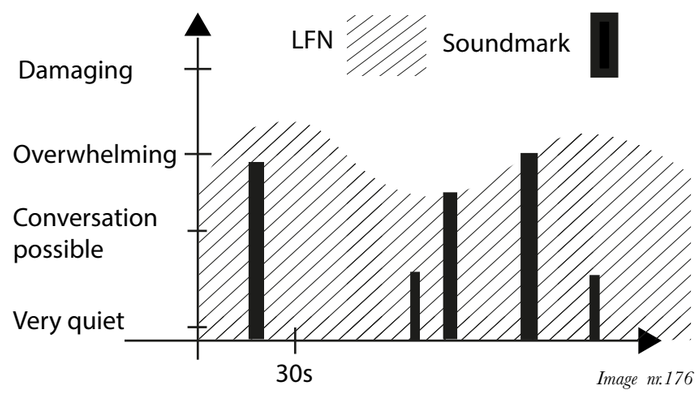


Image nr.176

LFN stands for Low Frequency Noise, usually caused by motorized vehicles. The y-scale indicates loudness, and the x-scale indicate time-intervall.

Height-to-width ratio

Here is the Columbus Circle at the southwest corner of Central Park. It is a busy place, and has some of the more extreme differences in building heights. The Metro station is marked by the circle which is where the stairs leading to the entrance are located.

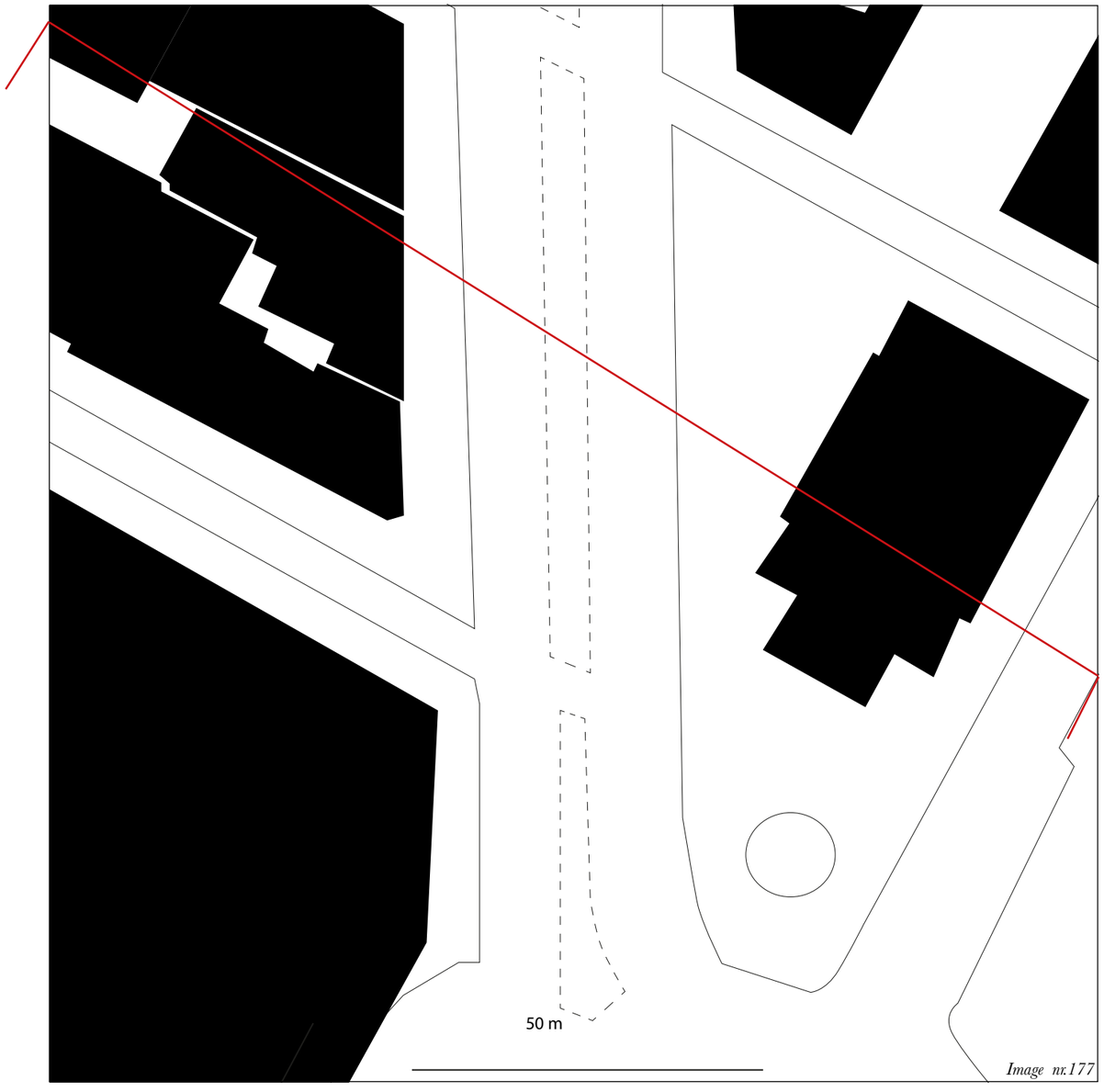
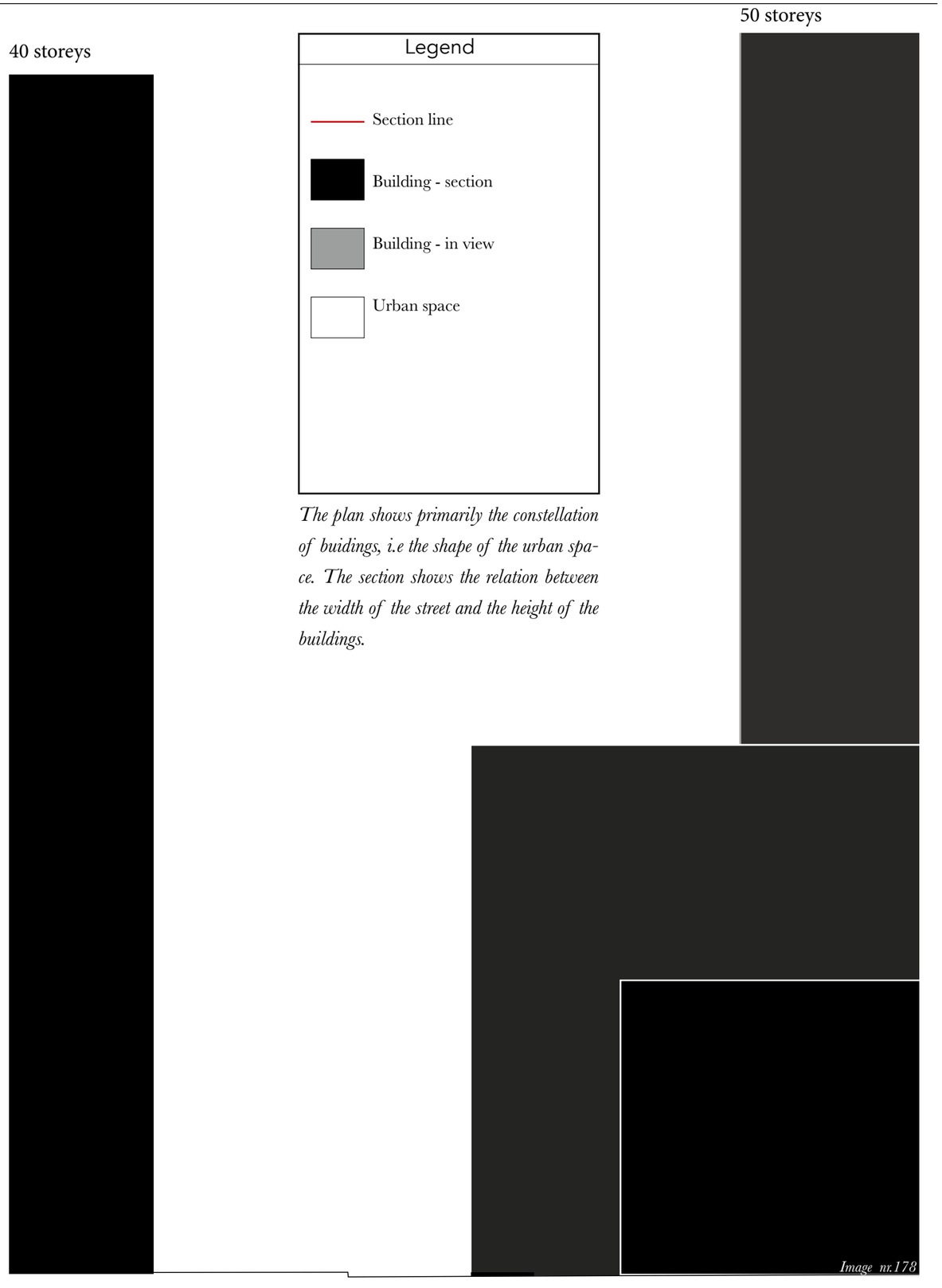
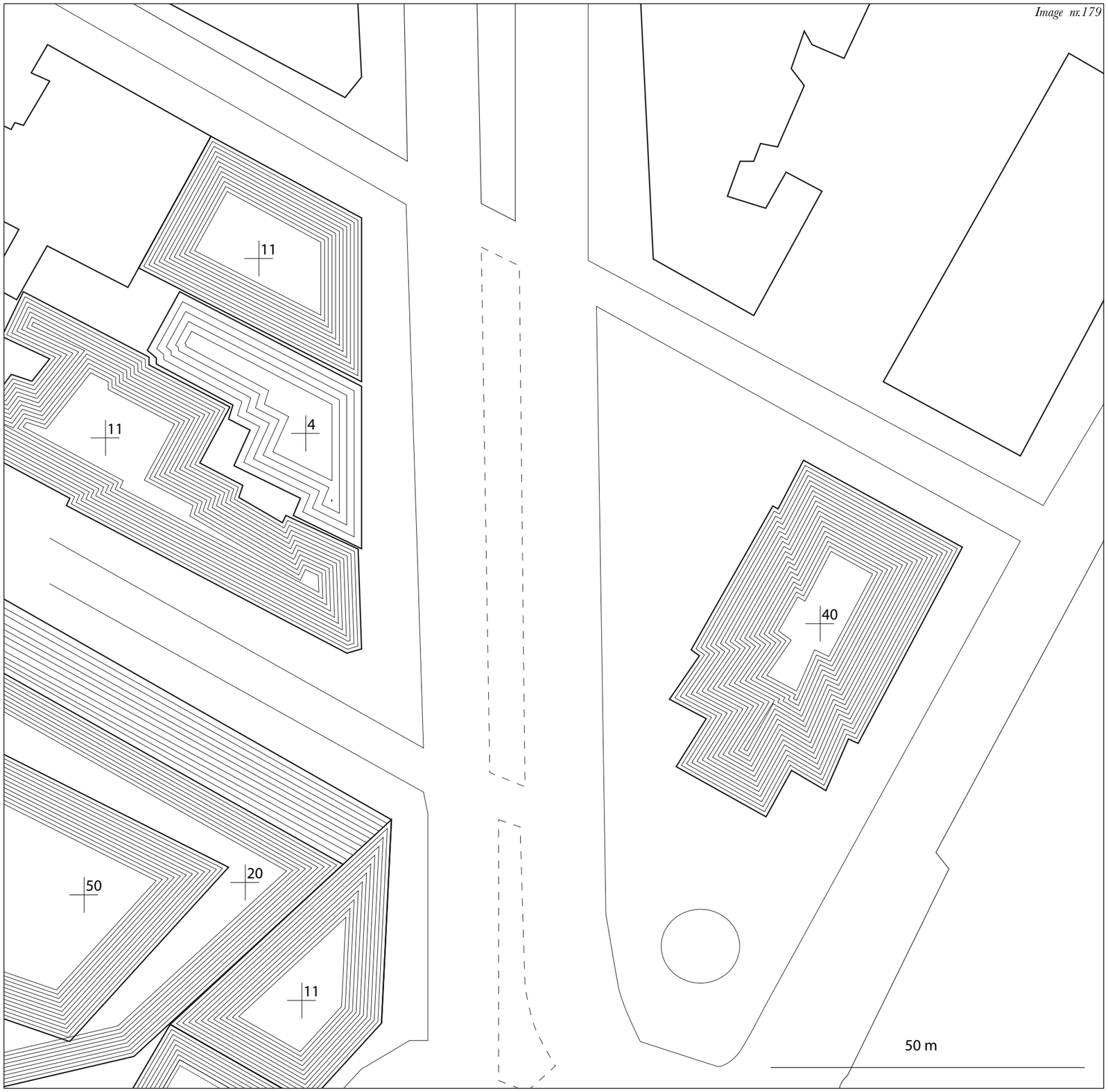


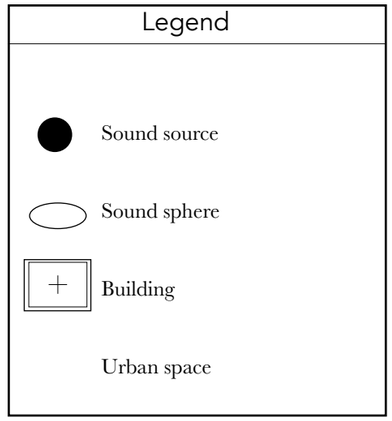
Image nr.177



The plan shows primarily the constellation of buidings, i.e the shape of the urban space. The section shows the relation between the width of the street and the height of the buildings.

Image nr.178

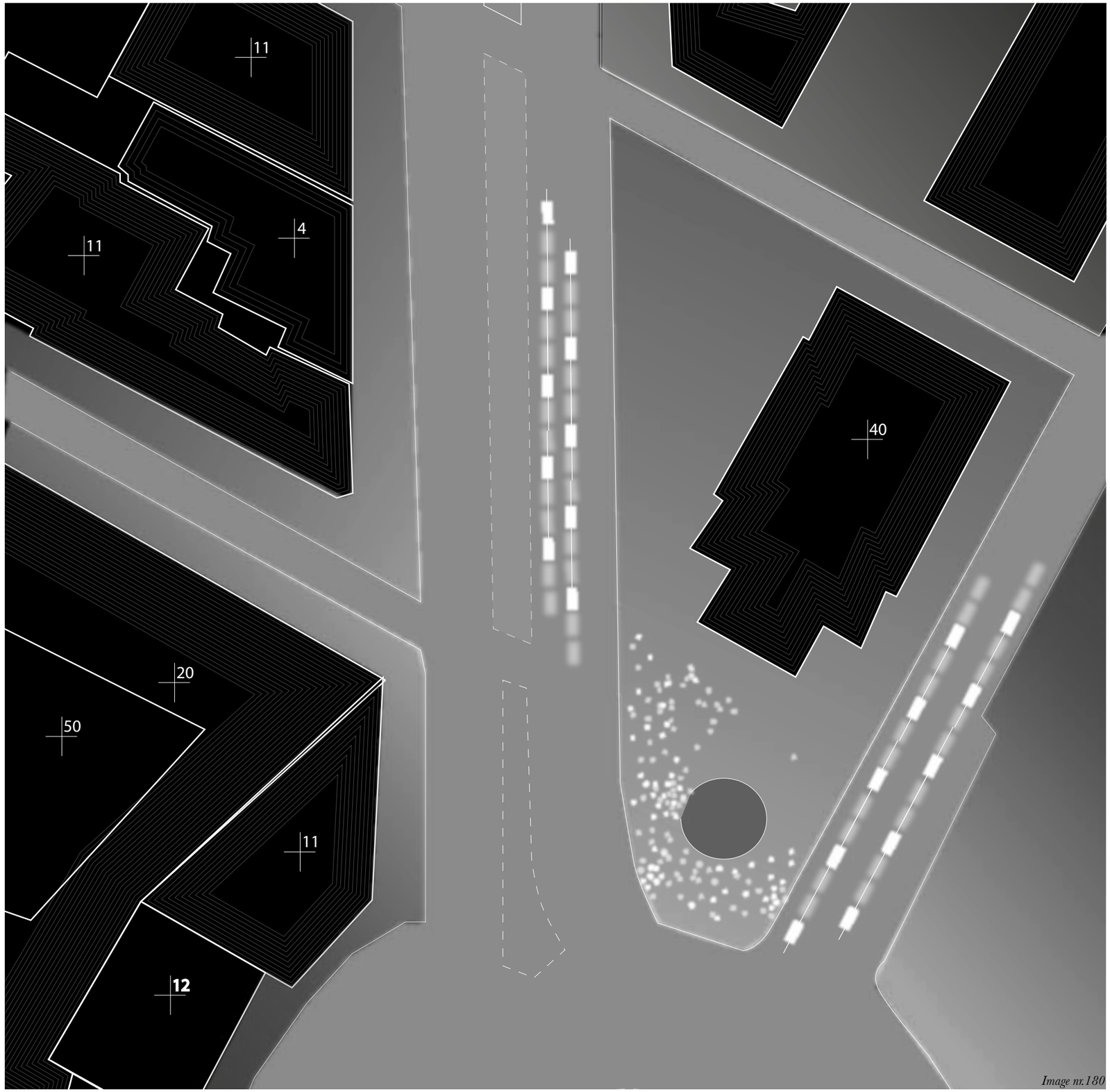




Aural topography

The building topography of New York varies extremely in height globally as well as locally. The total height of buildings in New York is quite high, and sometimes they stand in clusters, but sometimes a skyscraper may stand next to a very modest building.

However, unlike Johannesburg, the urban and public spaces between these vertical giants are tighter and less void of sonic activity.



Quiet/uncharted

Moderate volume

Very loud

Spatio-sonic illumination

This is Columbus Circle, where the entrance to the subway is marked by the grey circle. The space surrounding the entrance is very busy, with people moving in or out of the subway, vendors on the corner, street musicians, ventilation hatches that let out hot air and train noise from the subway.

Across the street, in the lower, right-hand corner is the edge of Central Park.

Image nr.180

Shapes

In New York, skyscrapers and 'normal' buildings co-exist together on a relatively small area (Manhattan Island). The footprints, or shapes, of the buildings are often determined by the grid. If there is a cut in the grid, there is a cut in the buildings on it.

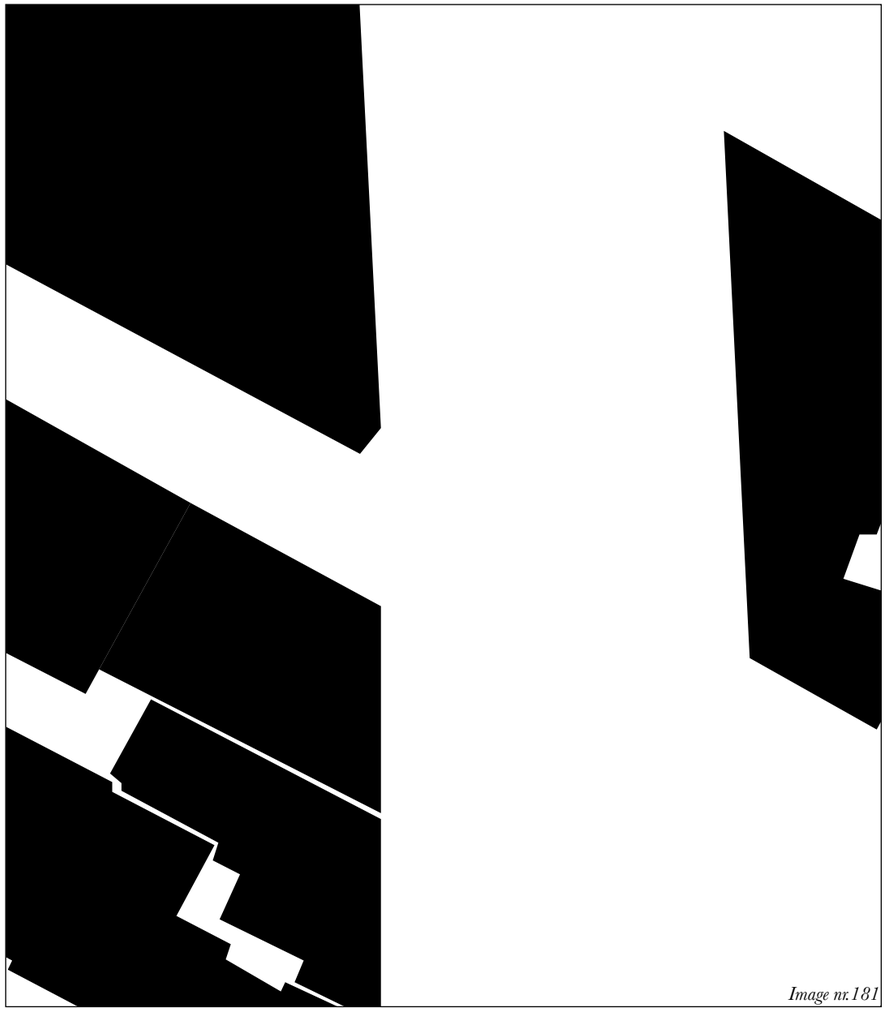


Image nr.181

Shapes - urban space

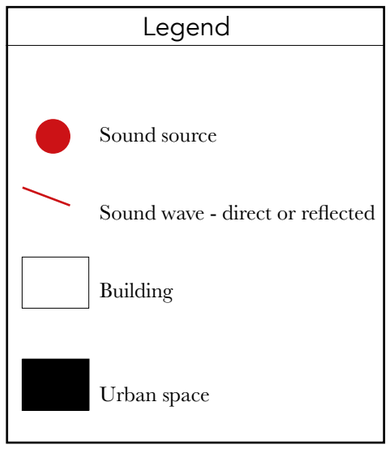
I thought that the urban space in New York was a comfortable size, even if I wasn't too impressed by the enormous heights of the buildings sometimes. But the streets were not too wide, and there is also quite a lot of public space as well.

