



Helsinki *soft*

Master Thesis

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Master Thesis

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Abstract

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The northern capital, Helsinki of Finland, is swiftly growing. Due to the growth there are possibilities for experimenting in the city. In this work we look at the possibilities of tensile membrane construction in the city of Helsinki. The imagined client of this study on tensile membrane construction and urban planning is the City of Helsinki. The vision we construct with a strategy here is called “Helsinki soft.”

In this study, tensile membrane construction, or “textile architecture,” is suggested as a theme with which to diversify the language of engineering and architecture in Helsinki. The work begins by surveying the state of tensile membrane construction in Helsinki and the whole country of Finland. The second section looks abroad for possible membrane construction examples that Helsinki could apply. The third section goes through three strategies for the City of Helsinki that support the idea of introducing a tensile membrane construction layer to the city. The fourth section finds concrete places and themes in Helsinki where tensile membrane construction could be applied. The last (fifth) section drafts a tensile membrane construction strategy for the City of Helsinki called “Helsinki soft.” It concludes the study with a strategy containing a catalogue of proposed structures in chosen places in Helsinki.

The strategy is motivated by the fact that the city is constantly growing. The mission of the study is to participate in building Helsinki into a world league city. Building with membranes is the focus in this particular work, and the envisaged vision for the future is titled “Helsinki soft,” a state where Helsinki has a tensile membrane construction layer built in the city. Along with this, several other aspects are influenced.

The work is part of the degree of Master Membrane Structures in the Anhalt University of Applied Sciences. The related work has been conducted as an independent project.

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0 Preface

My interest in tensile membrane construction comes from my two fields of study, architecture and textile design. I began my studies with architecture, and throughout my subsequent textile design studies, I always tried to combine these two fields. It was during my work on architecture studies' master's thesis that I found the Institute for Membrane and Shell Technologies, Building and Real Estate at Anhalt University of Applied Sciences in Dessau, Germany on the web and decided to try to enroll the course they offered. I thought the course was finally something I had been searching for. And it existed!

I worked as a strategic urban planner for the City of Helsinki, the capital of Finland, for several years and often heard questions about how my profession relates to my interest in textile architecture and tensile membrane construction. It seemed difficult for many to see the connection of this interest of mine with my field of work. I myself see the fields related and this is why I chose to work on this exact topic in relation to my master thesis in the Anhalt University of Applied Sciences. I wish to show that a highly specific field of construction can relate to urban planning in a natural way if one desires to see things that way. Thus I have chosen to work on the topic "textile architecture and urban planning" and my aim is to draft "Helsinki soft", a strategy for tensile membrane construction for the City of Helsinki.

0.1 Introduction

The aim of this master thesis is to build a story, or a strategy, on how tensile membrane construction could exist in Helsinki. The vision presented here is titled “Helsinki soft”. The vision is a state where the city has a layer of tensile membrane construction next to other, more traditional ways of building. The mission is to participate in building a world league city, with membrane structures playing a meaningful role in the process.

The thesis is divided into five sections, each building a part of our story. The sections are Start; Examples from abroad; Helsinki in strategies; Helsinki layers; and Helsinki soft. We begin by considering Helsinki and finally end up looking at the whole country of Finland, investigating the state of tensile membrane construction at the moment in Helsinki and Finland. In the second section we consider selected examples from abroad in order to find possible related applications for Finland. The third section discusses three of Helsinki’s strategical plans in order to understand how the City of Helsinki wants to develop itself and the city. The fourth section, “Helsinki layers,” considers concrete places for tensile membrane construction in Helsinki. The last section concludes the work with the strategy “Helsinki soft.”

0.2 Motivation, questions and goals

The motivation behind this work comes from the scarcity of examples of tensile membrane construction in Helsinki and the whole country of Finland. This raises the question why it is so. The issue we consider in this work is whether it would be beneficial to build more membrane structures in Helsinki (and Finland). Where could we make use of such structures and what could those structures be like? Which parts of the future city could have tensile membrane constructions and why? What are the applications and benefits of membrane structures?

We imagine our client being City of Helsinki. We look at the city from the point of view of tensile membrane construction. In reality the vision for a soft Helsinki, Helsinki with a tensile membrane construction layer, is far from being true in reality. However, in this work, everything is possible!

0.3 Sources

The sources and background material for this master thesis are numerous. The newest information is mostly from online sources: designers, builders and material suppliers form the majority of the sources. Also architecture and engineering books and magazines provided some information in some cases. Some of the cases are viewed only through the picture material available and analyzed in written text. The information regarding City of Helsinki is widely published on the web. The sources used are clearly marked.



Pictures:

Northeastern Europe and
Helsinki. (T Kuusisto 2016)

Aerial view of Helsinki 2015.
(kartta.hel.fi)





1 Start

Why do we have so few tensile structures in Helsinki and the whole country of Finland? It is often claimed that it is our climate the reason: too harsh, cold and snowy. However, at the same time, elsewhere in the world, we have examples of tensile structures used in the most demanding surroundings and climates; tensile structures are often the answer for temporary structures at wartime or they are used for housing refugees in refugee camps. We have also seen tensile radar shelters in the distant northern areas. This all shows that not only temporary, but stable tensile structures exist in harsh conditions as well. One begins to wonder, could it actually be, that Helsinki and Finland do not have that many tensile structures because our building culture is yet not so developed in terms of versatility.

In this first section we look at tensile membrane construction in Helsinki and Finland in order to understand the situation we are at now.