I think the busyness of the New York pulse helps to make it feel less huge.

Shapes - buildings

Usually, building corners are right-angled, but a block can be quite dense and the individual buildings in it vary a lot in shape.

It is almost like the buildings of Tokyo were squeezed into a right-angled grid and block.



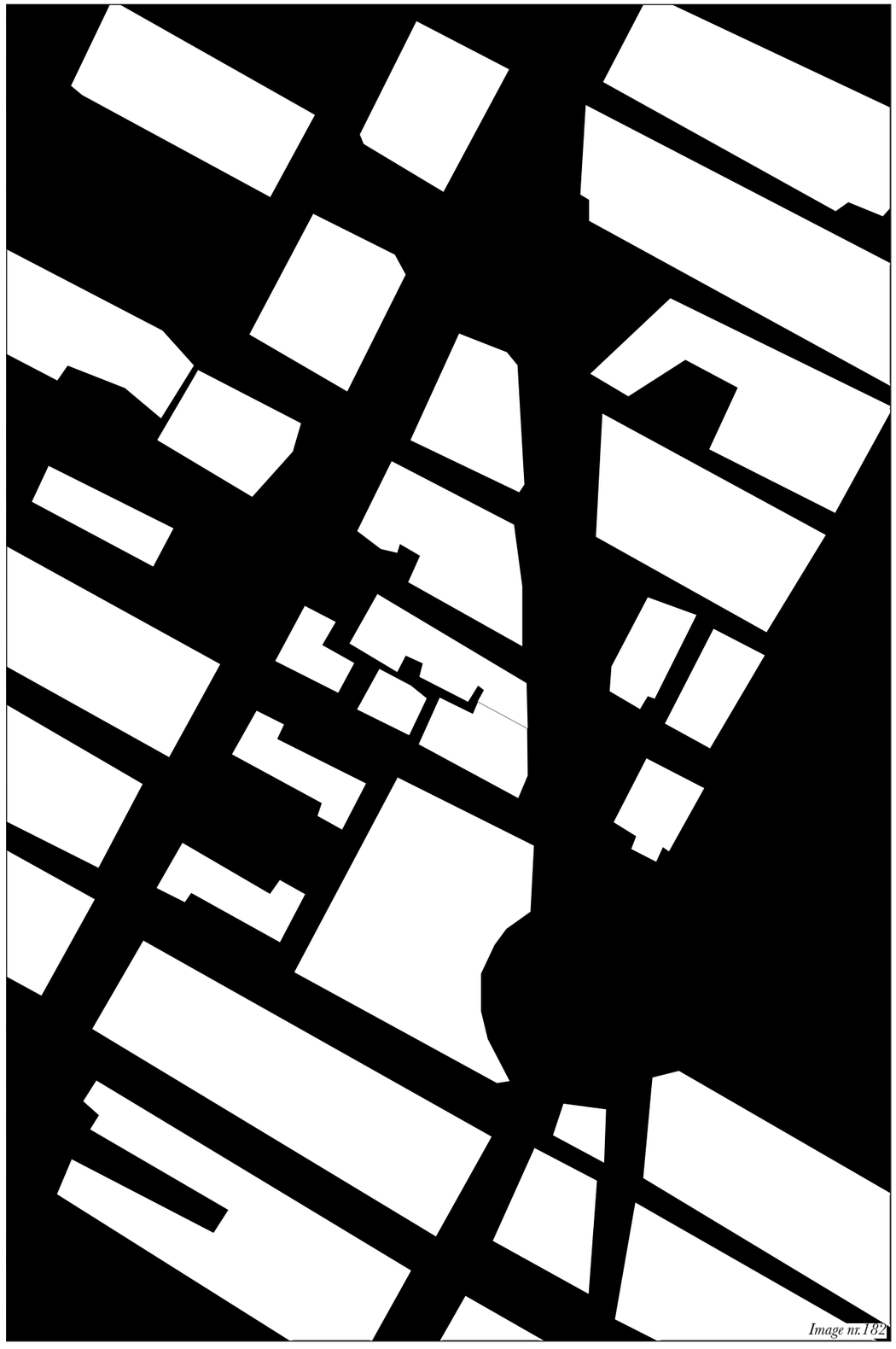


Image nr.182

Shapes - facades

There are lots of different facade types in Los Angeles, especially downtown where 'old' stone buildings are mixed with sheening skyscrapers completely covered in glass.

But I spent most of my time outside of downtown so what I mostly saw were flat, rendered, fake facades. By fake I mean, that they were not made out of solid materials that you would expect when you see a facade that looks like lime-rendered stone.

It could be real, but it could be a cheaper material made to look like stone.

Maybe I was under the influence of being in an area mostly known for its movies, but it did feel a little bit like walking around in a backlot or a movie set. The facades facing the street could be very nice looking, but when you turned the corner, you saw raw concrete bricks.

Image nr.183

Image nr.184

Image nr.185

Image nr.186

Case-specific morphologies

Form	Psychoacoustic properties
Fire escapes (facade)	A very typical feature for New York, visually acting almost like a piece of fabric draped over the facade. Sonically, the may help disperse a little bit of the sound waves acting on the facade
Masonry	
Glass-covered skyscrapers	Reflects both light and sound. If not treated with a special coating, the light reflection can be very disturbing. To mitigate sound reflection, it would require som sort of treatment of the glass surfaces.

CHAPTER IV

NOTATIONS

DRAWING SOUND

Notations

In this chapter I will discuss different approaches on the subject of notation and some of them I have adapted and tested as a tool for mapping of soundscapes.
The specific tools that I have used will be elaborated more in chapter V - Synthesis.

Notation in architecture is usually based on what the actual material looks like in real life, simplified in a pictorial way to be easily read and interpreted.

A hard material may have a heavy line and a light or thin material will most surely have a thin line or just two outlines showing the edges of it.

However, a notation is not the actual object, ceci n'est pas une pipe, it is the idea of an object, or in this case - the sound. "Symbols with a broad, ill-defined content of meaning have their place in all organic languages and notation systems, their special advantage being that they allow for subtle shades of meaning that can never be suggested if connotations are rigidly fixed. [..]"[20]

I will first mention some examples of existing notational theories and what elements of them that can be of interest in this subject.

In his paper ***Notation Systems in Architecture***, Premjit Talwar picks apart some of the notational systems that emerged in the 60's. Systems such as Lawrence Halprin's **Motation** (image 1), which has had and still has an impact on not only representing space and time but also the process of choreographing space.

Kevin Lynch is also mentioned in Talwar's paper, albeit about his collaborative work The View from the Road. However, I think that Lynch's work called The Elements of a City (image 2+3) is more relevant to my investigation in this thesis.

I really enjoyed reading Talwar's paper and it gave me insight into the strength and disadvantages in existing (architectural) notation systems.

Scales

Depending on whether you're analyzing a soundscape on a macro- or micro-scale will definitely change not just the level of detail but also technique.

I treat the macro-scale as a 'pure' landscape where the buildings are a part of the geographical topography. I also treat the sound sources as topographical objects.
This is shown in diagrams in the chapter on Morphology.

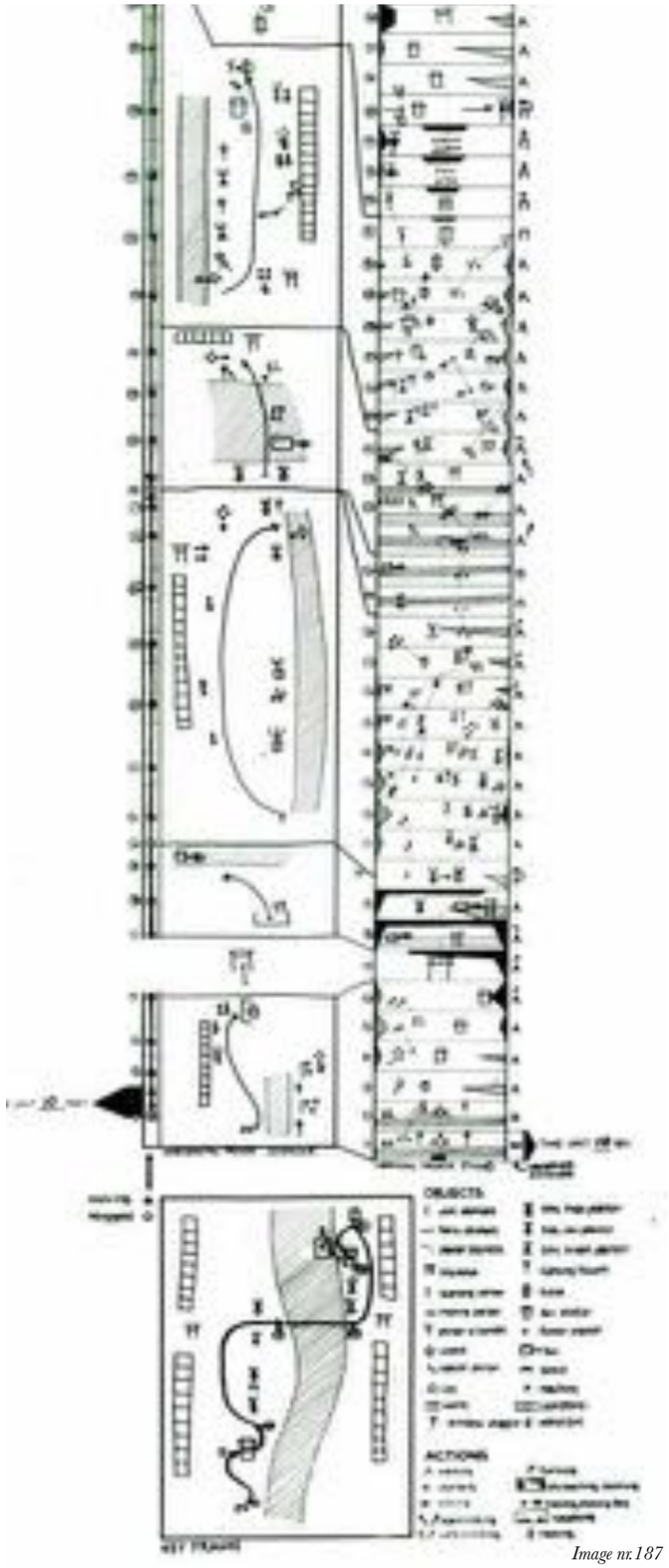


Image nr.187

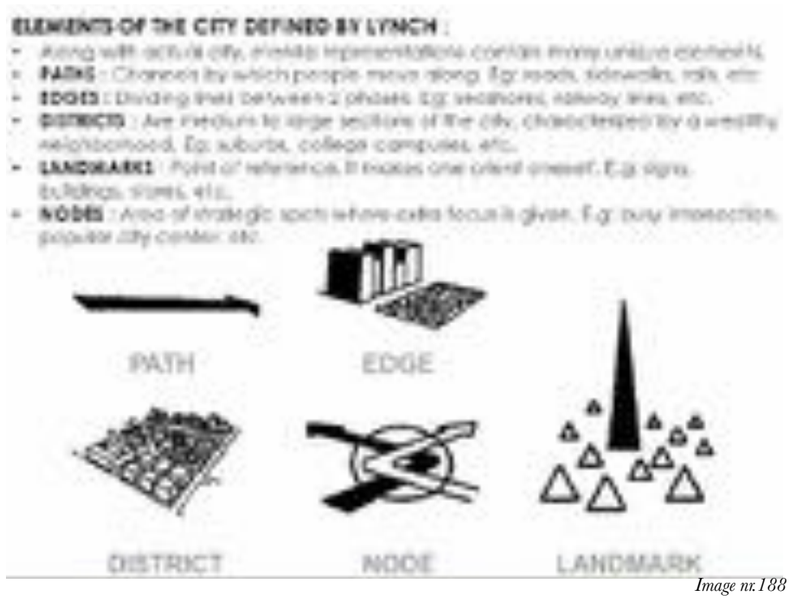
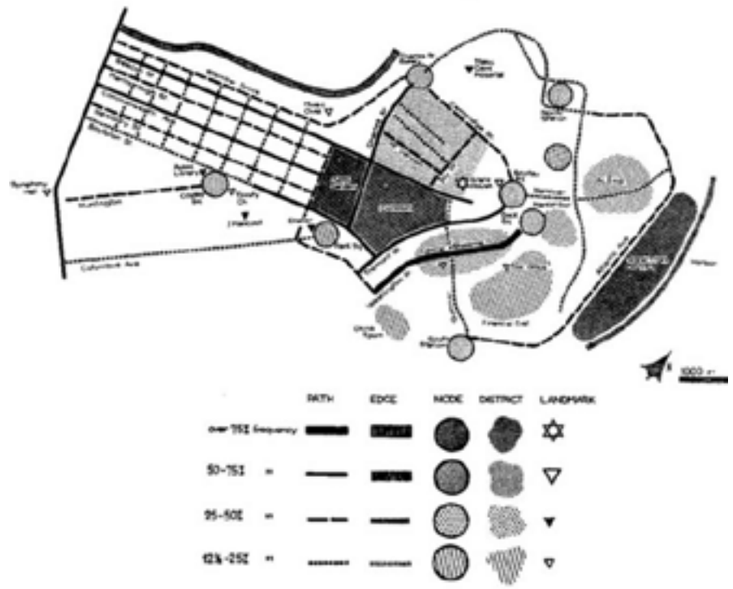


Image nr.188



Note: This is one of Lynch's original mental maps of Boston (Lynch, 1960), which shows both the different elements (nodes, paths, etc.) of the city image and their interconnectedess

Image nr.189

20 - Buck, David Nicholas. *A Musicology for the Landscape (2019)*

Cymatics and Chladni patterns
The inspiration for my sonic illumination maps comes from these images. And I would like to stress the word inspiration as they are not related in method, but in philosophy.

The illumination maps were made as a tool to visualize the sonic imprints in space, and that is what they have in common with Cymatics - the visualization of sound.

How does Cymatics work?
If you place a liquid, sand or any other inert substance on a flat surface that is then connected to a speaker, the vibrations of the sound will cause the media to form patterns.

There are specific patterns for every frequency. This method was actually first invented by Ernst Chladni, who studied nodal patterns on metal plates by sprinkling them with sand and then bowing them.

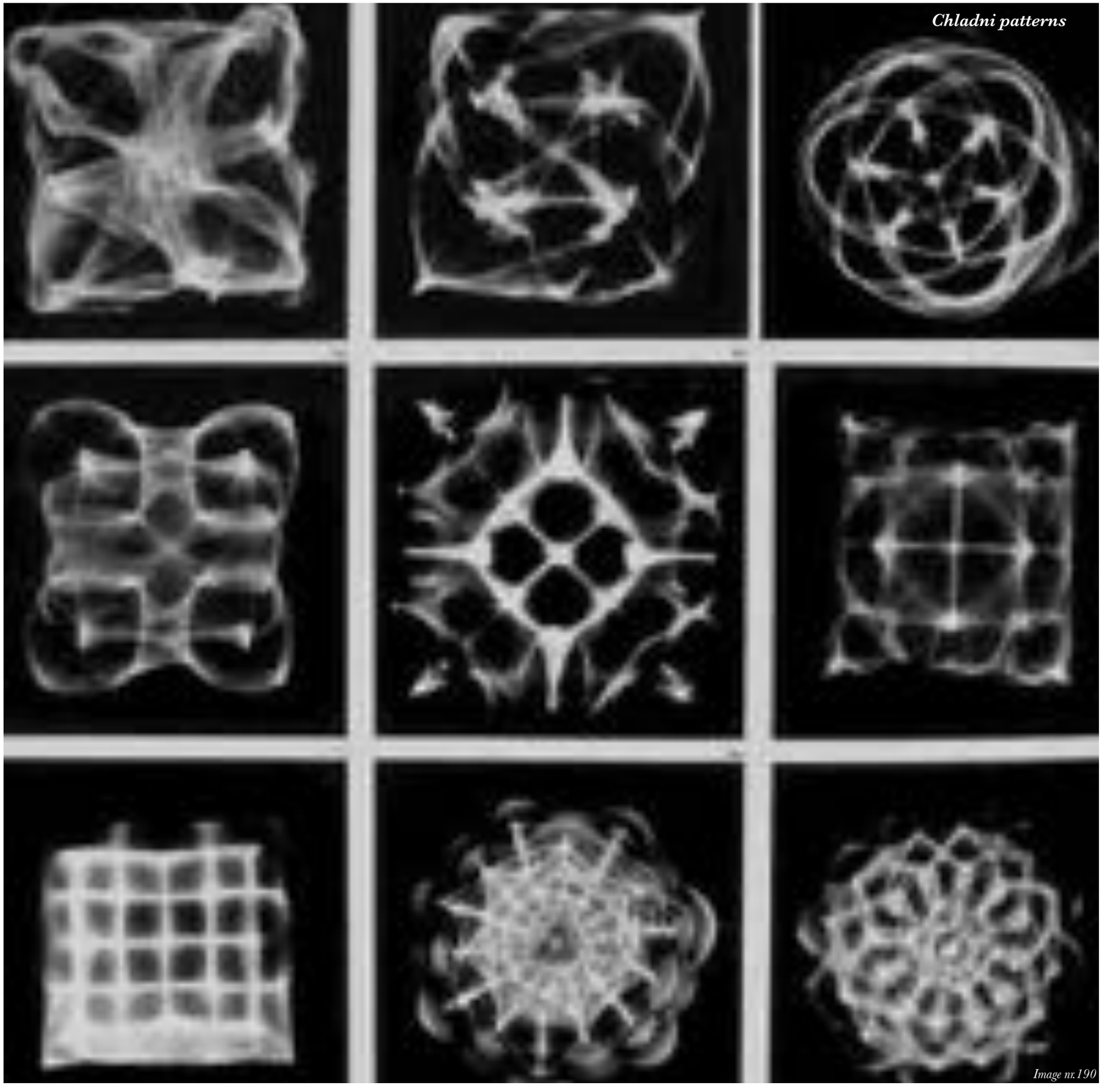
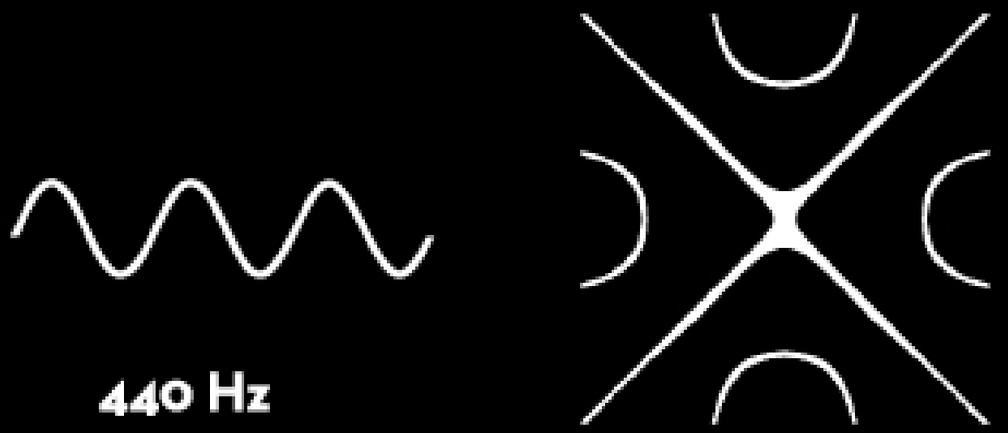
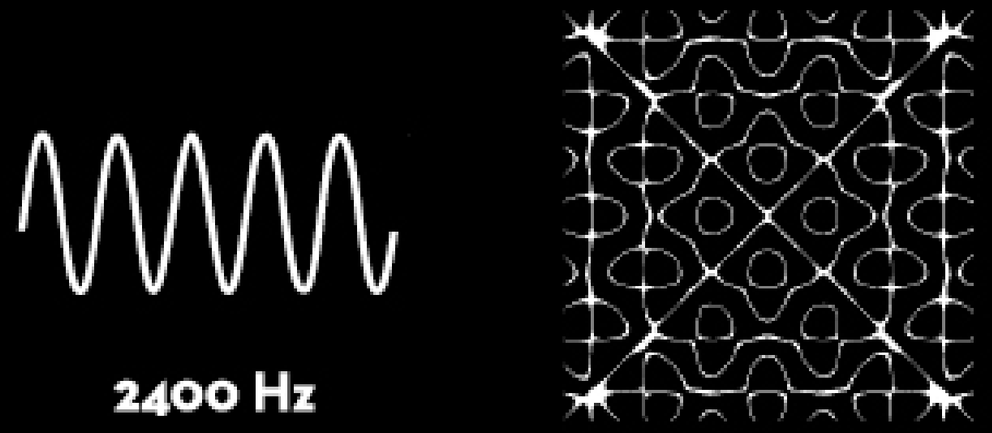
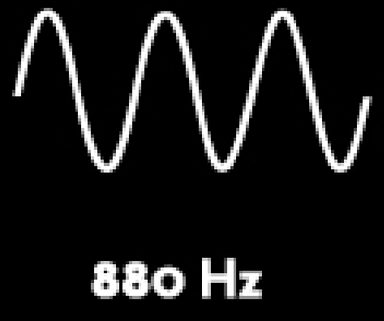


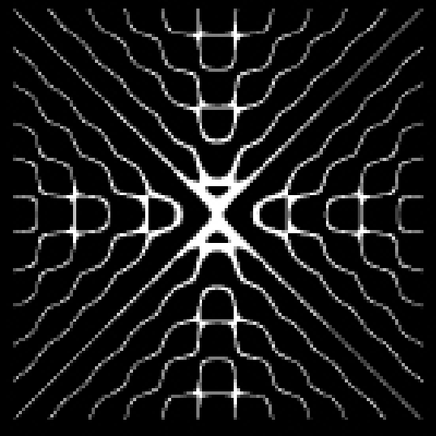
Image nr.190

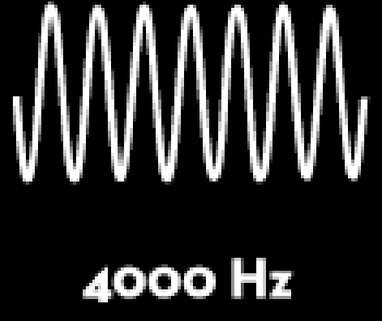
Chladni patterns











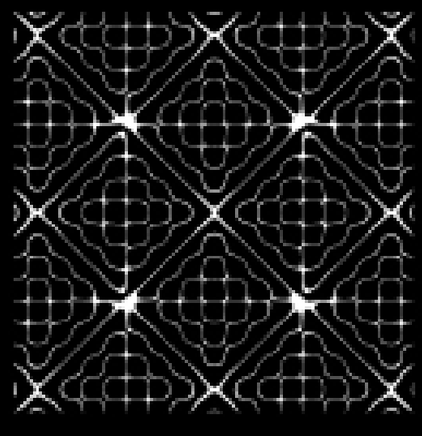


Image nr.191

Scoring the City

When it comes to **theory** on notations I think that Stan Allen and Mark Hacker expresses many significant things to consider in ***Scoring the City*** (image 4).

"Notations go beyond the visible to engage the invisible aspects of architecture. This includes the phenomenological effects of light, shadow and transparency: sound, smell, heat or cold, but also – and perhaps more significantly – program, event and social space. [...]"[21]

They also give examples of what such a scoring system could look like, unlike David Buck who in his book Musicology for the Landscape provides loads of interesting theories but hardly any actual examples of drawings.

Image 4

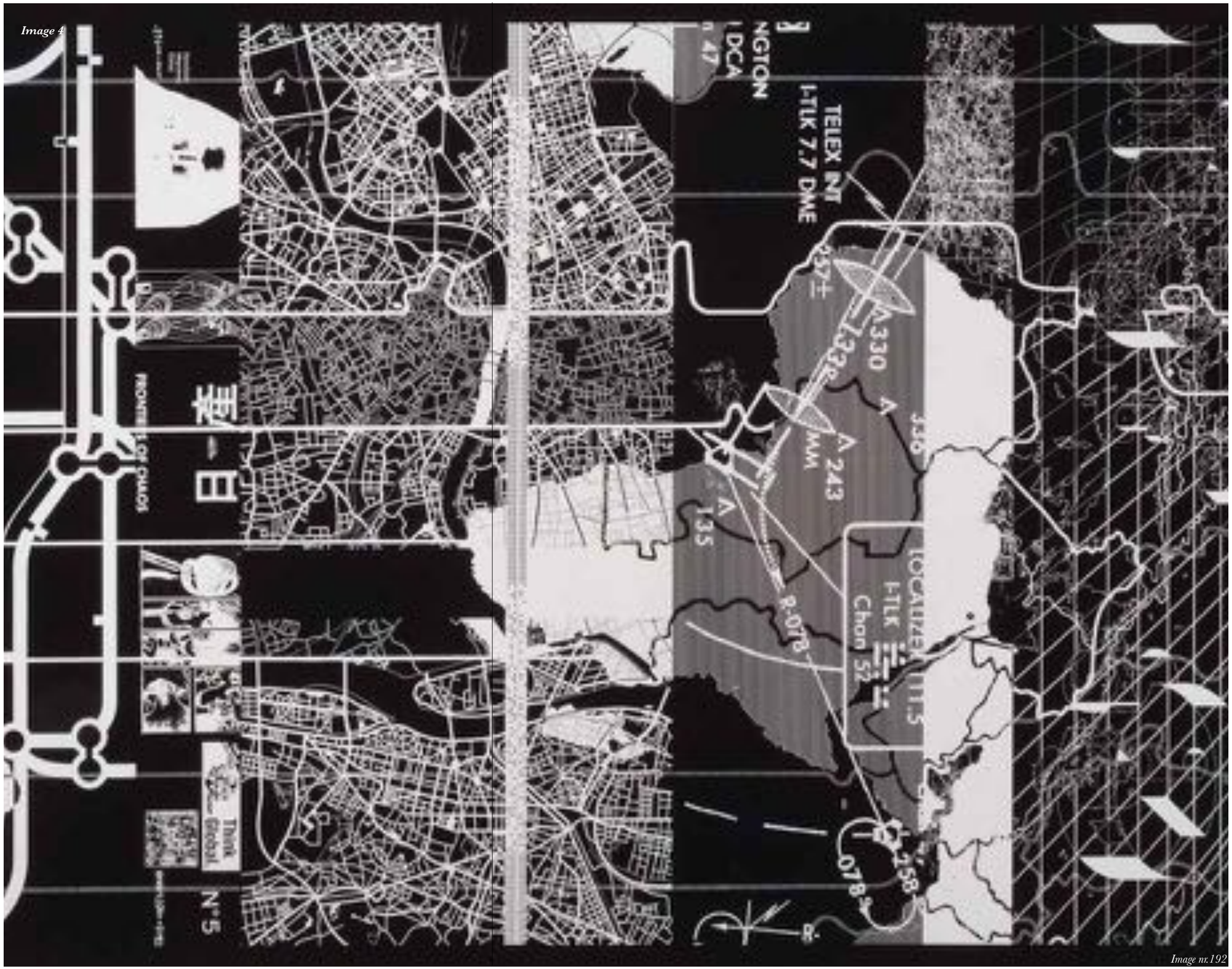


Image nr.192

21 - Allen, Stan and Hacker, Mark. Scoring the City

Storyboarding

Describing the sonic experience using simple images and short descriptions.

I start by writing a 'script', identifying first the surrounding environmental climate and where the listener is, what time of day it is, temperature, sun angle, weather.

Then in sequence, I do quick sketches of sonic events, objects, sound qualities and movement of objects.

This exercise is intended as a sorting tool, to identify listeners direction and movement, other objects position relative to the listener and also to try and describe what the sounds sound like.

EXT. DAY

Place
Corso Vittorio Emanuelo

It is sunny and warm
(34°C)

Image nr.193

a couple of CARS comes from behind , *wroom-wroom*, passes on my left

Image nr.194

a PERSON moves towards me, and passes, ***klick-klack***, on my right side

Image nr.195

two or more SCOOTERS swoosh by from behind, ***ra-ta-ta-ta-ta-wroom***, zig zags between the cars on my left

Image nr.196

red light in front, idle engines ***hummmmm***

TRAFFIC light ***ticks***

green light, shift gears, ***honk honk***

4D-drawing

When we draw a line, that is in two dimensions: *x* and *y*, if w want to add depth we add the third dimension called *z*. If we want to move our three-dimensional drawing in time we need a fourth dimension *w*. By taking a cube and moving it around itself you get a Tesseract, or Hyper-cube, which has four dimensions. The fourth being time. *See images to the right.*

To draw an accurate account of space and time together in one image we need all four dimensions. It is however, very difficult to produce a legible drawing in 4D that we can make sense of without animating it.

This is the problem that I have been struggling with when trying to visualize the urban soundscapes.

A 3D-cube unfolded (5-6-7-8 is the 'top' square of the cube

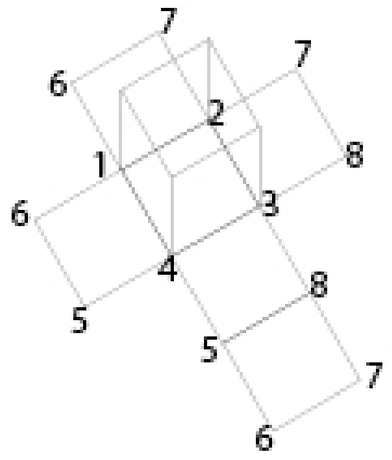


Image nr.197

Tesseract, or hyper-cube shown in three dimensions

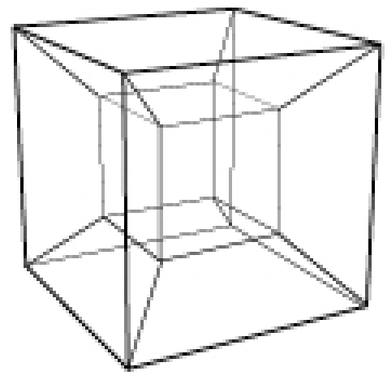


Image nr.198

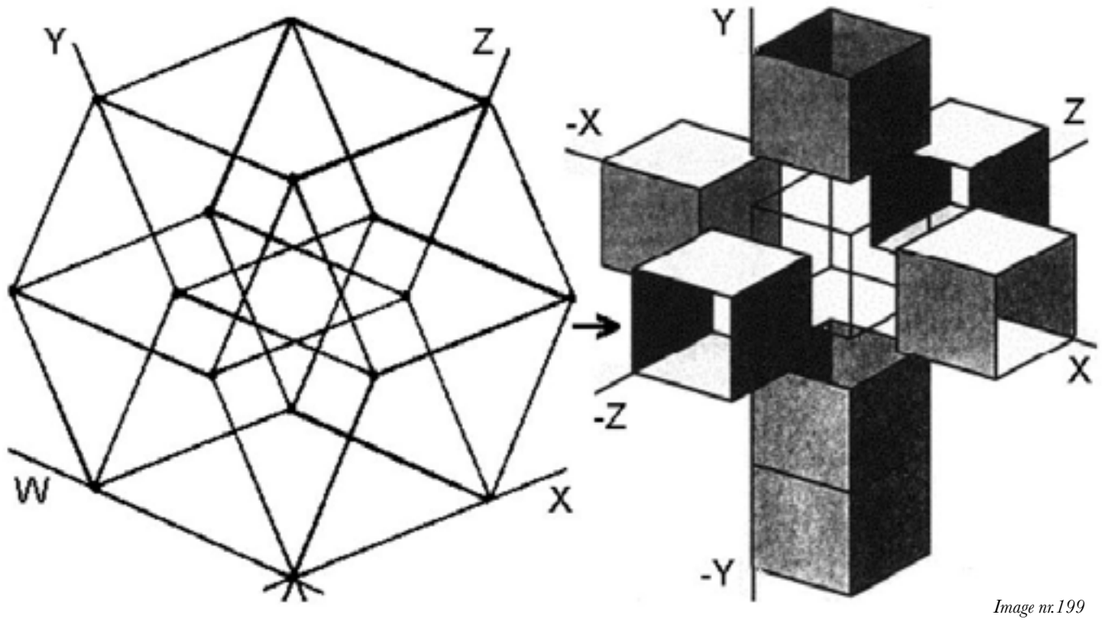


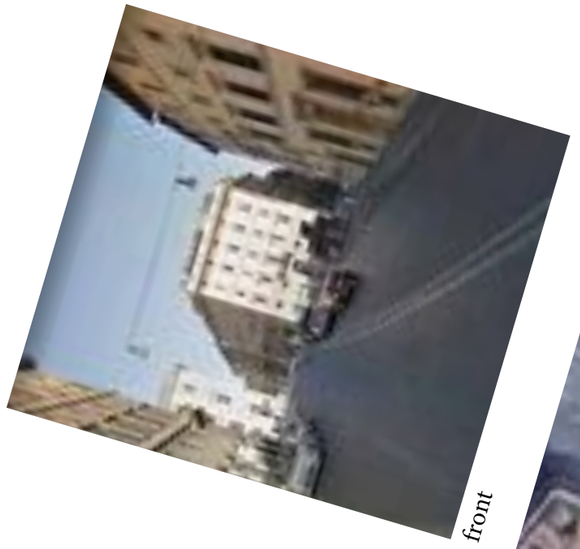
Image nr.199

Tesseract, shown in four dimensions on the left and unfolded into three on the right

360° view

This is a snibbet of my walk on the Corso Vittorio Emanuele II. With a full view of the place, to the sides, up and down. You recognize the idea behind this form of visualization from the discussion on 4D-drawing.


right


front


ground


back

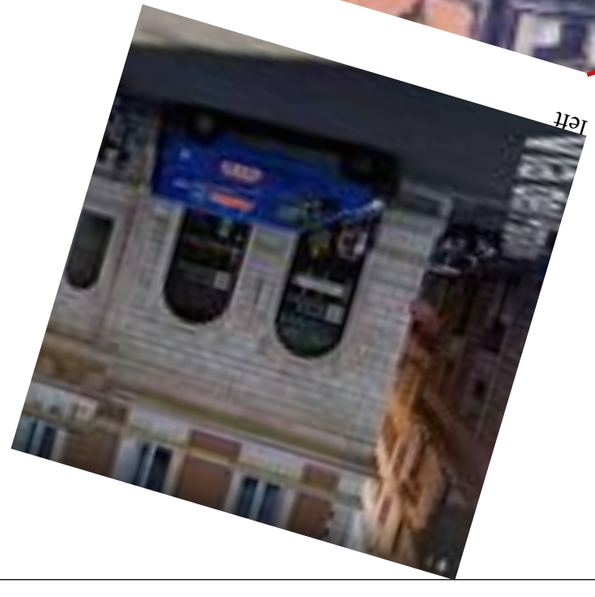

left


Image nr.200


above

Onomatopoetic drawing

The word onomatopoetic came to me and I remembered reading lots of comics when I was little and that I was fascinated by the way the managed to draw sounds that made it feel like you actually heard them when reading the comic.

I found a wonderful little comic strip (image 6) by Roberto Zamarin, a graphic artist that has a very distinctive way of drawing sound. His approach to representing sounds is very fresh, relaxed and intuitive. He utilizes both semantic effects (words that say Boing) as well as visual effects, lines cracking or twisting.

My wish would be for me to find some middle ground between the super intuitive and the more exact and scientific approaches to the idea of notation.

In fact I did a similar drawing six years ago in which I wanted to show the path (extrapolated from a map) that I walked and the sounds that I heard along that path. *See image*

At that time I thought it was best to leave out the actual map and physical environments. The intention was to just let it be a pure sonic experience.

Storyboarding

This image made me think of storyboarding. Storyboarding is what you do when you're planning every frame of a movie.

You have the script with scene directions, dialogue and specifications of where and when the scene plays out.

But it is up to the storyboard artist to ***visualize that which is written***. Often sounds or very important actions is marked in some way.

Soundwalk

This is a former (produced in 2013) attempt of drawing the same walk/experience as shown in 'Spacenuts' (my adapted take on music scoring) but with an onomatopoetic character.