1.1 Kota

The earliest modes of habitation in Finland are the tent like “kota”-dwellings. They remind us of the teepees of the American Indians and date back as early as Stone Age, from 6 500- 4200 B.C. They were in use still in the 20th century. Nowadays they are mostly used for recreational purposes in Northern Finland. (Kansallismuseo 2016)

The nomadic way of life made use of the easily demountable dwelling. The structure could be easily dismantled, transported to a new location and erected again. Originally, it was enclosed with animal hide or tree bark, also with fabric or turf. (Kansallismuseo 2016)

Kota is constructed with wooden poles assembled to a broad ring and tied together at the top. Above that, animal hide or other form of fabric is laid. Inside, in the middle, is a fire place, around which everything happens. The fabric is not double curved; the curve is instead only in one direction. The structure is not tensioned, but still kota can be considered an early type of membrane construction.

Indeed one of the original habitations in Finland has been “kota.” Kota has survived harsh weathers through centuries. How about more modern developments? Modern technologies should enable us to survive the challenges related to for example weather with newer modes of structures.

Picture:

Finnish kota.
(Finna 2016)

1.2 Helsinki - Finland

What exists in Helsinki at the moment, what are the tensile structures in the city right now? Finding the most important examples in Helsinki is fairly easy, as the total number of examples is rather small. This is why I had to also look at the whole country of Finland in order to build a perspective of existing membrane structures and the diversity of related solutions in Finland.

1.2.1 Helsinki

In Helsinki, there is only one stable tensile structure if we don't take into account the small scale awnings at building entrances. It is the multiconed shade along the Brahe sports field in Kallio neighbourhood.

Also some temporary tensile structures can be found in Helsinki. These are, for example, the small scale shelters at the market squares and temporary tensile structures housing yearly circus happenings and other pleasant outdoor happenings in the city. Also air pressured sport halls exist. One temporary solution worth mentioning is the Helsinki Festival tents erected every summer.

The multicone of Brahe stadion

The Brahe stadion's membrane construction outlines a large sports field. The blue colored steep multiconed shelter houses spectator benches next to a football field, and in the winter, a skating rink.

The five cones, open from the backside, are tensioned with masts and cables. The roof has a nice bright blue color of the PVC covered polyester. It is interesting that the roof is not removed for the winter, and it seems to be in good condition despite of that.

The structure is fairly small compared to the vast stadium, so it is not so conspicuous next to the trees it resides. When one gets closer, it becomes more visible. The grandstand and the cones align the sport field and create a nice space for the spectators to sit and follow the games. The blue colour has a huge impact visually.

Architect	Roy Mänttari
Construction	Scanhall Oy
Place	Helsinki, Finland

Picture:

Brahe stadion in the winter.
(Venere.com 2016)



Helsinki Festival tents

At least one higher quality temporary structure can be found in Helsinki. Actually it is two structures next to each other. Helsinki festival, organized every late summer, has its concerts housed under iconic tensile shelters, called Huvila Festival tents. The first, smaller tent was made ready for the year 1996, the second some ten years later. The tents are erected each year to serve for a period of few weeks and have concerts and other shows held under their roofs. (Helsingin juhlaviikot 2016)

The other shelter is a large tilted cone with a very dramatic design, mast and cables holding it in tension. The color is nice, warm yellow that brings its own, special atmosphere to the surrounding. The other one is a white, arched tent, with a large perimeter arch traversing the center of the tent to create a space underneath, with cabling holding the sides down. The material in both the tents is again PVC covered polyester. (Helsingin juhlaviikot 2016, Helsingin sanomat 2015)

The tents are like pavilions in the park. They can be seen from far. The tilted form of the yellow cone especially invites people to see what is happening underneath. The sizes of the roofs are big enough to create different spaces under them and at the borders of the structure. The forms are quite iconic and they create an interesting detail to the surrounding park scenery.

Architect	Roy Mänttäre, Finland
Construction	Scanhall Oy, Finland
Place	Helsinki, Finland
Period	- 1996, 2000's

Pictures:

Huvila tents pictured from above.
(Hs.fi 2015)

Huvila tent creates a warm atmosphere underneath its yellow shelter.
(Stadissa.fi 2016)



1.2.2 Finland

In Finland, there are more tensile membrane construction examples to be found, although they are not numerous in total and the quality is not always very high. The uses of membrane construction are typically for outdoor theatre coverings or shelters at squares. I have chosen three good representatives of tensile construction in Finland as examples of the good quality that can be found in the country.

Olavinlinna rain cover

One ambitious tensile construction example is the shelter of Olavinlinna castle in the city of Savonlinna in eastern Finland. It is particularly interesting as it combines a historical site with a very modern roof structure. The castle originates from the year 1475 and has been built in many stages after that. A result of an architectural competition, the tensile shelter was built in the year 2000 on the historical site of Olavinlinna. (Museovirasto 2016b)

The shade covers the inner court yard of the castle. The modern roof is a combination of cones and ridge and valley structure. The primary structure is delicately fixed to the yard and some newer concrete parts of the castle. The membrane material is PVC covered polyester. The shelter is erected and dismantled each year, so the structure has to be easily assembled. (Museovirasto 2016b)

From the urban planning point of view, the roof takes part in the design of the castle. Structurally it creates an opposite of the castle. It is an addition, which can be only slightly seen above the fortresses walls, so it succumbs to the whole and creates a sublime space for happenings, also giving shelter against the summer rain.