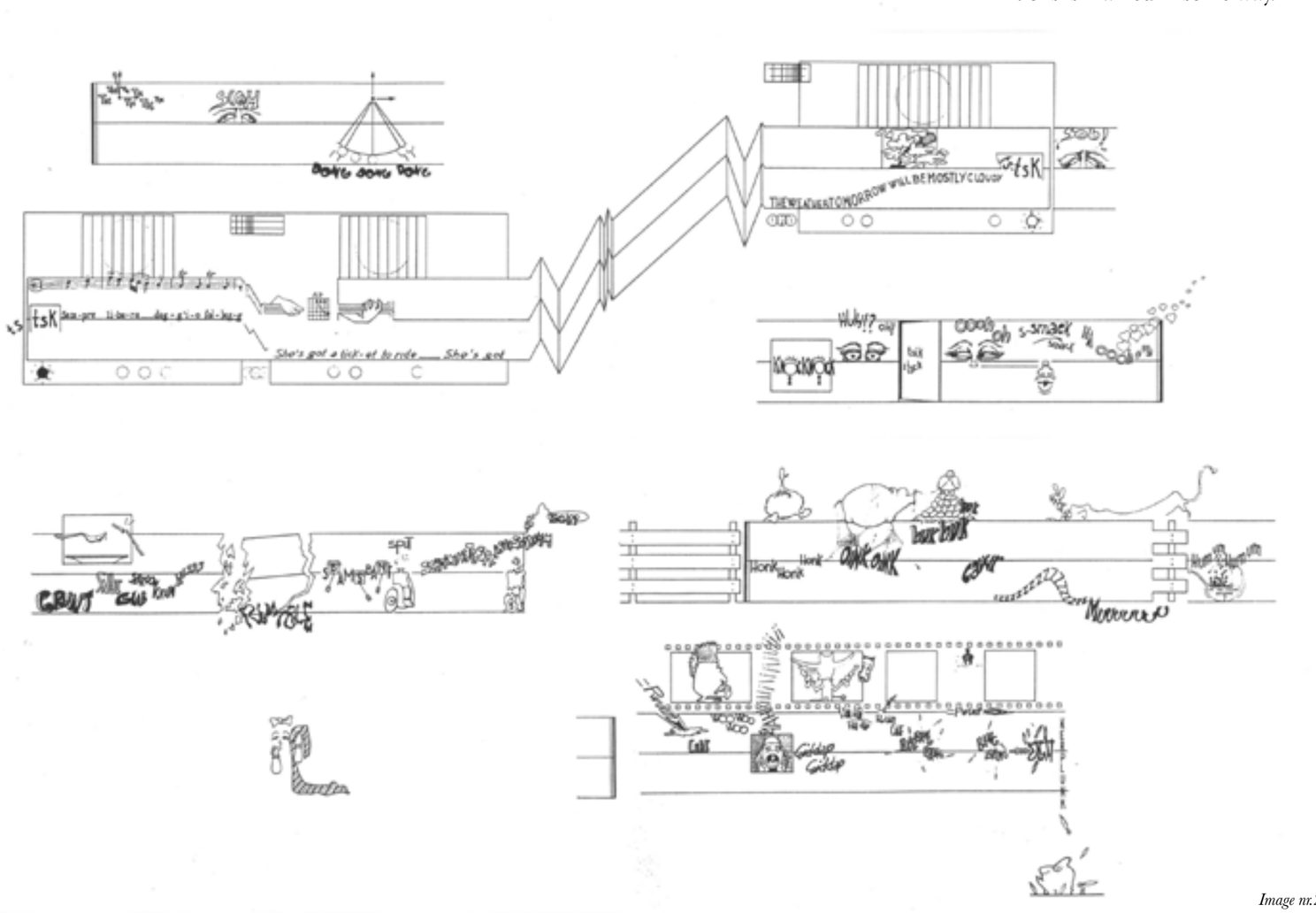


Image nr.201

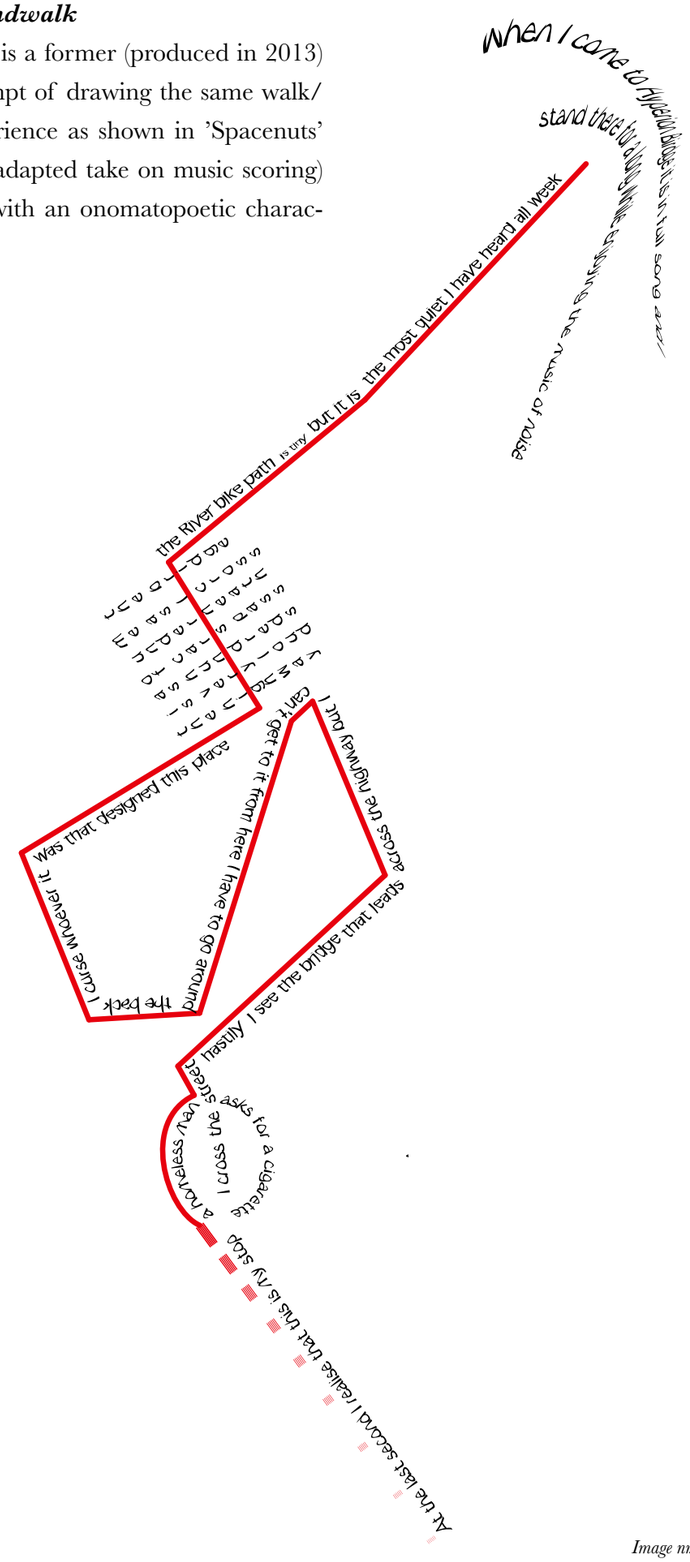


Image nr.202

Sensory mapping

An even more artistic approach to the mapping process is the Sensory Maps by Kate McLean and Anna Ruth. I first came across McLean's smell maps and thought that they were very interesting in terms of how they are generated as well as presented.

As with sound, smells are very fleeting experiences, even if the surrounding area around a bakery will usually smell like freshly baked bread, wind and other climate factors can influence the smell on any given day.

In chapter III - Morphologies, I used a similar visualization technique as the smell maps to show fields of sound.

Auto-drawing

Anna Ruth works in a slightly different manner where the mapping is done by physical transference of vibrations from a bus an onto a piece of paper in one continuous line. Graphically, her maps resembles something other than traditional cartography and is more like automatic writing.

What I take from these two examples is that it can be OK to do a *subjective mapping* of an experience.

An experience that might not be exactly the same the next day, or even in five minutes. A quantitatively tricky thing to pinpoint exactly.

But, with enough data, or sensitivity, a pattern does emerge eventually and can have validity as a study of a soundscape. The Chatty Maps study has attempted to do such a quantitative study, but I unfortunately have not had the means or time to do such an exercise myself.

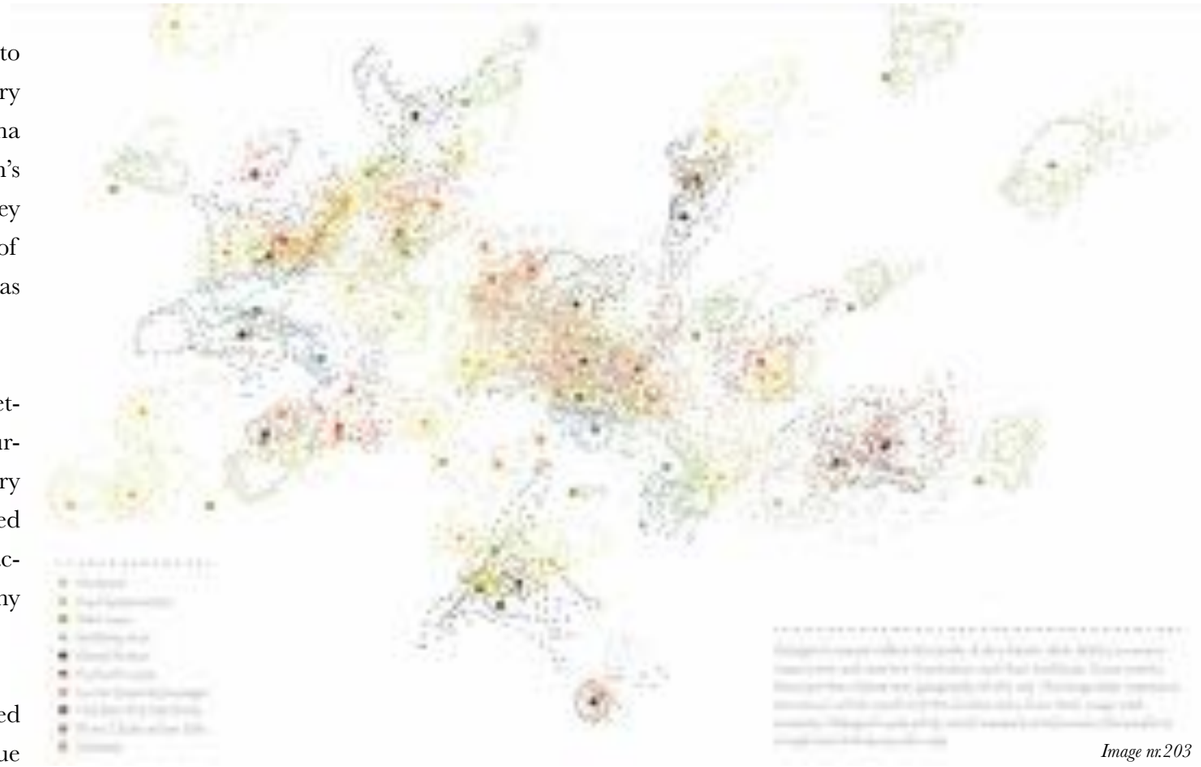


Image nr.203

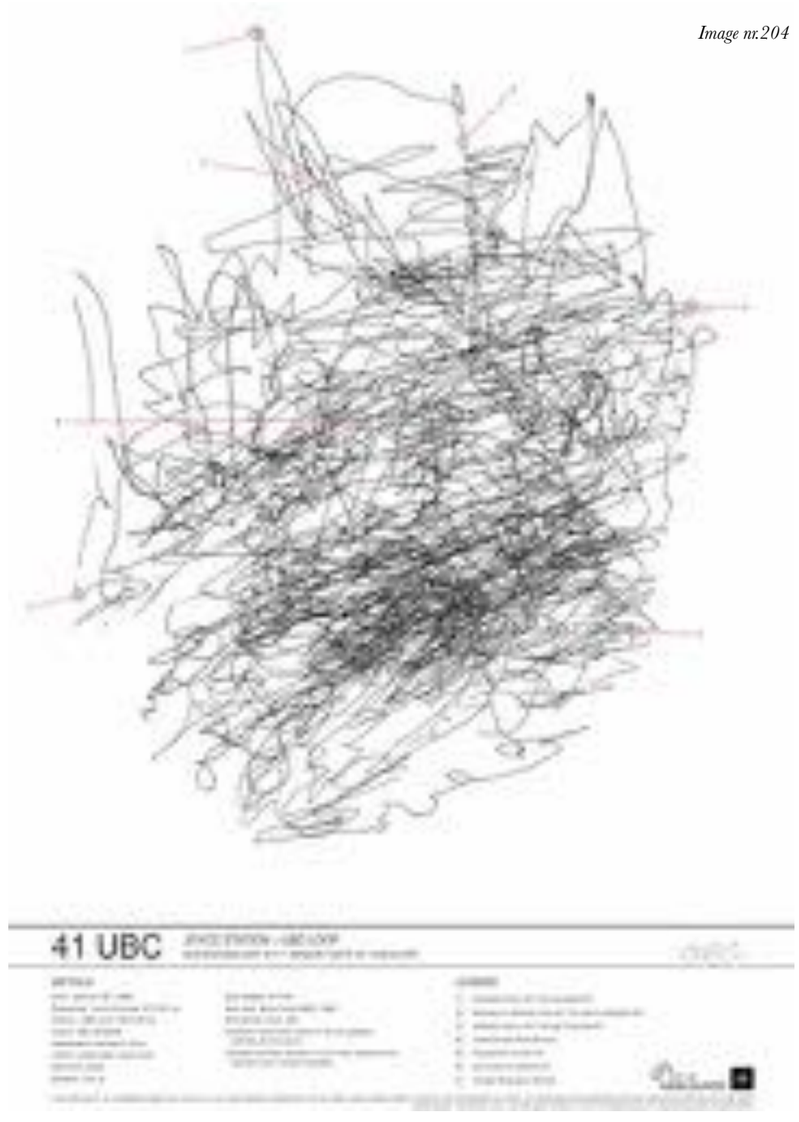


Image nr.204

Spacenuts

A former attempt of mine to draw soundscapes with musical notation as a base but heavily influenced by Halprin's Motation (the staves go vertical instead of horizontal).

The main focus of this system is to illustrate the quality of the sounds, and not to describe the source in detail. For instance, it shows if a sound is soft, approaching, decreasing, etc. Only in a few places does it clearly show the object that is creating the sound, e.g wind, water, pedestrian.

The keynote symbol is meant to simplify the notation. If cars are everywhere during this period of time that is being described it does not need to be written out in every time intervall.

Should there be a brief moment where the keynote becomes so quiet that it is inaudible (listener enters a tunnel or something similar), that will be indicated in the score with the keynote symbol crossed over.

Spacenuts (2014)

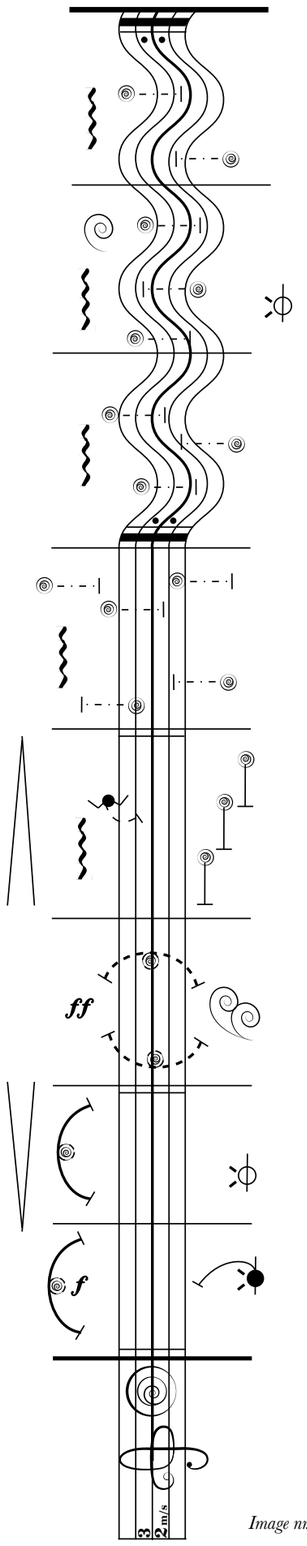


Image nr.205

Legend of the Spacenuts:

1) Starting point
2) Middle stave represents the listener's head
3) Side staves represents sounds coming in from right or left
4) Additional staves may be added when needed
5) Time counter
6) Beat mark
7) Distance measured/notated (top number) and general walking pace (lower number)
8) Keynote symbol, i.e the prevailing ambient sound (in this example cars)

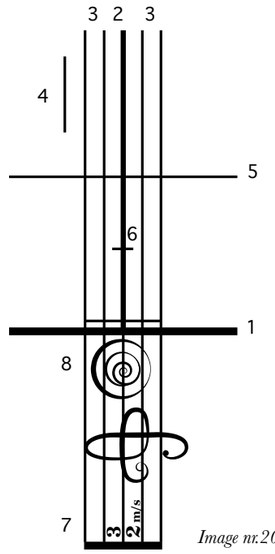


Image nr.206

Indicating that the part of the score is shown in all three dimensions sequentially. X is the horisontal axis, Y is the vertical, Z is depth, W is time.

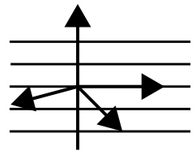


Image nr.207

Aural clave

Image nr.208

Sound passing by rapidly above the listener on the left side.

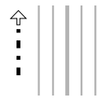


Image nr.209

Sound passing by rapidly below the listener on the right side.

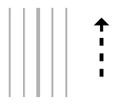


Image nr.210

Sound passing horisontally, left or right.

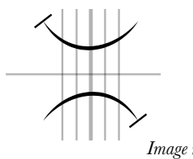


Image nr.211

A stationary source with a continuous sound fading out then in.

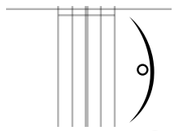


Image nr.212

A moving source with a continuous sound fading in and then out.

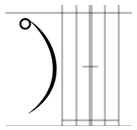


Image nr.213

Sound pocket or a drastic reduction of sound.

Image nr.214

Partial soundpocket on the right side of the listener.

Image nr.215

Strong sound appearing briefly from below on the left side of the listener.

Image nr.216

Soft sound appearing briefly from below on the left side of the listener.

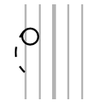


Image nr.217

Strong sound appearing briefly from above on the right side of the listener.

Soft sound appearing briefly from above on the right side of the listener.

Image nr.217

Crescendo and decrescendo or diminuendo of the keynote or general ambience.

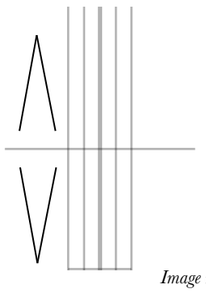


Image nr.218

Musical notation test

The spot illustrated in the LabAural notation is here depicted as a pseudo-musical notation. It is meant to purely illustrate ***qualities of sound***, e.g. loud, gliding, cranking, passing, etcetera.

Disadvantages

The notation is quite difficult when it comes to giving every specific sound artefact its own character and meaning that can then be read with ease by a receiver.

For it to work practically I think it would require some digital equipment, or app, into which all the signs can be read and played back. It would also be extremely useful if you could record the sounds in the environment you´re trying to notate and the program would translate it into a sheet of notations.

(There is an app called Phonopaper which does translates shapes, forms and hues into sounds. and sound into a form of image which can be played back to sound.
But it is a very crude tool and the synth sound is not representative of the actual sound that was recorded to begin with. I just wanted to mention it because the idea is very interesting, but the execution is not applicable to soundscape studies at the moment.)

Music notation test Rome
Link to animation: https://vimeo.com/419281507

Or scan the QR-code

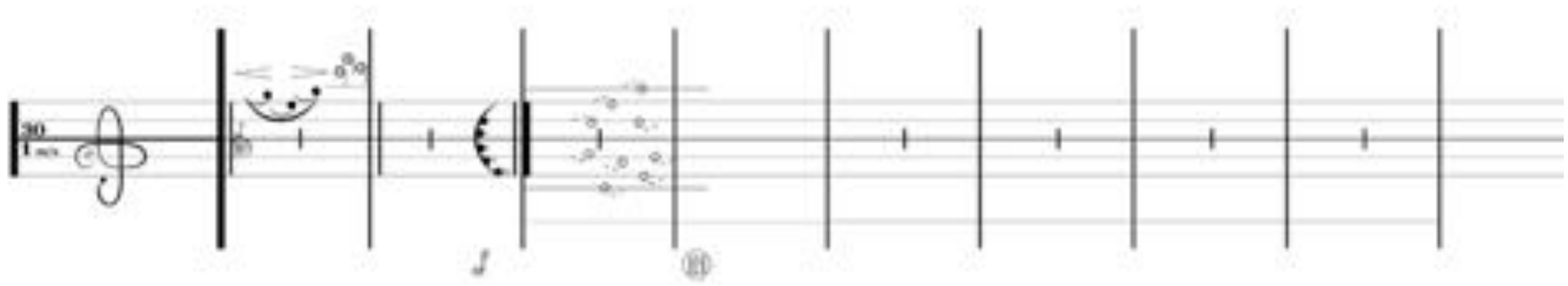


Image nr.219

Kinetography

Labanotation

Many notation systems have drawn inspiration from the Laba Notation (image 5), originally intended for dance and choreography. It is a simple, yet complex system that allows the information of the choreography to be accessible in written form.

The downside with any of these systems is that they require a deep knowledge and understanding of the system to be comprehensible. This is not a problem when used specifically by those who are very familiar with it. But I started thinking that it was a pity that these fantastic creations aren't being used and put to work in this field of study more.