Architect	Markku Erholtz, Heikki Paakkinen, Finland
Engineering	Matti Ollila & Co/ Eero Kotkas, Finland
Place	Helsinki, Finland
Period	- 2000

Pictures:

Olavinlinna rain cover pictured from air.
(visitsavonlinna.fi 2016)

Olavinlinna rain cover creates a subtle layer between the walls of the castle.
(museovirastorestauroi.nba.fi)



Hamina bastion shelter

Hamina Tattoo International Military Music Festival is a traditional, biannual festival in Hamina, south-eastern Finland. The site of the festival is a historical fortress in a star like form, built in the 19th century. A large central yard of the bastion ring of the fortress is covered with a tensile structure able to house 4000 people under its roof. It is erected for every summer season and dismantled for the winter. The bastion shelter is not only used for the music festival, but other happenings as well. (Museovirasto 2016a)

The membrane construction is a structure with combined eight cones and a ridge and valley structure. Eight primary structure masts help to raise the cones and sixteen smaller masts with cables on the sides tension the ridges and valleys. The roof is made with PVC covered polyester, silver on top and underside in luminous white. It is considered to be a nice opposite to the fortress's historical architecture. (Museovirasto 2016a)

The structure is situated in the central bastion of the fortress and lets the historical construction show. It can give shelter to a large group of people and enables a diverse use for the bastion. When people are under it, the surrounding fortress creates visual walls for the space. The interplay of the old and the new is an interesting aspect of this construction.

Architect	Roy Mänttäri, Finland
Specialist	Olli Hakanen, Finland
Engineering	Matti Orpana, Tensotech Consulting, Finland
Place	Hamina, Finland
Period	- 1998

Pictures:

Hamina bastion shelter takes part in the historical fortress's surrounding.

Hamina bastion shelter, a side view shows the space created underneath the membrane roof.

(visithamina.fi 2016)



Pyynikki summer theatre roof

A saddle shaped roof covers the summer outdoor theatre in Pyynikki in Tampere, midwestern Finland. The shade covers a spinning auditorium, thereby covering the spectators from rain and sun. From an urban planning point of view, the roof is a striking object-like form in the park. It creates an element where the grandstand and the roof invite people to sit under it.

The shelter is held up with four doubled, V-shaped mast constructions combined with a saddled arch onto which the membrane is tensioned with the help of cabling. The PVC covered polyester membrane of the saddle shaped surface is white. It was attempted to keep the roof in place for the winters but it turned out not to work well. The material started to sag and snow gathered into the sagging pockets. Nowadays the roof is dismantled for the winter and erected again in the summer. (Pyynikin kesäteatteri 2016)

Specialists	docent Tuomo Poutanen, Finland professor Kari Salonen, Finland senior assistant Ari Aalto, Finland research assistant Mikko Lahikainen, Finland
Place	Hamina, Finland
Period	- 2005

Pictures:

Pyynikki summer theatre with spectators under the shelter.
(pyynikinkesateatteri.fi 2016)

Pyynikki summer theatre roof lit in the evening.
(moro.aamulehti.fi 2011)



1.3 Companies and specialists in Finland

There are few bigger construction companies working with membranes in Finland and many small ones. The companies are multidisciplinary, they all have a slightly different selection of services: they may work with the material and construction from the beginning to the end, offer material, cutting and detailing services or only construction and assembling services. Most of the bigger companies work with steel framed flat membrane halls - only one works with tensile and air pressured construction. Some of the firms concentrate on producing and selling or renting different membrane materials.

The big membrane companies are named Best Hall Oy, Janus Oy, Lainapeite Oy, Nordic Hall Oy and Oy Scanhall Ab. Scanhall is the one working with tensioned structures. A company worth mentioning is a quality material producer and supplier named Oy Scantarp Ab.

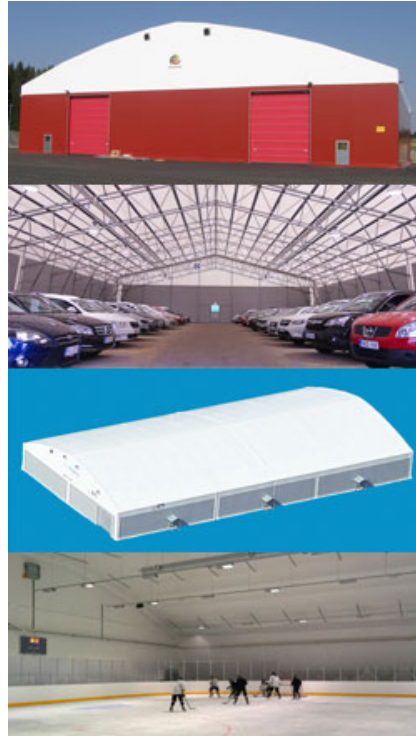
The list of companies here is not exhaustive, only the biggest companies have been gathered. The offered services deal with civil and military purposes, with storage halls, sports halls and halls for production. Scanhall has been producing tensioned structures for more diverse uses, for outdoor theatres, spectator shelters and market area shelters. The material most often used is PVC covered polyester. High quality construction of tensile structures is fairly scarce in the whole country. (Best Hall Oy, Janus Oy, Lainapeite Oy, Nordic Hall Oy, Oy Scanhall Ab, Oy Scantarp Ab, 2016)

In addition to the group of companies that work with membranes in Finland, there are of course also architects and engineers interested in the matter. They are not many, but probably very eager about this type of construction. One of the enthusiast architects is Roy Mänttari, who has designed many of the studied examples. Matti Orpana, from Tensotech Consulting, is in turn an engineer and an expert in the field. There are also other design specialists - architects and engineers and other experts, who have experience working with tensile membrane construction. They are for example the before mentioned experts from the tensile membrane construction examples in Finland.

Pictures:

Picture material from the companies' websites.

Best Hall Oy,
Janus Oy,
Lainapeite Oy,
Oy Scanhall Ab,
Oy Scantarp, 2016.

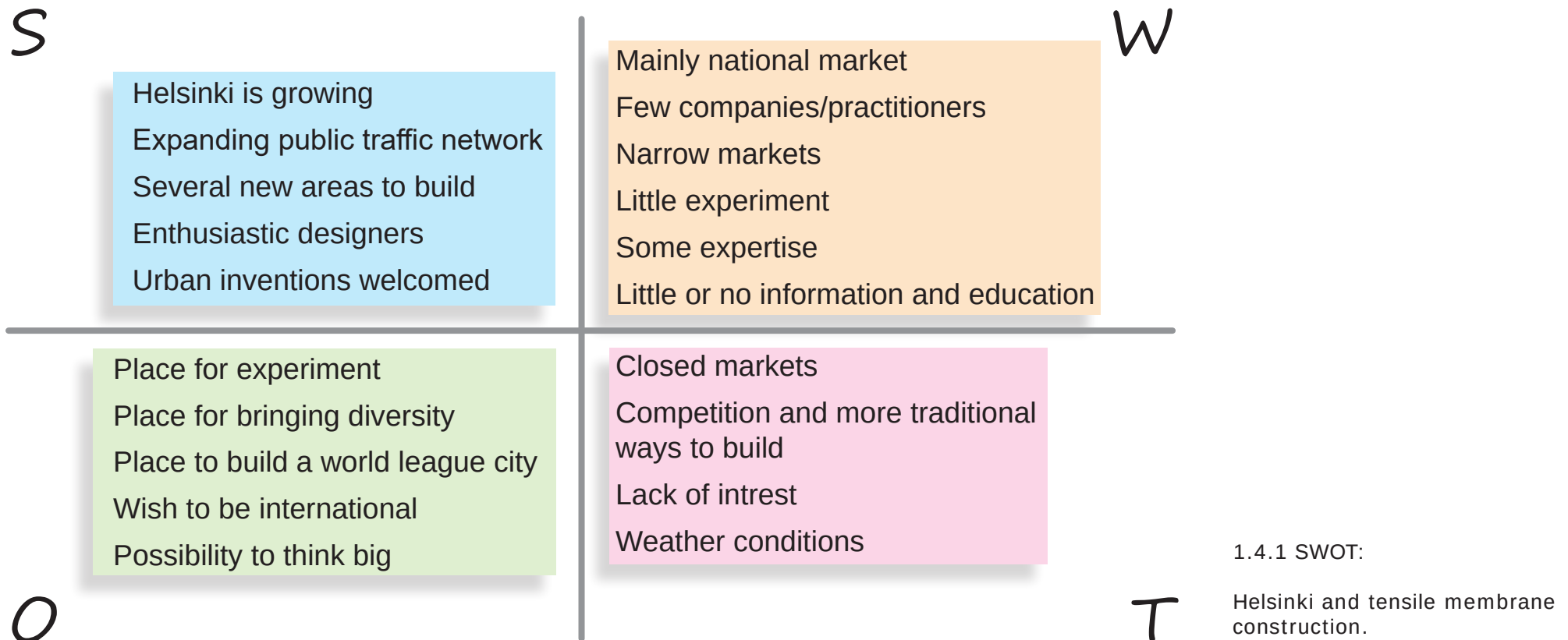


1.4 How about the future?

When we put the part of Finland's tented history and the practice at the moment together, it is easier to picture the future. The narrow markets we have at the moment could grow bigger if we were more aware about the possibilities of tensile membrane construction and if we made more attempts to use these kinds of structures in new applications of construction. We do have some expertise but very few realms in addition to simple storage, production and sports facilities, where membrane construction is considered a feasible option at the moment.

1.4.1 SWOT Helsinki and tensile membrane construction

Below is a SWOT analysis about the strengths, weaknesses, opportunities and threats of tensile membrane construction in Helsinki. It is gathered to give an understanding of the situation of Helsinki, with an eye on establishing more fresh and innovative structures to the city with the help of tensile membrane structures. Some parts of it work for the whole of Finland as well.



2 Examples from abroad - five examples

In the second section we look at foreign examples to find uses of tensile membrane construction that could be applied in Helsinki.

Will there appear relevant future structures in Helsinki that use tensile membrane construction as their building solution? Should we look abroad for examples to follow and get ideas from? The aim is to find projects for the 21st century and preferably for climates with snow. The purposes of use should be something that could be applied in Helsinki in a relevant way. We are after a vision for a softer Helsinki – Helsinki soft.

In urban planning, it is common to investigate other cities with similar kinds of challenges to learn and borrow ideas from, and of course, to apply and alter those ideas to the local surroundings in a suitable way.

The following cases we investigate have a number of central issues in common. First of all, they are applications that are suitable for Finland. They are ambitious, and they suit public construction purposes well. They complement each other in their variety of purposes of use and technical execution, and thus they give a broad perspective of the possibilities of tensile membrane construction. Most of them are from surroundings with snowfall during the winter. And most of all, they are examples of high quality.

2.1 Rosa Parks Transit Center FTL

The Rosa Park Transit Center is a monumental passenger terminal in Detroit, Michigan, United States. The construction has a passenger terminal and a place to drop off the passengers with a waiting area next to it, under a tensile roof. The task was to design a permanent roof structure which is durable enough to withstand the harsh weathers of the area. Relatively low cost and clear uniqueness were also desired.

Seven repetitive bays create the roof. Each bay has two trusses, a frame and pulled down fabric. The cones, which reach towards the ground, collect rain water. They let the rain run through the cones onto a small, sometimes green spot on the ground under each down reaching bay. Each spot is carefully designed to bring joy to the people waiting for the buses.

The shelter defines the space around it and creates not only a roof but also a wall to the surrounding. The ground level is carefully treated. The flowing canopy lets the sun shine through during the day and is illuminated for the night. The roof is not only part of a transit center, but the shelter also helps to orientate and creates a strong identity to this corner of the city. (Archdaily 2016)

Design	FTL Design Engineering Studio, Parson Brinkerhoff
Place	Detroit, United States
Period	2009



Pictures:

Rosa Parks Transit Centre 1.
Rosa Parks Transit Centre 2.
(archdaily.com 2009)

2.2 Railway station Leipzig Airport

The platform area of Leipzig Airport's intercity railway station's northern and southern sides is clad with a tensile membrane structure. A result of German know-how, it is an impressive construction of 40 fields of tensioned roof structure to keep the travellers dry from rain and safe from too much sun.