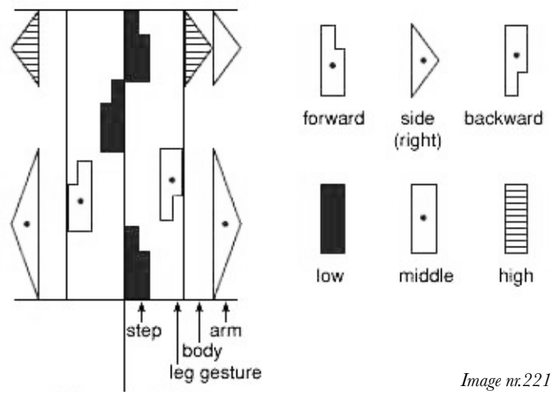


Image nr.221

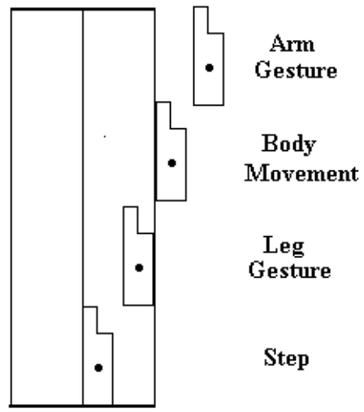


Image nr.222

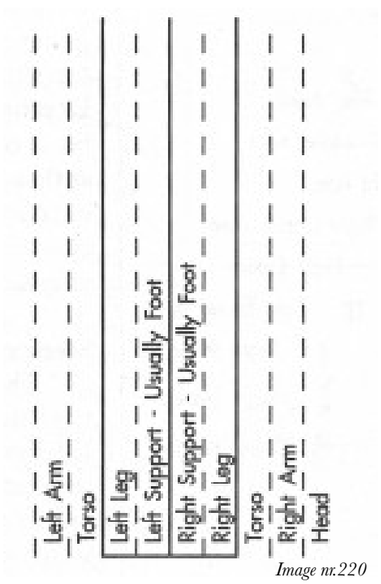


Image nr.220

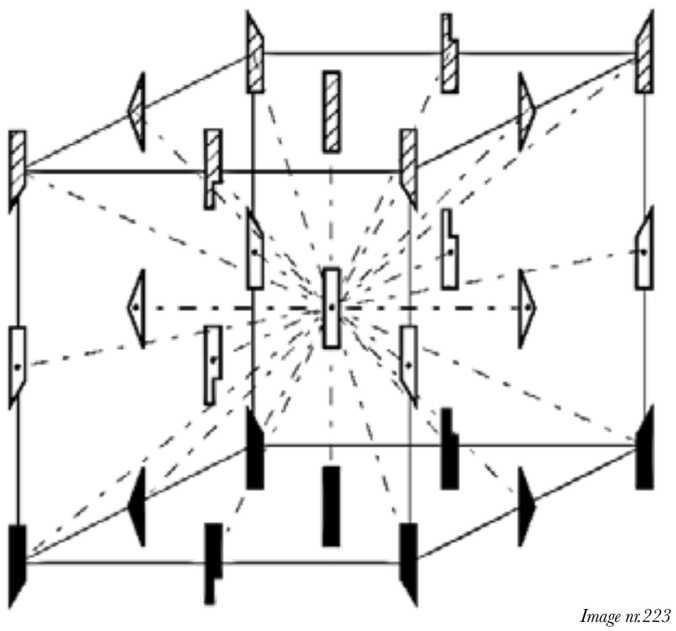


Image nr.223

Tweaking the Labanotation

to act as sonic notation I have called LabAural notation.

Here I have done some simple figures that could represent sound sources in space. The stave is the same as in the Labanotation, but instead of transcribing the listeners body it notates the environment that the listener inhabits.

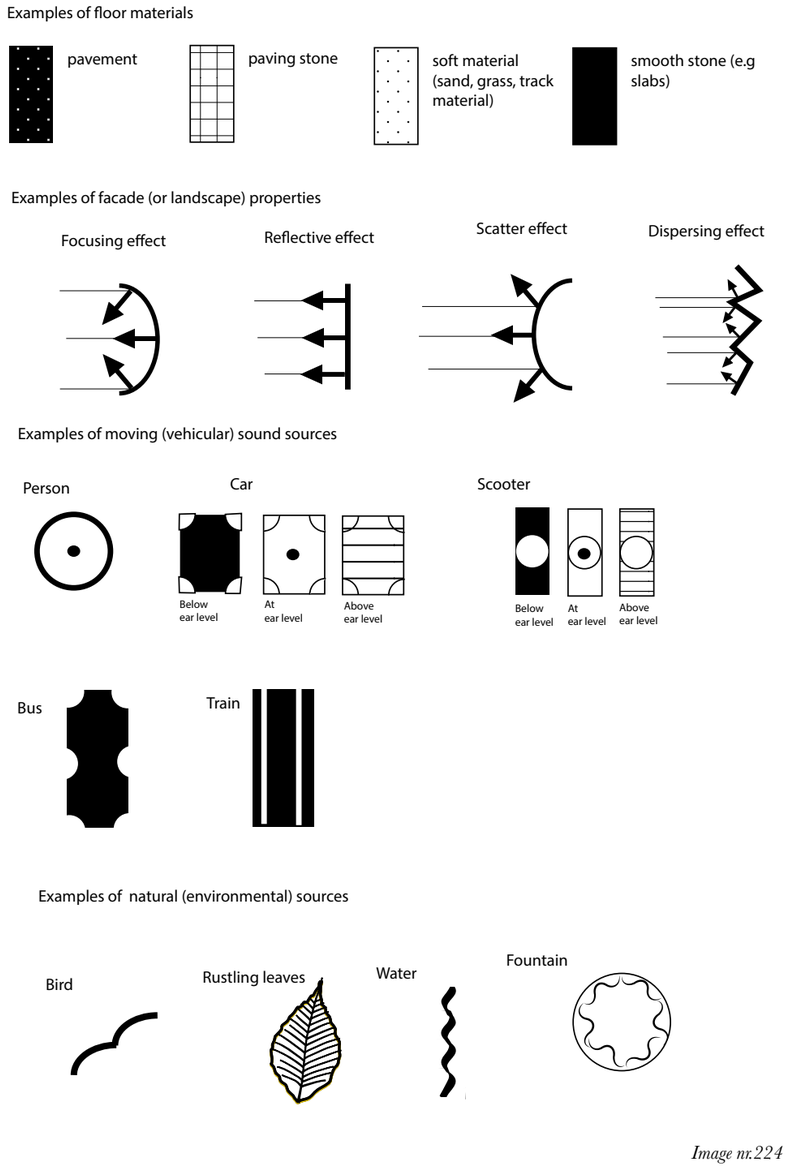


Image nr.224

LabAural notation

The spot shown in 3D-view on page 83 is here illustrated with my adapted Labanotation called LabAural notation.

The notation shows surface material, facade material and objects acting as sound sources or reflectors.

Disadvantages

The notation easily becomes muddled and it is difficult to discern what is happening simultaneously, especially when there are moving objects that move much faster than the listener but make a lot of sound that affects the listener.

A lot of information is competing for attention and because it is drawn in 'top-view' it can be tricky to create symbols that are easy to read.

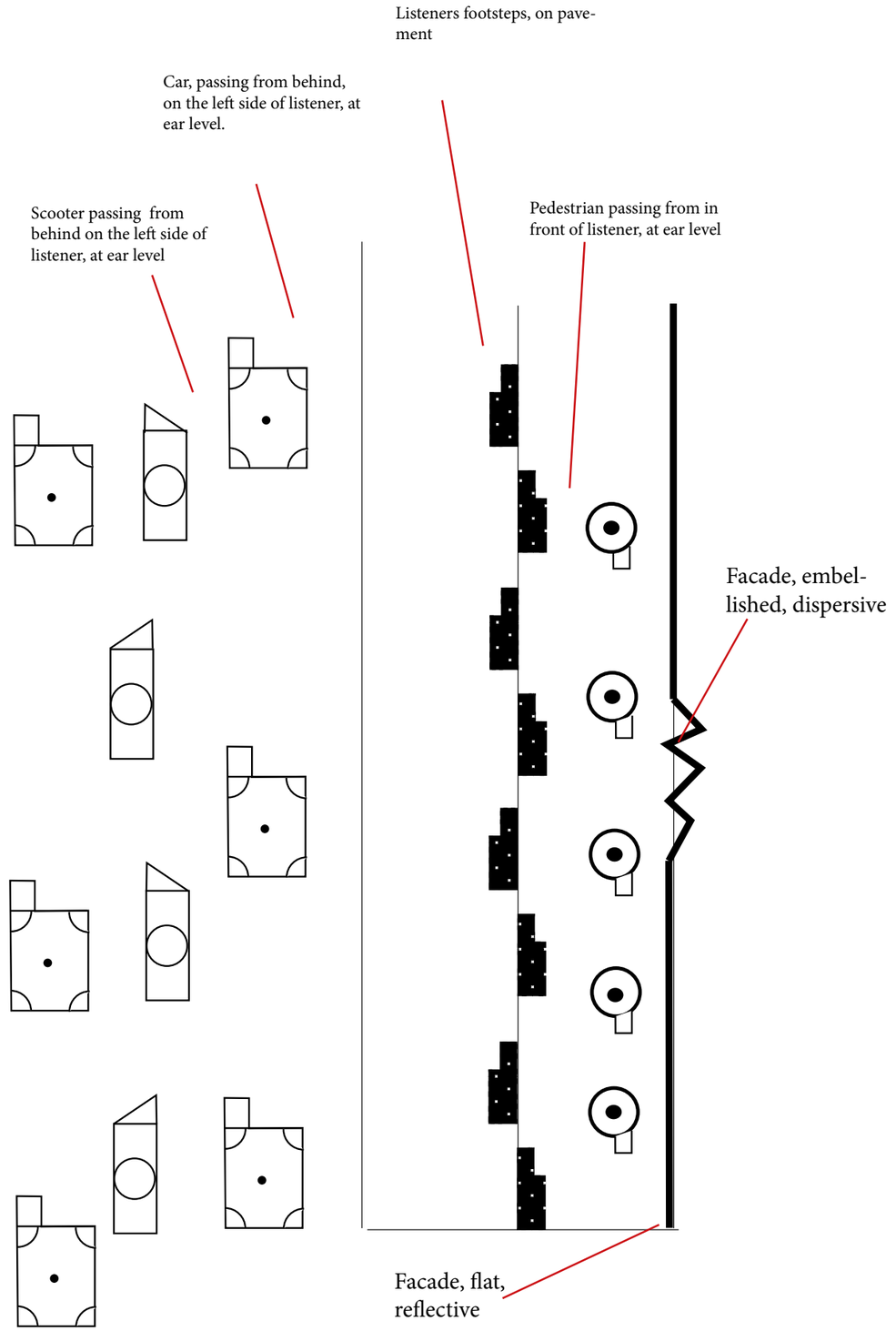


Image nr.225

Benesh notation

”Ballets have to be recorded accurately so that they can be passed on from generation to generation. Written descriptions are cumbersome and easy to misinterpret.

Video can be very useful, but even video can only show a dance in two dimensions, and is not completely reliable.

In addition video gives one particular interpretation of a ballet rather than a record of the choreographer’s intent. Dance notation is one tool that can be used to help dancers learn a ballet more quickly and accurately.

How the notation system works

This notation system uses the base of a music stave to record movement.

The “in stave” information will dictate what the performer is doing
The “above the stave “ will tell us when this movement is done and with what quality of movement

The ”below stave information” tell us where this action takes place and the relationship between the dancers.”[22]

Advantages with the Benesh notation for sonic recording

Having some theatrical experience myself, I find the Benesh system to be easy to read (the system is fairly straightforward and logical) and it is seemingly easy to draw because it uses single lines or marks rather than voluminous boxes that the Laba notation utilizes.

Both the ease with which you read and draw a notational is quite essential when it comes to practical use. If it is too difficult or time consuming to read and write then you’re just not going to bother with it for long.

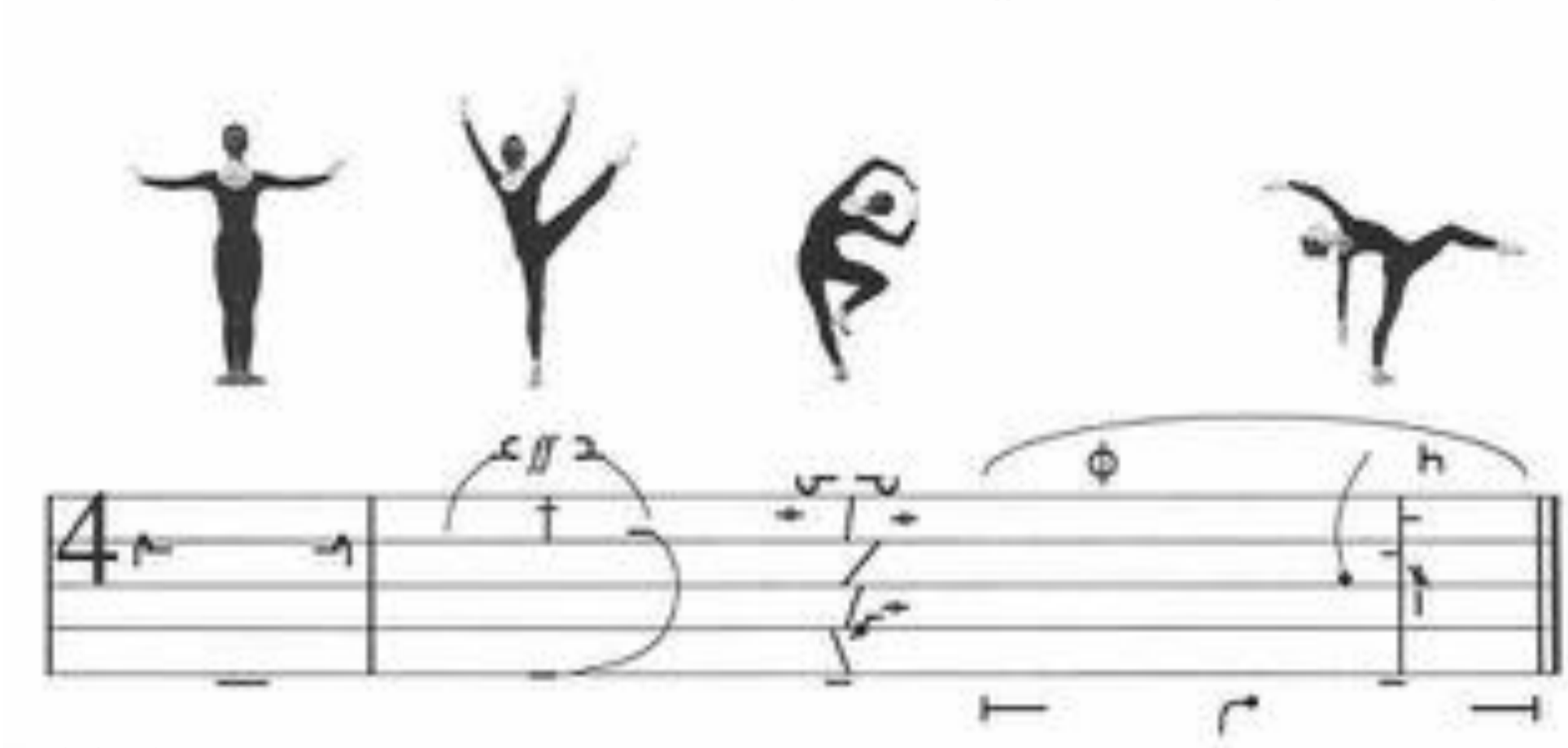
The legibility in this system probably comes from the way it is presented; as a horizontal staff where the feet are on the lowest line and the head on the top. Even if you don’t know exactly what the scribbled signs mean, you get a sense of what it is trying to convey.

What also appeals to me with this system, is that it reminds me a little bit of the attempt at sonic notation that I did six years ago (See ’Space-nuts’ on the following page). Those ideas were based on Halprin’s Motation and modern music notation. Unlike the Benesh system it is drawn as a top view, more similar to Labanotation and Halprin’s motation.

These three systems (Halprin, Laban and Benesh) have similar problems; they are basically two-dimensional, even if they of course deal with directions such as in front, behind, crossing, etcetera. The drawing is still 2D and we have to interpret the signs into a virtual 3D-image in our minds.

And wanting to draw sound, which is a 4D experience, it becomes complicated when you loose not just one dimension (3D-drawing), but two!

The downside with 3D-drawing is that it is time-consuming to draw and legibility becomes muddled.



Example of Benesh notation

Image nr.226

22 - Benesh in Action - https://benesinaction-com/what-is-benesh-moevement-notation/ (2020)

Adapting the Benesh notation for sonic recording

I have chosen to do a simple structure for my adapted Beneshnotation, and call it Son-esh.

Since the original system is intended for dance and not sound, we first need to consider the placement of sound sources on the staves.

If the top stave represents the head in the original and the middle the waist and bottom the feet. If we were to apply the system directly to a sonic notation then almost all the sound sources would be at or above the top stave or at shoulder/ear height.

I therefore propose to place the listeners head (illustrated in image 1) on the middle stave to save paper space, meaning that everything that is sounding at ear level will be placed in the middle of the system. A car will be slightly below the middle stave and a bird in a tree will be just below or at the top stave. An airplane will be high above the staves.

As in Benesh, the sign indicating the body center will eventually disappear and be something that we know is there but don't have to draw it in to every single frame. The only time that we would draw the listener center would be if there is a dramatic shift in position for some reason, if we are lying down on the floor, or hovering above it.

I will use the feet signs to indicate whether the listener is moving, or resting. See images 2 and 3. (we don't walk 'on point', but I thought it would do nicely to indicate that we are walking).

Remember that the Benesh notation assumes that we 'see' the actor form behind, so if I hear something on my right side, it will be drawn to the right of my listening center!

I have also thought about floor material, as this has an effect both on the listeners own footsteps sound like, but also to guide the reader to understand what the sound propagation might be like in that particular environment (reflective, absorbent, etcetera). Of course, there can be several different floor materials in one frame. *See images 4 to 9.*

The resting sign will also be used for sound sources to indicate whether they are moving relative to the listener or the other way around or if they are both moving or still. *See example in image 10.*

I use the basic in front, level and behind signs as in the original, but for movement I will use more arrows to show direction rather than the original Benesh closing signs. One major problem with showing movement is when something moves horizontally from back to front or vice versa.

I use the same basic principle as in the original notation but with some minor tweaks. An object that comes from behind, passes and continues to move in front of the listener is shown in image 11.

You will recognize the signs, or piktograms, used for vehicles, people, birds and more from the previous chapters.

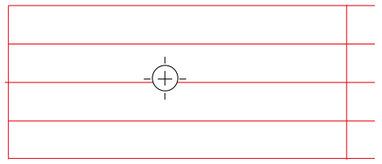
Disadvantages

The notation is, as with the previous examples, in 2D which means that you lose some of the finer depths of orientation of the soundscape. For instance; how far away a sound is heard, is it faint, strong, etcetera. It is a very intimate notational system in that sense.

Advantages

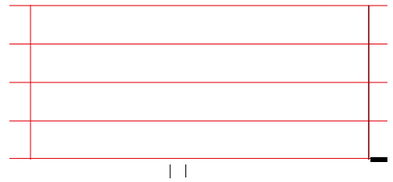
It can be given certain morphological powers in terms of architectural or spatial form. By including the floor material I see no reason why I can't add physical structures as well. For an example of what that could look like go to Chapter VI - Synthesis.

Image nr.227



1 - Listening center

Image nr.228



2 - Listener walking/moving

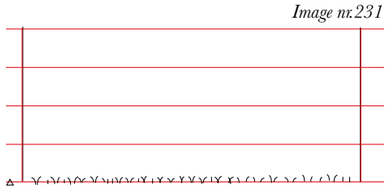
Image nr.229

3 - Listener resting (in place)

Image nr.230

4 - Sand

Image nr.231

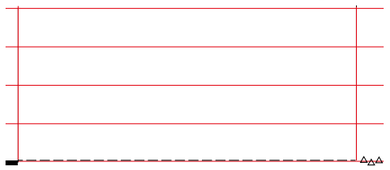


5 - Grass

Image nr.232

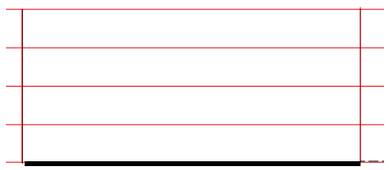
6 - Macadam

Image nr.233



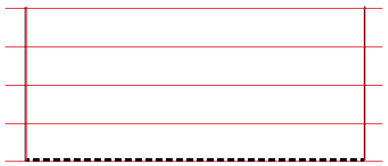
7 - Paving stone

Image nr.234



8 - Tarmac/asphalt

Image nr.235

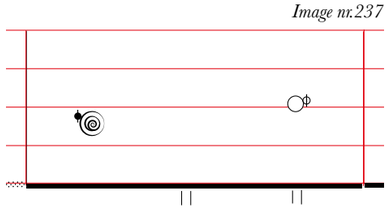


9 - Cobble stone

Image nr.236

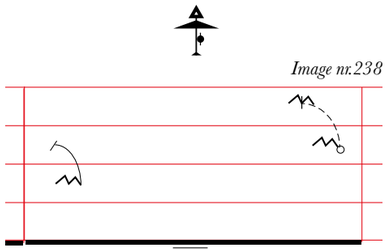
10 - A bird singing while sitting still. The listner is resting in place. The sonud from the bird is slightly above the listeners head.