The structure was realized with Teflon coated glass fibre fabric which was attached to steel arches with clamping tape. Each center of the membrane has a guttural cablw with which the membrane achieves its shape. (Sattler global 2016)

The whole structure reminds an airplane wing with its supporting steel structure and the membrane stretched between it. From an urban planning point of view, the roof creates a long, luminous waiting area covered by the membrane that shows far to the surrounding and gives character to it. It gives shade to two sides of the railway station, and its chosen form reminds us that we are next to an airport.

Architect	AP Brunnert Plan, Stuttgart
Engineers	IF Ingeniure, Reichenau Schlaich Bergermann, Stuttgart
Place	Leipzig, Germany
Period	- 2003

Pictures:

Leipzig Airport railway station 1.
Leipzig Airport railway station 2.
(sattler-global.com 2016)



2.3 East River 34th street Ferry Terminal

The third chosen case is the East River Ferry Terminal in New York, United States. It was designed by Kennedy Violin Architects and engineered by Schlaich Bergermann. The terminal is part of seven ferry landings in total and works as a terminal hub. (Schlaich Bergermann 2016)

The result is a lenticular structure, cladded with a continuous textile on both sides, top and under. A double row of columns support the curved roof. One row of columns is triangulated in order to bring lateral bracing to the structure. The membrane materials were chosen to create a more opaque atmosphere during the day and a translucent one at night. (Schlaich Bergermann 2016)

The chosen offices worked together in order to develop a soft approach for the construction. It took fourteen years after the commission to open the terminal to the public (this was in 2014). Now the terminal works as a multimodal hub of the East River Ferry system, bringing an alternative to other lines in the city. It has been a successful piece of design with a growing number of passengers each year. (Schlaich Bergermann 2016)

The membrane hub works together with the surrounding and invites people under its shelter to wait for the ferry. It is a very busy structure with the passengers continuously walking by. The membrane roof is quite a delicate construction, but strong visually, especially at night time, when it is lit. When the sun sets, the structure becomes quite an otherworldly, illuminated creation and brings strong identity to the peer. It is a nice, maritime membrane element at the waterfront of New York.

Architect	Kennedy Violin Architects, NY
Engineering	Schlaich Bergermann, NY
Place	New York, United States
Period	2000 - 2014

Picture:

East River 34th Street Ferry.
Terminal. (John Horner 2016)



2.4 Vienna City hall travelling membrane roof

The almost rectangular travelling roof of the Vienna City hall court yard covers an area of over 30x30 square meters. The yard functions as an outdoor room, extending the space inside: It is used for different happenings. The travelling roof is used in the warm season whenever needed to protect the audience from rain or sun. (Tensinet 2007, 311-320)

The folding roof is operated by motors. The structure is like an accordion and when closed, it becomes a pack of four meters. When opened, it extends to over 30 meters in length. The task was challenging because no columns were wanted to disturb the space, and the protected historical monument's walls were not to be touched either. The result of the task was a solution, which respects the neogothic building. When the roof is opened, the top parts are always above the gothic arcades of the city hall. (Tensinet 2007, 311-320)

The travelling roof extends the possibilities to arrange happenings in the courtyard. It is kinetic structure which is easy to assemble when needed. It is used only in the summer. For the winter, it is packed. (Tensinet 2007, 311-320)

Architect	Silja Tillner, Vienna
Specialist	Christopher Lottersberger
Engineering	Schlaich, Bergermann und Partner, Stuttgart, Vasko + Partner
Place	Vienna, Austria
Period	- 2000
Period	2000-2014



Pictures:

Vienna City hall travelling
membrane roof 1+2.
(structurae.net 2016)

2.5 Mobile Art CHANEL Contemporary Art Container

The traveling exhibition space, designed by Zaha Hadid for Chanel, was designed to resemble Chanel's iconic quilted handbag from 1955. The task by Karl Lagerfeld was to create a mobile pavilion for art; the result is a futuristic demountable building, which contains membrane materials among other construction materials. The mobile art pavilion travelled the world, Hong Kong, Tokyo, New York, before landing in its permanent location in front of the Institut du Monde Arab in Paris. During the voyage, it housed work by the best artists of the world and gathered spectators in every corner of the world it visited. (Architen Landrell 2016, Designboom 2016, Zaha Hadid Architects 2008-2010)

The exhibition is in the outer ring of the construction and there is a court yard inside, under the ETFE roofing. The structure is a combined I-beam structure with fibre reinforced plastic panels, all different in size and form. The roof is clad with PVC coated polyester and ETFE cushions. It has been designed easy to assemble by a two person team in three weeks. (Architen Landrell 2016, Place and Ornament 2008)

The structure was designed to travel and it is an interesting example or a temporary structure used in the urban context. The different cities it visited shows that Chanel indeed operates internationally.

Architect
Engineering etc.
Place
Period

Zaha Hadid, Thomas Vietzke, London
Arup, Edwin Shirley Projects, Architen Landrell
Mobile pavilion, later Paris, Institut du Monde Arab
2008 - 2010

Pictures:

Chanel Art Container 1.
(designboom,
Francois Lacour 2016)
Chanel Art Container 2.
(place n ornament 2008)



3 Helsinki in strategies - three tools

Helsinki is a member of Unesco's network of Creative Cities since 2014. The City was awarded City of Design status as a good continuation of Finnish design tradition and the Design Capital Year 2012.