Image nr.237

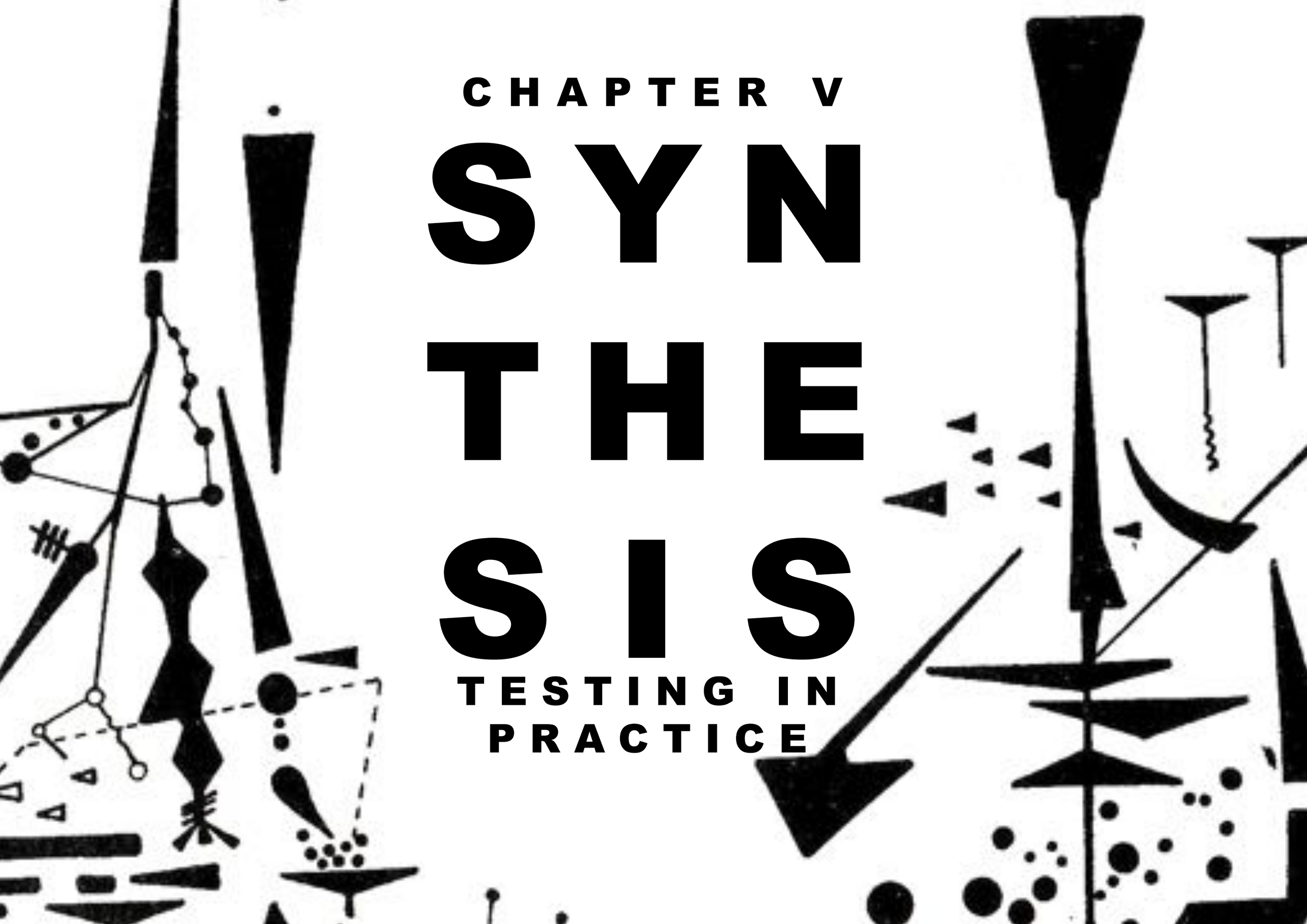


11 - A car passes the listener from behind and continues to move in front without diverting from its path. A person approaches the listener and continues on the same path behind.

Image nr.238



11 - A plane passes overhead and two birds are flying around.



CHAPTER V

SYNTHESIS

TESTING IN PRACTICE

Synthesis

In architecture, synthesised composite drawings is like a collage mixing different techniques and graphic styles in order to convey the most information possible about a project.

In the previous chapters I have tested different techniques, old and new, to see which one/s fit the bill. I think that there is no absolute answer to this, as this is a very subjective discussion. But, by doing these exercises a pattern could be emerging.

Testing in practice

On the following pages I will revisit an old project of mine, from my third year in Architecture School.

The brief

West Kungsholmen is (was) expanding and needs a strategy for building more housing. The brief focuses on developing the west side of Kungsholmen and also include Alvik (further to the west, across the water).

It was a group assignment and together we did a variety of site analyses which then lead us to a proposal of a ”master plan”.

Fortunately for me I have actually lived in Kristineberg for a couple of years so I have a pretty good idea of what the area is like and, most importantly, what the soundscape is like.

Testing framework

I will go over the project from 2011 again and do the analysis part with sound as the key factor. The idea of this whole thesis is that if we start the project from that point of view then, hopefully, the sound scape will have more resilience to projected sound pollution in the future.

In this project we encounter a type of sound that has not been visible in the case studies, namely air plane noise. The national airfield Bromma Airport is located west of Kungsholmen and the planes that arrive or depart from the airfield usually pass over Kungsholmen.

I’ll start the analyses where we finsihed the project in 2011. I will do a set of analyses, utilizing techniques tested in previous chapters, that could indicate what the soundscape is like with the planned additions and what can be done to alleviate sonic problems.

The area before 2011

Essingeleden, the highway connecting north and south of Sweden through Stockholm has been in use since the late 1960’s. When it was constructed the area was home to many families living in the so-called Barnrikehusen, a form of social housing, homes built by the state in the 1930’s to accomodate families with at least three children.

When Essingeleden was built there was a need for expanded transportation routes and the site was probably chosen beacuse of its location, just outside the busiest parts of Stockholm as well as plenty of available land.

We spoke to the Board of Transportation, asking if there was any possibility of rebuilding the highway or putting it under ground. But the cost of doing that would be enormous, not to mention the time it would take and the negative impact on transportation during that time.

This problem wasn’t really a problem until housing developed next to the highway and people living near the highway were affected by the noise. The same problem as with Bromma Airport.

The area in 2011

Around the same time as the construction of Barnrikehusen, the Bromma airport was inaugurated in 1936. Just like the Essinge Highway, the noise pollution from the aircrafts didn’t affect enough people for it to be placed somewhere else.

The plans for the expansion of the city, however well designed in other aspects, did not take into consideration the development of vehicular and aerial transportation. The rate at which technical development is moving is, and was, too fast for city planners to keep pace with.

The area in 2020

The area is very different now than it was less than a 100 years ago. The green areas have shrunken down considerably and the amount of traffic has increased.

The soundscape varies over the day, with flights to Bromma airport restricted to day-time only so you basically only hear it if you are at home during the day.

The subway runs between 05.30 and 01.30 in the weekdays and all day and night during weekends. Highway traffic also fluctutates when people are leaving or going to work, or go on holiday outings.

In the park, marked with a red ring, there is a little pond where birds flock. They seem to love it there and they make a lot of noise.

When all the other noises fade, the birds are heard more clearly, taking over the soundscape.

The work on noise reduction is not, in an apparent way, making the same progression as would be needed to mitigate the effects of noies pollution.


Map dated 1939

Image nr.239


Map dated 1960’s

Image nr.240


Map dated 2020

Image nr.241

West Kungsholmen - Plan

Legend

- Very reflective surface
- Semi-reflective surface
- Absorbent surface
- Normal reflective surface (e.g. asphalt)
- Airplane
- Bird
- Boat
- Highly trafficked
- Parallell walls (reflecting sound)
- Flight path
- Walk (illustrated on page 46)
- Sound source and sound waves
- Building
- Sound source
- Sound wave

LILLGSSUNDET

TRANEBER

0 100 m

Image nr.242

West Kungsholmen - Perspective view

Image nr.243

West Kungsholmen

Population (the whole of Kungsholmen): ≈ 71 000 (2018)

Area: 3,9 km^2 (the whole of Kungsholmen)

Grid type: right angle, diagonal cuts

Keynotes: Highway traffic, subway, airplanes

Soundmarks: Boats, birds

Signals:

The proposal from 2011

The buildings and green areas that have a darker hue are the proposed additions to the area. I have included markings for different types of surfaces and soundmarks that can be of interest for the sonic tourist.

The brief

This map is only showing a part of Kungsholmen, and a part of Alvik - across the water. This is beacuse the main objective with the project was to expand and densify the city (Stockholm) to the west.

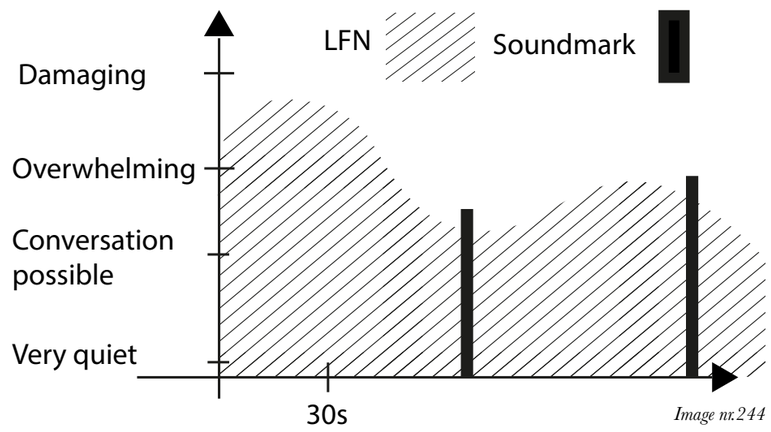


Image nr.244

LFN stands for Low Frequency Noise, usually caused by motorized vehicles. The y-scale indicates loudness, and the x-scale indicate time-intervall.

Traffic - ground, rail, air

The estimated average traffic during high rush hours (16.00) based on my memory (I lived there for more than a year) as well as traffic maps illuminates the roads.

There is much traffic in this area, not only cars and trains, but also aircrafts coming in low for landing at Bromma airport. From the west point of Kunghsolmen, where the bridge meets the water, to the airstrip it is approximately 3,5 km. This means that when the aircrafts pass over Tranebergssundet, they have started their descent to the airfield.

When they fly over the water, the noise amplifies. There are, of course, quiet(er) times of the day, after the rush hours and later in the evening when the air traffic stops.

The subway, however runs late at night during the weekdays and all night on weekends. The traffic going east-west is usually spaced out a bit more than the north-south bound highway over the day, even if rush hours can get very congested there too.

Focus area

From here on I will focus on the the are marked by a red circle. This is a part of the area that I was in charge of for the project. It is also quite exposed to all the main sound pollutions in the area.

Image nr.245

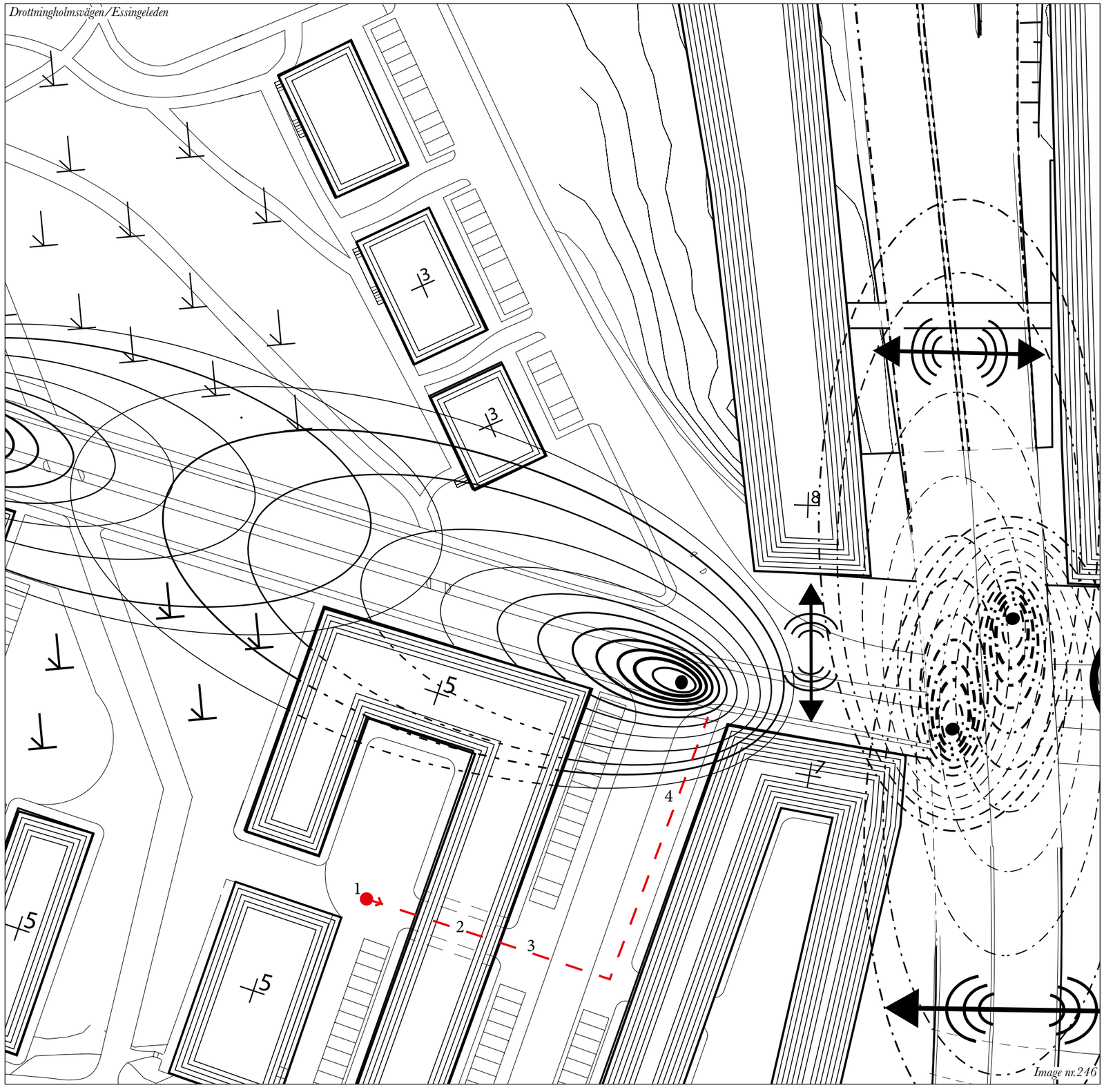
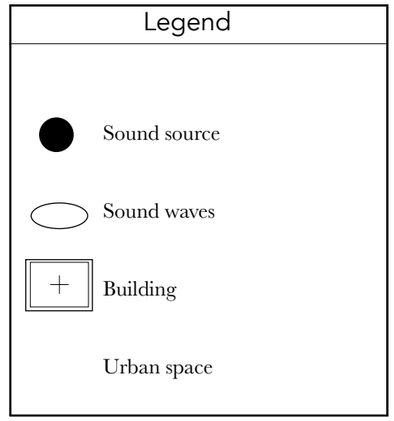


Image nr.246



Spatio-sonic topoghraphy

From what we have seen in previous chapters, we can deduce that this spot is particularly noisy locally as well as globally. There is a direct noise impact on account of the direct sound waves, but also from reflected and amplified waves. The crossroads in the residentail areas face the busy streets on a right angle meaning that the sound from cars can propagate freely in between the buildings.

The tall buuoldings enclosing the highway unfortunately have parallell standing walls meanin that the even louder noise there also is amplified. And because sound waves move in all directions the ground level is polluted by the noise.

By using simple morphological design some of this could be avoided. The crossroads should be angled 45° to the main road and they should also be narrower, resembling the layout of the case study in Rome more.

The tall buildings enclosing the highway should be replaced with landscaping in the form of small and dense hills.

Soundwalk

We can clearly see that the semi-walled in highway is somewhat shielded form spilling noise when the cars are driving between them (although they should probably be a bit taller). However, the part when the highway crosses the road beneath, the buildings act like a valley and noise that spills out on the sides is amplified.

The road below has very little in terms of sonic shielding. And the buildings are facing the street straight on and the roads are in a perfectly right angle towards the road, meaning that the noise has completely free mitigation into the domestic area.

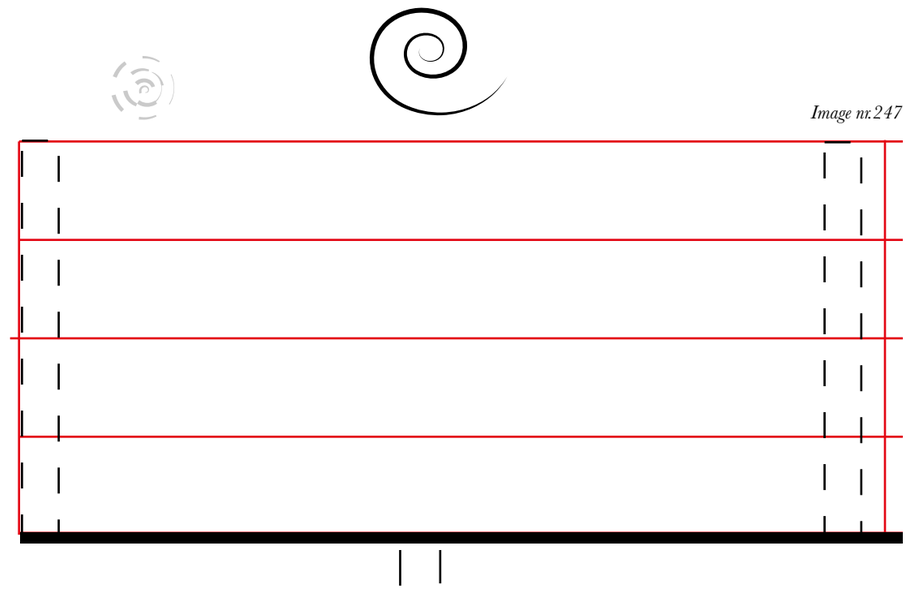


Image nr.247

I walk on asphalt, there are buildings on either side of me. I hear cars faintly to my right.

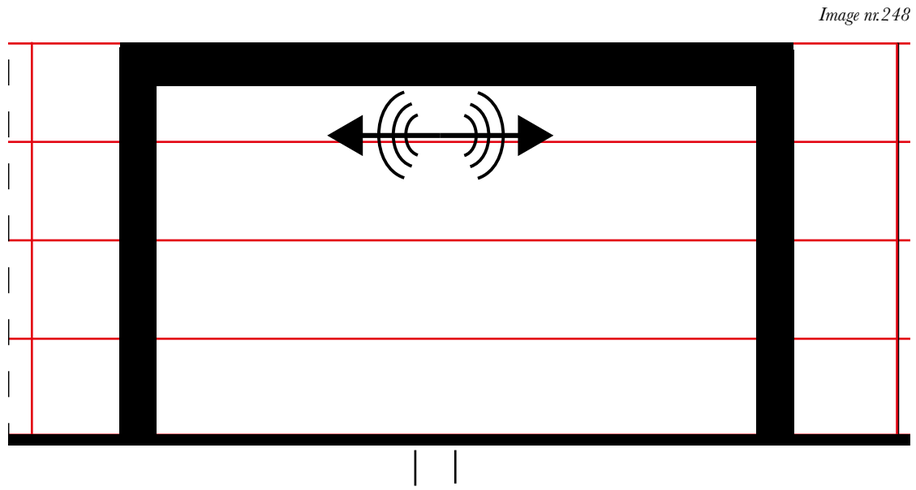


Image nr.248

I am inside a tunnel, my footsteps echoe on the walls.

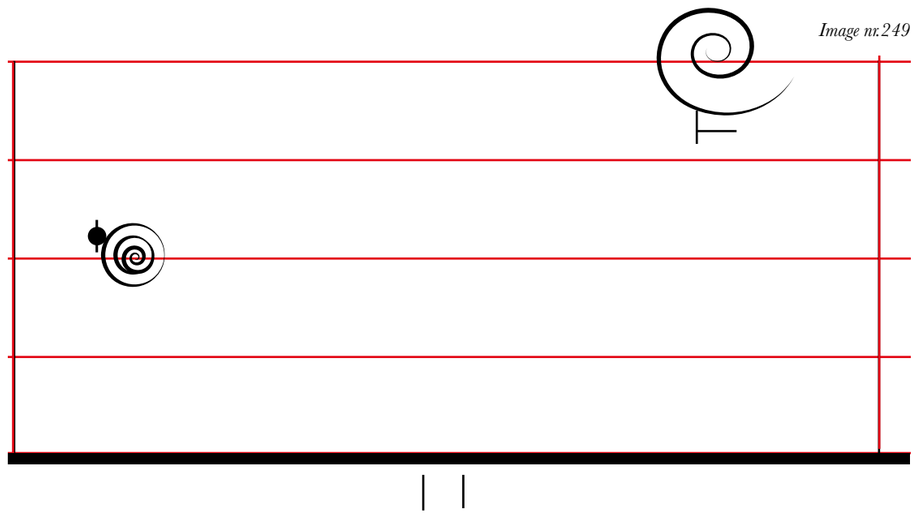


Image nr.249

I have exited the tunnel, a gust of wind shoots over me. A car passes on my left (from behind).

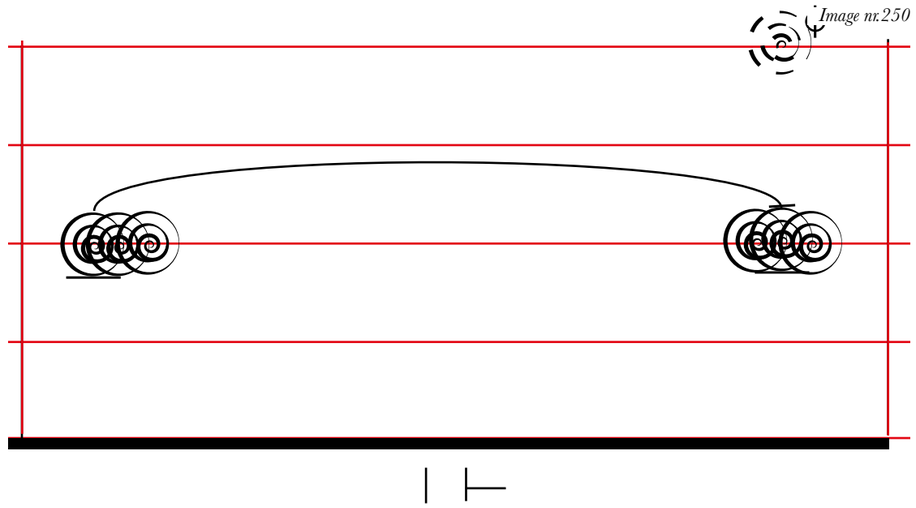
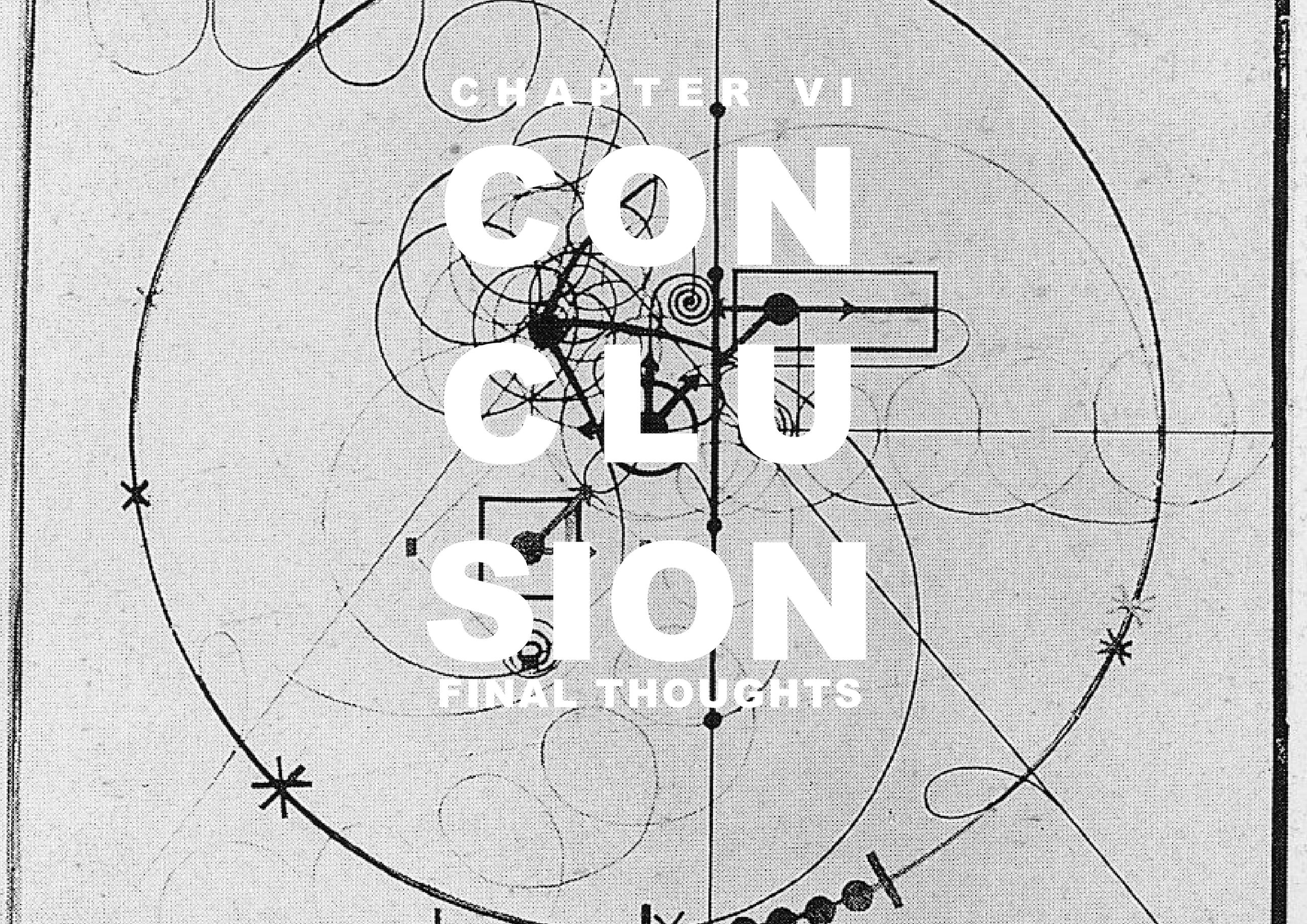


Image nr.250

I turn 90 degrees and the cars now pass i fron of me, from left to right. I hear cars above me, passing from behind me.



CHAPTER VI

CONCLUSION

FINAL THOUGHTS

Final thoughts

This is a summary of my work and what I have learned from it.

The three most important things from which I believe that the reader can benefit the most from are: ***aural topography*** - and the idea that sound can be given solid properties in mapping, ***sonic illumination*** - and the theory behind that particular style of mapping sonic environments and ***sonic notation systems*** - a study in how to create a shorthand for quick and easy written notation of soundwalks, serving as a memory aid or communicative tool.

Digital vs. analogue sound

I said in the beginning of this thesis that I am interested in the physical, built in sounds of architecture and urban spaces. I am interested in both mitigating the future increase in sound pollution as well as the identification and preservation of sounds that are of aesthetic and/or cultural value. To me, the life-expectancy and evolution over time, of a soundscape is on the scale of centuries, not decades.

Applications in the form of technological interventions (e.g loudspeakers, digitally interactive facades, etcetera) have been consciously excluded from my research or when formulating theories, other than stating the fact that some of the soundscapes I visited had digitally produced sound artifacts present in their soundscape.

Experimental interventions, such as the placing of speakers, in a soundscape can be very exciting and provide interesting data. But, since I do not wish to implement such devices in any future soundscape designs of mine I think that I am the wrong person to conduct such experiments at this point of my research.

I believe that digital sonic interventions, while being lovely and creative and interesting as an experiment, doesn't fix the problem with poor sonic planning decisions, nor the formation of sustainable soundscapes and noise-resilient cities that are not dependent on technology that need maintenance.

I want my future research to focus on large urban soundscapes rather than a handful of installations that would run the risk of drowning in an ever louder soundscape.

I do not in any way mean to direct negative critique to those who do sonic installations, (in my bibliography you will find examples of publications that deal with sonic installations in urban environments, for example the dissertation by Gunnar Cerwén) I just want to explain why it is not **my choice** to do so at this time and point of my research.

Alternative data

This journey that I did taught me about more things than just urban soundscapes. I have also learned quite a bit about how, or how not, to conduct this kind of research.
For example, I wish I would have had the means to do high-quality recordings or thought of preparing questionnaires that I might have given to the people I met.

Constructing questionnaires is a science in its own right and I am not sure that I would have had the time or ability to make proper ones given the limited time in which I had to prepare for my journey in 2013.

Considering scale

My work moves between large landscapes and more intimate scales and I think it is important to deal with them both, to consider the soundscape as a whole world which is greater than the sum of its parts. The small scale affects the larger soundscape and the other way around, and the lines between them shift all the time.

I hope that I have been able to show this logic of scales in the chapter on morphology where the grid, layout and height-to width ratio of urban environments have been given much weight in terms of sonic effect in the soundscape.

Research method

I recently learned the difference between deductive[23] and inductive[24] analysis. I think my work in this thesis has been more of the inductive kind, by this I mean that the main portion of my time has been spent on gathering data and testing ways to analyze them and through that work I have gained new knowledge and theories on how to analyze urban soundscapes.

I believe there is much more data waiting to be uncovered and many more ways of collecting that data.
I sincerely hope to be able to explore this subject further in the future. In a future work I would probably try to use slightly different methods, not because I think the methods I used now was wrong but because I want to broaden my perspectives and further my knowledge and research skills even more.

Last words

This has been a very challenging project given that the subject positions itself between architecture and landscaping as well as between acoustics and dance/movement.

I have learned a lot from this research project and I hope that I have been able to convey something of value to the reader and that it can influence new thought and ideas regarding urban planning.

I don't see this as the end of a research, but as a beginning. I look forward to see what the future will sound like.

23 - **Deductive research**: developing a hypothesis based on existing theory, and then designing a research strategy to test the hypothesis

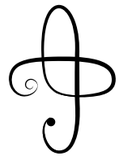
23 - **Inductive research**: the generation of new theory emerging from the data. The aim is to generate a new theory based on the data

Spatio-sonic symbology

Here I will list the key factors of soundscapes, along with the symbols that I have chosen to assign them. In the previous chapter, Synthesis, some of them have been implemented and tested on the proposal from 2011.

And some have emerged during the final testing stage due to the vastness of sound sources in urban soundscapes.

Aural architecture

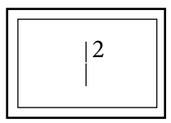


Acoustic space/accidental aural space

Aural void

Bird

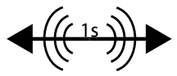
Building. The number of storeys are indicatd with how many lines that are filled in as well as a number in the right corner of the cross-hair



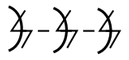
Car

Church bells

Echo/reverb

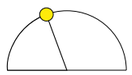


Electrical fence



Environmental factors (temperature, wind, rain, etc.)

34ºC



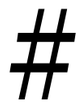
Fake natural sound (birdsong in the subway)

Fountain

Spatio-sonic symbology

Gridtype/s

"the grid" (right-angle)

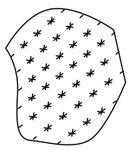


semigrid (right-angle cut with diagonals)

no grid/organic

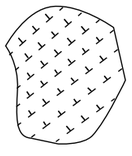
Ground materials and sonic properties

semi sound absorbents (trenches, dense forest)



semi reflectants (grass, shrubs, cliffs with vegetation etc.)

hard/very reflective (metal, water, bare cliffs etc.)



Keynote

Loud speakers

above

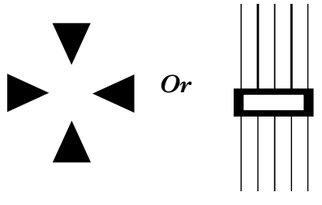
below

ear level

Siren

Soundmark

Soundpocket



Time (of day)

Glossary

Most of the words in this glossary are commonly used in musical theory, acoustic theory or related subjects.

Some are invented or re-purposed by me (marked in yellow) and some are likely unknown for others than the initiated.

Acousmatic referring to a sound that one hears without seeing the causes behind it (Schaeffer 1966: 91)

Acoustics From the greek word akoustikos now refers mostly to the behaviour of sound waves.

Acoustic Architect Uses the language of physics to describe sonic processes as phenomena that can be measured.

Acoustic Architecture Design that manipulates physical objects and spatial geometries. Focuses on the way that the space changes physical properties of sound

Ambience Quality or character given to a sound recording by the space in which the sound occurs.

Amplitude The height of the sound wave and that which makes the sound loud or quiet.

Ant trails The seemingly random pattern of movement in a landscape (urban or rural alike) and diagonal paths chosen for optimization of path of least resistance, (instead of moving in right angles)

Archetypal sound Carried forward century after century and knit societies with ancestral heritages, providing continuity at the deepest levels of consiousness.

Audio Audioanalgesia Latin word for; I listen, to listen
the use of sound as a painkiller, a distraction to dispel distractions. (Schaeffer 1966: 142)

Aural Refers exclusively to the human experience of a sonic event

Aural Architect An aural architect, acting as both an artist and a social engineer, is therefore someone who selects specific aural attributes of a space based on what is desirable in a particular cultural framework.

Aural Architecture The properties of an acoustic space that can be experienced by listening. Frequently an incidental consequence of unrelated sociocultural forces. Exists regardless of how the acoustic attributes of a space came into existence; naturally, incidentally, unwittingly, or intentionally.

Aural void In this thesis I use it to describe places that are *void of sound because of social, rather than physical, mechanisms.* For example, a deserted office-block at night, a park or open field without any audable human acitivity. In Jacky Bowring's Melancholy of the Landscape she decribes it like this: 'The coming of silence creates a temporal 'space'. [Aural voids are] moments in the aural landscape which are sculpted as explicit absences of sound.'

Auto-ethnography a form of qualitative research in which an author uses self-reflection and writing to explore anecdotal and personal experience and connect this autobiographical story to wider cultural, political, and social meanings and understandings

Broadband Noise No distance, only presence

Cymatics The study of visualizing sonic wavepatterns by vibrating a selected medium.

Decibel Commonly abbreviated as (dB) used to express the absolute level of the physical quantity, as in the case of sound pressure (against the ear drum)

Doppler Effect A phenomenon in which a listener hears a higher pitch than that produced by an object when the object is mowing towards the listener, and a lower pitch when it is moving away.

Echolocation Biological SONAR. A technique mostly found in animals (e.g bats, whales, etc.) in which calls or clicks are emitted and the bouncing echo is used to navigate and identify objects or spaces. See SONAR

Frequency The frequency is what is known as the pitch, and it is defined by the number of wavelengths that pass through a given point per second.

Hi-Fi High Fidelity;
a favorable signal-to-noise ratio.
A Hi-Fi environment is one in which sounds may be heard clearly without masking or crowding.

Interference The general name for what happens when two or more waves combine.

Isobel Map See section on notational systems.

Keynote In SOUNDSCAPE studies, keynote sounds are those which are heard by a particular society continuously or frequently enough to form a background against which all other sounds are perceived.

Laban See section on notational systems.

Landscape The creation of inter-sensory spaces in landscapes is the combination of all sensory-based contributions that create an overall experience.

Listening Listening is an active, conscious and focused act unlike hearing, which is often an involuntary experience.

Lo-Fi Individual acoustic signals are obscured in an overdense population of sounds.

LFN Low Frequency Noise. Usually caused by cars, but can also be ventilation fans or similar.

Masking sound [..]the process by which the threshold of hearing for one sound is raised by the presence of another sound. ... The loud sound has a greater masking effect if the soft sound lies within the same frequency range, but masking also occurs when the soft sound is outside the frequency range of the loud sound

Musical Intelligence Can be divided into separate skills of recognising melody, harmony, pitch and rhyme. These skills may or may not be present all at once in one single individual. The various abilites to appreciate, or even recognise, them differ significantly among the population.

Node A node is where the amplitude of the wave is zero. Antinodes are where the amplitude (positive of negative) is a maximum, halfway between two adjacent nodes. In a traveling wave, both move with the propagation velocity of the wave

Noise Unwanted and/or disturbing sound

Noisemap Map showing levels of sound pressure (dB) in a landscape/urban area.

Notation a system of graphic symbols for a specialized use, other than ordinary writing

Ocularcentrism The privileging of vision over the other senses.

Onomatopoeitc A word that sounds like what it represents. For example: gurgle or clang.

Psychoacoustics the study of the perception of sound. This includes how we listen, our psychological responses, and the physiological impact of music and sound on the human nervous system.

Resonance In sound applications, a resonant frequency is a natural frequency of vibration determined by the physical parameters of the vibrating object.

Reverb created when a sound or signal is reflected causing numerous reflections to build up and then decay as the sound is absorbed by the surfaces of objects in the space

Rhythm Timed movement through space

Sacred Sound Any noise or sound which is exempt from social proscription.
Originally referred to natural phenomena such as thunder, volcanic eruptions, storms, etc... [...]

Sensory Overlap The expression may be extended to social noises which, at least during certain periods in history, have escaped the attention of noise abatement. Touch is the most personal of the senses. Hearing and touch meet where the lower frequencies of audible sound pass over to vibrations.

Signals Foreground sounds, listened to consciously. For example: bells, whistles, horns and sirens.

SONAR SOund Navigation And Ranging. Passive sonar listens for the sounds made by vessels. Active sonar emits pulses of sounds and listening for echoes. See Echolocation

Sonic object An object that either produces sound (vehicle) or transmitts sound (speaker), or an object that reflects or enhances sound (see sonic illumination)

Sonic illumination is typically an artifact (e.g. sound reflection) of some social activity, such as a concert, lecture, or traffic in an urban environment.
[...] the visual equivalent of a space illuminated with multiple lights: some bright, some dim, some colored, some blinking, and some moving.

Sound Created when an object, or a surface, vibrates causing the molecules in the air to shift in a corresponding way. (We hear the sound when the waves caused by this vibration hits our eardrums, which then also starts to vibrate and send signals which our brain can interpret.)

Soundmark The term is derived form landmark, it refers to a community sound which is unique or posesses qualities which make it specially regarded or noticed by the people in that specific community.

Soundpocket an urban space in which a Hi-Fi environment can exist, inside a landscape of Lo-Fi environments, due to physical enclosure (tall buildings, walls, earth mounds, etc.)

Soundscape The sonic environment. Technically, any portion of the sonic environment regarded as a field for study. The term may refer to actual environments, or ot abstract constructions susch as musical compositions and tape montages, particularly when considered as an environment.

Sound signal Any sound to which the attention is particualrly directed. In soundscape studies sound signals are contrasted by KEYNOTE SOUNDS, in much the same way as figure and ground are contrasted in visual perception.

Soundwalk To move through a landscape with the intent of recording the soundscape. Or; to recreate a asoundscape in a controlled environment e.g a recording accompanied by moving images.

Spatio-sonic Illustration aspects of space, sound and temporal variables are highlighted in spatio-sonic illustrations

Sustain the period of time during which the sound remains before it becomes inaudible, or silent

Synthesis the combination of components or elements to form a connected whole

Tempaural [A play on words (temporal and aural), which] describes sonic events in conjunction with the passage of time.

Temporality the state of existing within or having some relationship with time

UX User experience.