Helsinki uses design to improve the city life. "The city is being created through the creativity of its people". Design is seen as a strategic tool to build an open city together with its citizens and designers alike. The widely available public information makes it easier to be involved in the city life and create services that are needed. (Unesco 2014)

I have chosen three tools of the City of Helsinki to discuss possibilities for membranes for Helsinki. They are tools, which deal with the development of the city. The tools are chosen as they are powerful in considering the growth of the capital and ones that have an impact on the future. They are the Strategy Program of the City of Helsinki, the Strategic spatial plan for Helsinki 2050 dealing with the land use of the city and the Brand New Helsinki project envisioning the city from branding point of view. After looking at these entities, we may have found possibilities for tensile construction to consider. These tools may also be strategic tools helping to try and create a softer layer for the city, the layer for membranes.

3.1 Brand New Helsinki

Helsinki is, for the first time, preparing a brand for the city. The work started in 2015. Part of it, the Brand New Helsinki –project took almost a year to complete and its aim was to find a brand for the city 2020. The project came up with a concept for a brand. Through this, the branding work of the City and the city could be built. The concept is used in the marketing of the city, for citizens, business and events and tourism, and should also traverse all the work done in the City as something holistic to look through. (Brand New Helsinki 2015)

"Hel of an impact" is the slogan for the Brand New Helsinki. It is mentioned to be the position for the future Helsinki. It is something the city wishes to achieve, to give, an attitude: "Helsinki in 2020 will be a city of powerful people, acts and encounters". And who are the ones making the impact? It is us, citizens, tourists and workforce, investors. Everyone is part of this brand. "Helsinki refers to people whose ambition is to solve meaningful problems and to build the world's most successful everyday life". (Brand New Helsinki 2015)

The aimed position "Hel of an impact" is the core of the brand concept, which is then divided into four themes, or cornerstones, as they are called, all looking at the city from slightly different point of view. The four cornerstones of the brand concept are "Transforming Helsinki, Functioning Helsinki, Helsinki

of contrasts and Original Helsinki". "Transforming Helsinki" forms the base for the future city; Helsinki is in the middle of big changes and growth, which opens up possibilities for new deeds and thoughts. "Functioning Helsinki" is a partner for transforming Helsinki. It includes the services of the city, education and know-how. Helsinki is a city of low hierarchies and flexibility, a good base for experiments and ideas. "Helsinki of contrasts and originality" include the diversity of the city, the opposites it offers and the creative atmosphere and openness to experiments. (Brand New Helsinki 2015)

3.1.1 Helsinki brand and membranes – a mission

The position "One hel of an impact" challenges to think big. It is said to encourage exceptional deeds with which to create impact, something that gets to be told to the world.

When a city is expanding like never in the history, it should have a multifaceted vocabulary in doing so. The transforming city could have membranes as part of the new hardware of the city. The mission of our work could be to diversify the language of the architecture and urban planning and in doing so, develop an internationally interesting capital. The capital that wishes to keep up with the international competition develops not only its services but also the hardware, the cityscape. The vision for a softer Helsinki is backed up with the mission to develop a world league city. With a soft layer of membranes it would also be possible to enter the international discussion of tensile membranes and to challenge the attitude of "harsh weather – no membranes".

3.2 Strategy Program of Helsinki City

Strategy program of the City of Helsinki is published every four years. The program aligns the operations for different instances working for the city. As it is a strategic tool, the actions it advises to take are on a general level. The strategy program at the moment was endorsed 24.4.2013 by the City Council and is serving the term of 2013-2016. (City of Helsinki 2013)

The strategy program includes the city vision, Helsinki's values and ethical principles and the actual measures to take in order to gain wished objectives. The part of the program with objectives, targets and measures is divided into four theme categories; "Well-being for the residents of Helsinki, Helsinki is full of life, Functional Helsinki and Well-balanced economy and good management". All these headlines include more detailed tasks in order to achieve what is wanted. (City of Helsinki 2013, 3-6)

The part of the program with objectives, targets and measures includes actions that are in accordance of creating something new, for example proposing tensile structures to the city. Two of the objective themes in the program include ideas that a tensile strategy could use as advantage. The especially suitable actions are chosen from the program in the following.