Bibliography

Books and publications

Allen S., 2000, ***Practice: architecture, technique and representation***
(ISBN 90-5701-072-0)

Amoroso N., 2010, ***The Exposed City - Mapping the Urban Invisibles,*** 1st edn, Routledge, 2 Park Square, Milton Park, Abingdon, Oxon
(ISBN 978-0-415-55180-9)

Belgiojoso R., 2014, ***Constructing Urban Space with Sound and Music,*** Ashgate Publishing Limited, Farnham, Surrey
(ISBN 9781472424648 hbk)

Blesser B., 2007, ***Spaces speak, are you listening?: Experiencing Aural Architecture,*** The MIT Press, Cambridge Massachusetts
(ISBN 978-0262513173)

Bowring, Jacky., 2017, ***Melancholy and the Landscape*** **Locating sadness, memory and reflection in the Landscape**, Routledge, NY, (ISBN: 978-1-315-67038-6 (ebk))

Buck, David Nicholas., ***A Musicology for Landscape (Design Research in Architecture)***, Taylor and Francis. Kindle Edition (2019).

Cerwén G. 2017, ***Sound in Landscape Architecture - A Soundscape Approach to Noise***, Swedish University of Agricultural Sciences, Alnarp
(ISBN e-pub 978-91-7760-073-2)

Hellström B., 2003, ***Noise Design; Architectural Modelling and the Aesthetics of Urban Acoustic Space,*** Doctoral dissertation, School of Architecture, Royal Institute of Technology, KTH, Stockholm, Sweden
(ISBN 91 88316 38 6)

Hällgren N., 2019, ***Designing with Urban Sound - Exploring methods for qualitative sound analysis of the built environment,*** Licentiate Thesis 2019
(ISBN 978-91-7873-054-4)

Kipnis J. 2001, ***Perfect Acts of Architecture***, Museum of Modern Art, New York, NY
(ISBN 0-87070-039-1)

Larice M., Macdonald E., (editors) ***The Urban Design Reader***

Meyers V., 2014, ***Shape of sound,*** Artifice books on architecture,
(ISBN 97B190867299)

Robertson W.C., 2003, ***Stop faking it! Sound,*** NSTA Press,
(ISBN 9780873552165)

Schaefer M., 1993, ***The Soundscape: Our Sonic Environment and the Tuning of the World,*** Destiny Books, Rochester Vt.
(ISBN 978-0892814558)

Talwar P., 1972, ***Notation Systems in Architecture,*** B.Sc. Al-HIKMA University, Baghdad, IRAQ. (1968)
Submitted in partial fulfillment of the requirements for the Degree of Master of Architecture at the MIT

Mars N., contributor Hornsby A., 2008, ***The Chinese Dream: A Society Under Construction,*** 010 publ.
(ISBN : 978-90-6450-652-9)

Web sources

The audible Landscape: A manual for highway noise and land use chapter 4. Physical techniques to reduce noise impact
https://www.fhwa.dot.gov/ENVIRonment/noise/noise_compatible_planning/federal_approach/audible_landscape/al04.cfm 2020-04-15

Soundscape in Architecture: Design Criteria
http://www.deidea.net/project/soundscape-design/
2020-04-15

Sounding Drawing
https://ontheedgeresearch.org/sounding-drawing/
2020-04-15

Chatty Maps
https://royalsocietypublishing.org/doi/pdf/10.1098/rsos.150690
2020-04-15

Favourite sounds
https://favouritesounds.org/
2020-04-15

Sensory Maps
http://sensorymaps.com/
2020-04-15

UNDARK
https://undark.org/2017/12/27/highway-noise-barrier-science/
2020-05-14

Proceedings of 20th International Congress on Acoustics, ICA 2010

23-27 August 2010, Sydney, Australia

Low Frequency Noise from Transportation Sources

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ABSTRACT

Low frequency noise (LFN) is common as background noise in urban environments and as an emission from many artificial sources: road vehicles, aircraft, industrial machinery, artillery and mining explosions, and air movement machinery including wind turbines, compressors, and indoor ventilation and air conditioning units (Tempest, 1976; Leventhall, 1988 from St Pierre and Maguire [1]). LFN may also produce vibrations and rattles as secondary effects. The effects of LFN are of particular concern because of its pervasiveness due to numerous sources, efficient propagation and reduced efficacy of many structures (dwellings, walls, and hearing protection) in attenuating LFN compared with other noise.

Current transportation noise impact assessments are usually based on broadband A-weighted noise indicators. Over the past 50 years, the A-weighted sound pressure level (dB(A)) has become the major measurement descriptor used in noise assessment. This is despite the fact that many studies have shown that the use of the A-weighting curve underestimates the role that LFN plays in loudness perception, annoyance, and speech intelligibility. The de-emphasizing of LFN content by A-weighting can also lead to an underestimation of the exposure risk of some physical and psychological effects that have been associated with low frequency noise.

As a result of this reliance on dB(A) measurements, there is a lack of importance placed on minimizing LFN impacts. A more complete picture and better correlation with annoyance and health effects may result from indicators that include temporal aspects and frequency character. This paper presents an overview of some examples of low frequency indicators applied to transportation sources.

INTRODUCTION

Low frequency noise (LFN) is common as background noise in urban environments and as an emission from many artificial sources: road vehicles, aircraft, industrial machinery, artillery and mining explosions, and air movement machinery including wind turbines, compressors, and indoor ventilation and air conditioning units (Tempest, 1976; Leventhall, 1988 from St Pierre and Maguire [1]. LFN may also produce vibrations and rattles as secondary effects. The effects of LFN are of particular concern because of its pervasiveness due to numerous sources, efficient propagation and reduced efficacy of many structures (dwellings, walls, and hearing protection) in attenuating LFN compared with other noise. Current transportation noise impact assessments are usually based on broadband A-weighted noise indicators. Over the past 50 years, the A-weighted sound pressure level (dB(A)) has become the major measurement descriptor used in noise assessment. This is despite the fact that many studies have shown that the use of the A-weighting curve underestimates the role that LFN plays in loudness perception, annoyance, and speech intelligibility. The de-emphasizing of LFN content by A-weighting can also lead to an underestimation of the exposure risk of some physical and psychological effects that have been associated with low frequency noise.

As a result of this reliance on dB(A) measurements, there is a lack of importance placed on minimizing LFN impacts. A more complete picture and better correlation with annoyance and health effects may result from indicators that include temporal aspects and frequency character.

EFFECTS OF LOW FREQUENCY NOISE

For those who are sensitive to low frequency sound the effects can be dramatic. Complainants often describe the noise as:

- Pressure in the ears
- Affecting the whole body
- Sounding like a large, idling engine
- Coming from far away
- Arising in quiet rural or suburban environments
- Often close to inaudibility and heard by a minority of people
- Typically audible indoors and not outdoors
- More audible at night than during the day
- Having a throbbing and rumbly characteristic

Also, research relating to the effects of low frequency noise, including increased fatigue, reduced memory efficiency and increased risk of high blood pressure and heart ailments, were analyzed. The results showed a need to develop and utilize other measures of sound that more accurately represent the potential risk to humans. Kjellberg and Goldstein in St Pierre and Maguire [1] showed that dB(A) measurements can underestimate loudness by as much as 14 dB when the noise primarily consists of low frequency components (below 400 Hz). In reviewing studies comparing annoyance to dB(A) measurements, Leventhall [2] points out that dB(A) underestimates annoyance for frequencies below about 200 Hz. Brambilla et al from St Pierre and Maguire [1] when analyzing the noise produced by a skid steer loader, concluded “from the results obtained the A-weighted L_{Aeq} appears to not be adequately correlated with the perception of the noise at the operator’s seat in an earth moving machine, as it does not properly take into account the distribution of sound energy in the frequency, predominantly in the low-medium frequency range (40-315 Hz).” Finally, in surveying research into low frequency noise, Alves-Pereira et al from St Pierre and Maguire [1] concludes that “it is invalid to compare acoustical environments based on dB level measurements because, despite comparable dB level measurements, the distribution of the acoustic energy over the low frequency spectra can be substantially distinct.

MEASURING AND REGULATING LOW FREQUENCY NOISE

When prominent low-frequency noise components are present, noise measurements based on A-weighting are inappropriate. A-weighting has the effect of reducing measured levels of low and very high frequencies, but has less filtering effect on most mid-range sound frequencies where speech and communication are important.

Many jurisdictions measure both dB(A) and dB(C), and take the following steps (or something similar) to determine whether or not there is a low frequency noise problem:

Step 1: Determine difference (Δ) between dB(C) and dB(A).

The difference between dB(C) and dB(A) provides crude information about the presence of low frequency components in noise. Research suggests that when the difference (Δ) is great enough that further investigation or action related to the presence of low frequency noise is warranted.

- In Germany, $\Delta > 20$ dB is used as an initial indication of the presence of low frequency noise, and the need to conduct further investigations. (Leventhall, 2003 [2])
- If $\Delta > 10$ dB the World Health Organization (1999) [3] recommends that a frequency analysis of the noise be performed
- Kjellberg and co-workers (1997) [4] have suggested that when $\Delta > 15$ dB, an addition of 6 dB to the measured A-weighted level is a simple procedure for addressing the annoyance.

Step 2: Conduct frequency analysis of low frequency noise and compare to criteria.

There are numerous methods for determining the significance of low frequency noise. Over the past 25 years, many European countries (Sweden, the Netherlands, Germany, Denmark and Poland) have developed national criteria for

environmental low frequency noise. According to Leventhall (2003) [2], the move to develop criteria was driven by specific problems, "particularly gas turbine installations, which radiate high levels of low frequency noise from their discharge." Low frequency threshold curves for the European countries mentioned above are shown in Figure 1.

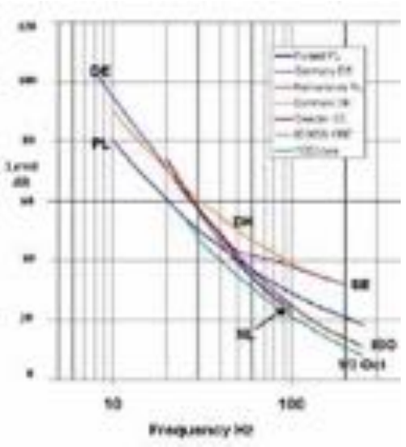

Figure 1. Low frequency threshold curves for various European countries Source: (Leventhall Powerpoint)

In Sweden and Germany, low frequency noise may be considered a nuisance if its level exceeds a criterion in any third-octave band. In the United States, a standard for low frequency noise from wind turbines has been developed for the U.S. Department of Energy. (Kelley, 1987) [5] Also, some counties in northern Michigan have developed ordinances that reference low frequency noise as separate to other noise issues. Denmark has taken an entirely different approach. Queensland in their draft Ecoaccess Guideline ‘*Assessment of Low Frequency Noise*’ 2010 [6] has applied a combination of the German and Danish guidelines.

LOW FREQUENCY NOISE SOURCES AND IMPACTS

Low frequency noise and infrasound are produced by machinery, both rotational and reciprocating, and all forms of transport and turbulence. Typical sources include pumps, compressors, diesel engines, aircraft and fans.

Combustion turbines are capable of producing high levels of low frequency noise generated by the exhaust gas.

Burners can emit broadband low frequency flame roar.

Structure borne noise, originating in vibration, is also of low frequency, as is neighbourhood noise heard through a wall, since the wall attenuates higher frequencies more than lower frequencies.

Low frequency noise can be noise or vibration from traffic or from industries, totally or partly transmitted through the ground as vibration and re-radiated from the floor or the walls in the dwelling.

Low frequency noise creates a large potential for community annoyance. It is most often experienced inside of homes and buildings where resonance amplifies the sound. It is a general

= 29 dB and Δ = 25 dB respectively in the higher exposed group.

Netherlands [15]

In the Netherlands, transport activities from roadways, airports and railways are major noise sources. The resulting noise levels have a severe impact on the environmental quality. Noise from roadway traffic causes the highest rate of annoyance: 29% of the Dutch population above the age of sixteen are severely annoyed by this source.

Because complaints due to LF noise are often difficult to resolve, these complaints take up a disproportionate amount of time. To address this, RIVM has modelled and mapped the LF noise from motorways. The research program aimed at extending knowledge on noise exposure from the usual A-weighted noise exposure indicator (L_{den}) to other noise indicators such as background noise levels and low frequency (LF) noise.

After modelling LF noise, RIVM used two methods to evaluate the scope of the LF noise exposure, namely the guidelines proposed by the Dutch Association for Noise Annoyance (NSG) [16] and a method based on the difference between C-weighted and A-weighted noise levels.

NSG guideline [16]

In the NSG guideline the reference values are based on the hearing threshold for a group of 50 to 60 year old people, of which 10% are just able to hear the sound.

In order to objectively evaluate the complaint, the sound levels of the frequencies in the defined region are compared to the reference values. If these reference values are exceeded, it is assumed that the complaint is objectively attributable to a LF source.

C-A method

In order to apply the NSG method, the sound pressure levels in dB had to be assessed for each of the 1/3 octave bands. Since measuring noise for specific frequencies requires specialized equipment, RIVM proposed to assess the LF content in the total spectrum of the noise by assessing the difference between average C-weighted and A-weighted values.

Noise Maps

Using traffic data from the Dutch motorways, LF noise maps for the major motorways were set up according to the two methods outlined above. All calculated outdoor levels were converted to indoor levels before testing, using the isolation from Table 5 [17].

Frequency (Hz)	20	25	31.5	40	50	63	80	100
Reference (dB)	74	62	55	46	39	33	27	22
Assumed isolation (dB)	8	9	10	11	12	13	14	16

Table 5. Reference threshold values (NSG) for LFN assessment and assumed isolation

Isolation is based on the sound isolation characteristics of 4mm glass. All indoor levels were calculated for average night-time exposure from 23:00 to 07:00 hours. In order to apply the NSG assessment, the RIVM model was used to calculate the noise exposure for single octave band frequencies. For the low frequency region, this means that calculations for the 31.5 Hz, 63 Hz and 125 Hz octave bands were made. The noise exposure levels were subsequently weighted with the isolation values from Table 5. Taking the maximum of the three weighted levels resulted in a measure of low frequency noise exposure caused by road traffic.

For the C-A weighting method, the RIVM model was applied to calculate C-weighted and A-weighted noise exposure for the entire frequency range. The result of the subtraction of the two exposure levels (Δ) revealed the low frequency characteristic of the noise exposure.

The noise map of the 'Randstad' region for the dwellings where the NSG guideline was applied demonstrated exceedences up to 15 dB (classified as high). The noise map for the same area using the C-A method gave exceedences as high as 28 dB and as low as 10 dB.

When observing the entire noise map for both methods, two problem areas emerge where the noise exposure contains unusually high levels in the lower frequencies. These turned out to be areas behind noise barriers, and motorways with a large amount of heavy vehicle traffic.

Table 6 shows the number of households situated in areas where the limits proposed by the NSG were exceeded, or where C-A weighted noise levels exceeded 15 or 20 dB. As can be seen, the number of households where these limits were exceeded can be substantial. Table 6 shows that the frequency of 125 Hz is important when looking at the number of exposed households.

Guideline	Number of households (min)	Percentage of total (%)
NSG guideline 63 Hz	3.0	43
NSG guideline 125 Hz	5.6	79
NSG guideline 63 or 125 Hz	5.6	79
C-A >= 15 dB	4.2	59
C-A >= 20 dB	0.64	9

Table 6. Number and percentage of households exceeding two guidelines for LF noise in Dutch study

Almost 80% of households in the Netherlands showed a LF noise exposure exceeding the NSG guideline. In the Randstad this guideline was exceeded almost everywhere. From the results it seems that the frequency of 125 Hz is the determining factor in the amount of exposure. However, in more than half of those households the limit for 63 Hz was also exceeded.

Other Noise Evaluation Methods [18] [19]

In looking to alternative methods of evaluating sound, one needs look no further than the original 1936 sound level meter standard. In that standard, the B-weighting scale was introduced and since has drifted into obscurity, even though its inclusion in sound level meters is still required to meet full ANSI S1.4 – 1983 standards. Several studies have shown that the B-weighting scale correlates much better to subjective responses than the A-weighting scale, most likely because it is based on the 70 phon equal loudness curve which is more applicable to most typical transport noise events.

Acoustic Technologies evaluated 96 recordings against the Sonus 'Rise and Fall' method as well as a range of other algorithms namely:

- root mean square (RMS);
- tonal; and
- harmonic content.

It was concluded that RMS of the modulation characteristic was best at distinguishing the level of annoyance of a noise event. The RMS algorithm also has other advantages in terms of repeatability, certification and the availability of software and instruments.

The identification of the modulation characteristic as a way to identify engine brake noise annoyance is supported by previous studies commissioned by Austroads from Vipac. Vipac Report No. 34950-2, 1991[22] references a 1981 Vipac study [23] which concluded that:

- A-weighted peak engine brake noise level was not an adequate predictor for assessing the changes in noise emission due to brake operation; and
- the annoyance due to engine compression brakes was the result of a change in the spectral characteristic of the noise emission rather than due to an increase in the overall A-weighted peak noise level.

Following the Sonus work and the later Acoustic Technologies investigations, it was clear that while modulation is the key, there were at least two ways of capturing modulation and identifying a quantifiable measure of the degree of annoyance of the 'bark' associated with engine brake:

1. By measuring the RMS of the modulation characteristic (Acoustic Technologies); and
2. By measuring the number and amplitude of rises and falls of the noise over a certain period (Sonus)

COMPARISON WITH AUSTRALIAN STANDARD AS3657

Australian Standard AS3657: *Acoustics - Expression of the subjective magnitude of a sound or noise*, provides methods for expressing the subjective magnitude of a sound as a single number. The Standard takes account of the frequency spectrum of the sound and is identical to the internationally accepted method of assessing the annoyance a sound would be likely to create.

The calculations for AS3657 are too complex to allow routine analysis of engine brake noise, but AS3657 provides a benchmark to compare with the candidate algorithms.

CONCLUSIONS

A literature search of research carried out by various countries on LFN from motor vehicles has revealed that the major frequency content of motor vehicle emission in terms of one third octave bands is in the range of 63 Hz to 125 Hz depending on vehicle speed and engine size. A lower frequency peak of 16 Hz has been identified from the firing rate of a pair of cylinders from a V8, 8 litre, four stroke diesel configuration [10].

The Netherlands has seen the value of producing LFN maps in addition to the traditional A-weighted approach. Modelling in the Netherlands study [15] using the C-A method indicated that areas behind noise barriers and motorways with a large amount of heavy vehicle traffic show high C-A levels. This may indicate that these areas are exposed to noise with a strong low frequency charactistics.

This C-A level approach appears to be popular in establishing low frequency content. Recently the Z-weighting is being proposed to replace C-weighting [6] for low frequency industrial noise immission and there is no reason why Z-A could not be used for transportation noise sources. Recent research seems to suggest an application of two equal loudness contours (A- and B- weighting) (dynamically based on the overall sound pressure level) and Zwickers method for loudness determination although this is a laborious process. There is even a suggestion that the loudness of transportation sources can be best represented by the phased out B weighting than the A-weighting due to its resemblance to the 70 phon contour more representative of the level and frequency of transportation noise sources.

LFN auditory threshold curves in one third octave bands have also been successfully applied for indoor spaces after correcting outdoor measurements for sound transmission loss through building facades.

The German study [14] indicated that a limitation to L_{Amax} < 45 dB(A) as suggested by WHO (2000) [3] does not protect against awakening due to low frequency truck noise.

There has been extensive research undertaken to identify the characteristic 'bark' of engine brakes. The 'bark' can be clearly seen as modulation when engine brake noise is recorded and graphed. There are two methods of measuring the modulation of the waveform and both offer potential as a means of identifying engine brake noise annoyance. Relying on traditional A-weighted measurements will not capture the modulation nor would it offer the potential to distinguish engine brakes from other traffic noise.

The technology is available, especially with digital methods, to use much more complex filters and calculations in the measurement of low frequency sound, and studies have shown that these methods yield results that are more useful. However, until the acoustic community begins to seriously question the use of A-weighting measurements, more accurate measurements will continue to be ignored by both engineers and manufacturers.

In order to provide policy makers with the best information regarding noise exposure, a thorough knowledge of the various types of noise exposure and a better understanding of the relation between exposure and effects is needed. In particular, the present knowledge of the influence of time and spectral characteristics of the noise on human perception should be improved.

REFERENCES

[1] Richard L. St. Pierre, Jr, Daniel J. Maguire " The Impact of A-weighting Sound Pressure Level Measurements during the Evaluation of Noise Exposure", Noise-Con 2004, Baltimore, Maryland July 12-14 2004.