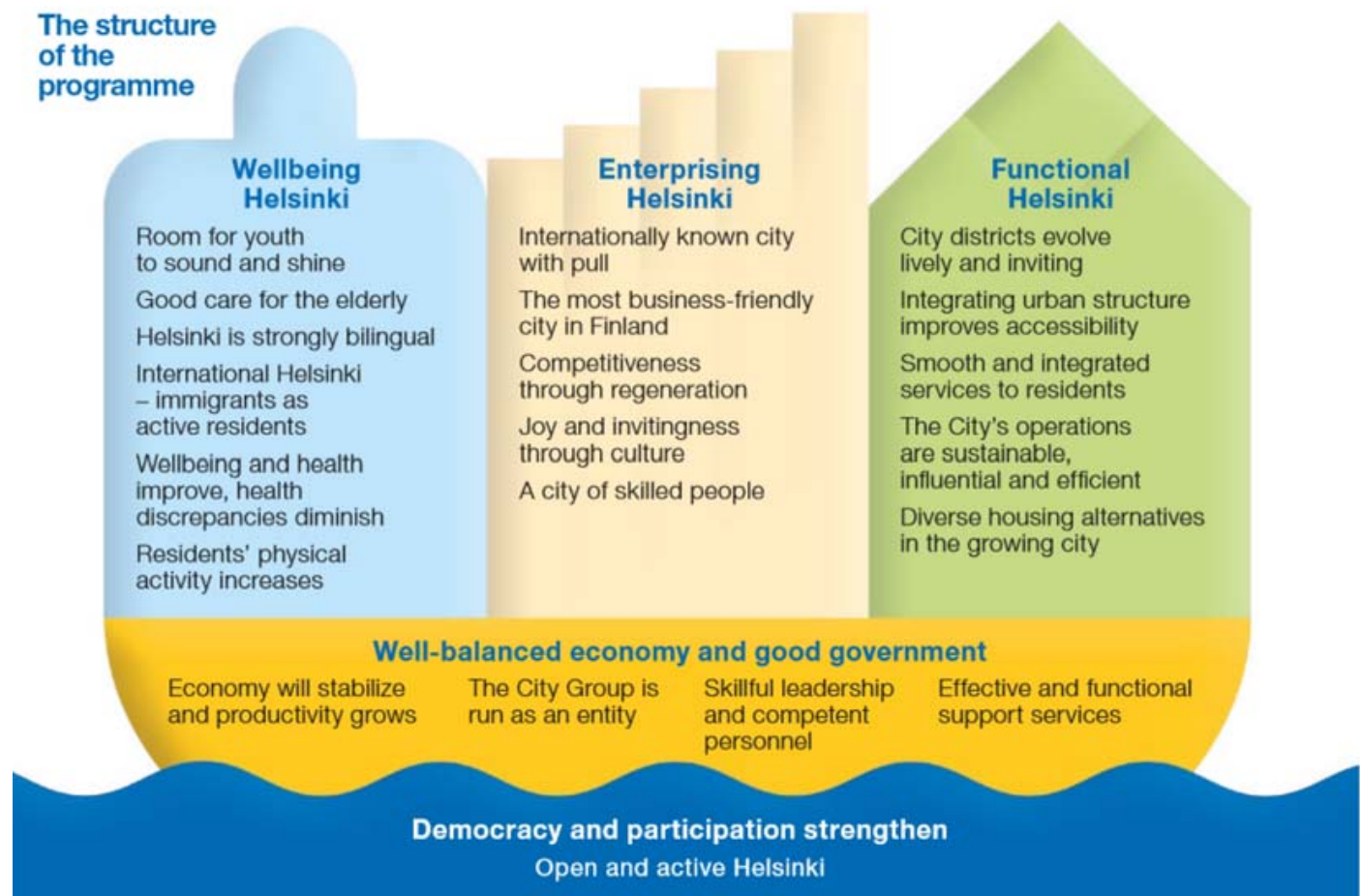
Helsinki is full of life (Enterprising Helsinki)

The objective called "Helsinki is full of life", includes the idea of marketing the city. One of its targets is that "Helsinki is internationally known and attractive city". The measure is to market the city for the purposes of tourism, events, experts and investments. The new living and working areas are emphasized. The seaside is seen as an asset: "Seaside Helsinki offers experiences to city residents and tourists, and business opportunities to companies". The development of water traffic is pointed out as an important goal to achieve. Helsinki is also seen as a fun city, where places suitable for organizing events are easily found and where organizing events is enabled. "Helsinki is a fun city that is full of events". (City of Helsinki 2013, 12-19)

"The city that has the most positive outlook on entrepreneurship in Finland". Under this target is a wish to combine business life with the public sector in order to achieve better city planning processes. The fields that are encouraged are ICT, wellbeing, tourism, environmental business and design. New business areas are developed. Co-operation of universities, polytechnics and research institutes is a goal, as well as different types of development programs and projects. The accessibility of Helsinki is improved and its status as an important traffic hub will be continuously developed. The center of the city is developed with the area's operators. (City of Helsinki 2013, 12-19)

Under target "Renewal offers competitiveness" "Helsinki is an internationally famous development and experiment environment for new products and services". More detailed, it is stated that the new living and housing areas are places for the development. The specialty of each area is seen worth promoting. (City of Helsinki 2013, 12-19)

"The City strengthens Helsinki's position as a major design city by utilizing design in the renewal of the city and in the development of services". The profile is capitalized in City's marketing. Helsinki Design Week happening will be strongly developed. "Culture offers delight and attraction". Visibility of environmental art in the city is encouraged through art percentage programs. (City of Helsinki 2013, 12-19)



Picture:

A logo-like sketch of the Strategy Program of Helsinki. (City of Helsinki 2013)

Functional Helsinki

The objective “Functional Helsinki” includes several targets and measures, which may include possibilities for tensile construction. The target “The districts and neighborhoods are developing as lively and attractive areas” deals with new and existing areas. The new areas are to be designed versatile and with their own personal features in order to strengthen the areas’ urban identities. The existing subcentres are densified and renewed. Emphasized are the cross-city public transport connections, centers, which include housing, jobs and possibilities for recreation. The quality, safety, tidiness and functionality of public areas are improved. The tasks in order to achieve versatile housing areas in the city are also numeric; Each year, 5500 housing units are meant to be built. The target “Helsinki is a fun and attractive city” includes a goal to create possibilities to use the city spaces for different kind of events in order to bring sense of community to the residents. (City of Helsinki 2013, 19-25)

The target “The completion of the city structure improves accessibility and fluidity” includes issues for public transport. Public traffic projects are to be combined with the construction of new areas in order to have the services ready already when moving in. Existing areas in connection to the new tram lines are to be densified. New connections are to be established. Along with public traffic, also cycling and pedestrian traffic are endorsed. A comprehensive development program for traffic is to be drafted. “Sustainable transportation is forwarded by increasing the share of walking, cycling and public transport”. (City of Helsinki 2013, 19-25)

3.2.1 The Strategy Program’s possibilities for tensile strategy

Helsinki wishes to be internationally known and markets itself for tourism, business and living. The center is developed continuously and it is expanding. The seafront is being developed and has multiple possibilities. The business life is being developed through co-operation of the different practitioners. The city is seen as potential development and experiment hub. Happenings are encouraged. Areas are to be developed with identity of their own. City is seen as a hub for culture and design, where art is part of the new areas. Public traffic is extensively expanding with new rails and stations to be built.

The strategy program deals with the development of the city. It touches almost all the possible areas. There is a strong will to develop the city through new construction projects, be it housing, working places, recreation or traffic.

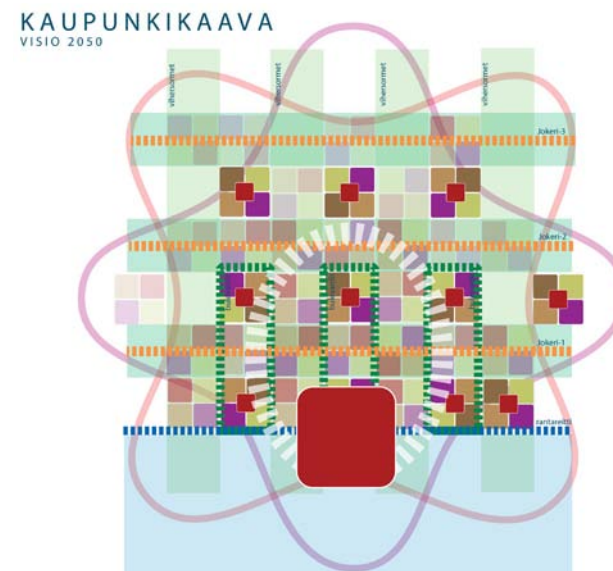
Along the new development, opens up possibilities for new experiment, for example tensile membrane construction: New public transport connections mean new stations. New housing areas mean new public spaces. Developed waterfront means new possibilities for construction. The wish to be international includes globally interesting projects. Culture includes experiments of different kinds. Co-operation with private, public and third sector makes possible fresh attitude towards development. City as an experiment hub tries new things. Areas with strong identity need elements to encourage personality.

The strategy program involves multiple possibilities for tensile membrane construction even if it is very general in nature. Tensile membrane construction is global field of expertise and offers fresh possibilities for Finnish and international engineering, architecture and design. New areas, their connections and public spaces can be potential places to build with membranes. If the city wishes to experiment, why not with membrane among other materials, stone, wood, glass and metal?! If art and design are strongly encouraged, there could be place for tensile structures as well. Helsinki could be a place for new, softer layer of construction.

3.3 Strategic spatial plan for Helsinki 2050

Helsinki is one of the fast growing capitals in Europe. According to the strategic spatial plan of Helsinki, having been accepted by the City Council in 27.10.2016, the city is expected to grow with 260 000 new inhabitants until the year 2050. This means, in total for Helsinki, 860 000 inhabitants and 560 000 jobs for 2050. With the neighboring cities, the area is a region with over a million and a half inhabitants altogether. (Helsinki City Planning Department 2015)

The swift growth of the capital opens possibilities for new developments. The strategic spatial plan of Helsinki is called "City plan", a plan for "networked rail traffic city". Along with new housing and places to work for the inhabitants, will also stronger centers, new rails, new kind of roads, new and renewed squares and networked parks, continuous waterfront, pedestrian and bicycle routes be introduced to the city. This development forms the background for the urbanism of Helsinki. And here, should also be potential place for tensile membrane development, place to develop a soft layer for Helsinki. (Helsinki City Planning Department 2015)



Picture:

Helsinki City plan logo.
(Helsinki City Planning
Department 2015)

City plan

When we talk about strategic urban planning, we talk about few themes. The themes, roughly, are housing, traffic, jobs and recreation. Those with additional themes of urbanity, internationality and the sea form the City plan of Helsinki. Each of these themes has potential to offer something for tensile membrane construction.

The City plan (Strategic spatial plan) for Helsinki 2050 is simplified in a logo, seen on the previous page, which easily explains the main ideas of this strategic land use plan. At the same time being very general, the City plan also includes investment potential for billions of euros. It is not unimportant as a plan. In brief, the logo of the vision stage of the strategic spatial plan shows the networked nature of the future Helsinki 2050. Here is the City plan in brief:

Helsinki's city center area will grow and densify and along this process, the smaller centres will develop in the now suburban areas of the city. The densification will occur in three different ways; by infilling the existing areas, by establishing new project areas on empty spots and through boulevardisation of the highway areas in the city. The surrounding region is also of importance and the city border areas are developed together with the neighbors.

Traffic development is of high priority in the plan. The whole of the city will continue its growth as a networked rail traffic city. This means investments in public traffic connections, especially tram connections. Along with public traffic development, the new city boulevards are nowadays highways transformed into urban boulevards then with tram connection and densely built sides. The boulevardisation means also new radial tram connections in each direction starting from the city center. With all the new tramlines together the city will have an efficient net of rail traffic.

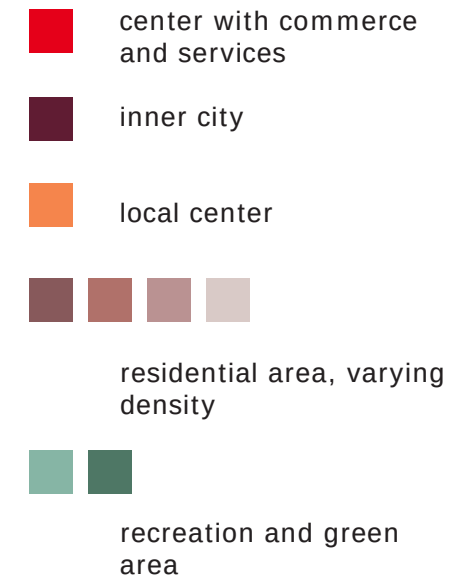
Green and blue network will densify its status with augmented quality. Especially the tangential connections are established to work together with the radial green fingers of the city. The seafront and the sea with its islands are added to the whole. The sea is a growing asset with more potential, as many of the new areas are situated next to the sea. An important new element will be the Helsinki Waterfront route along the sea facade of the city.

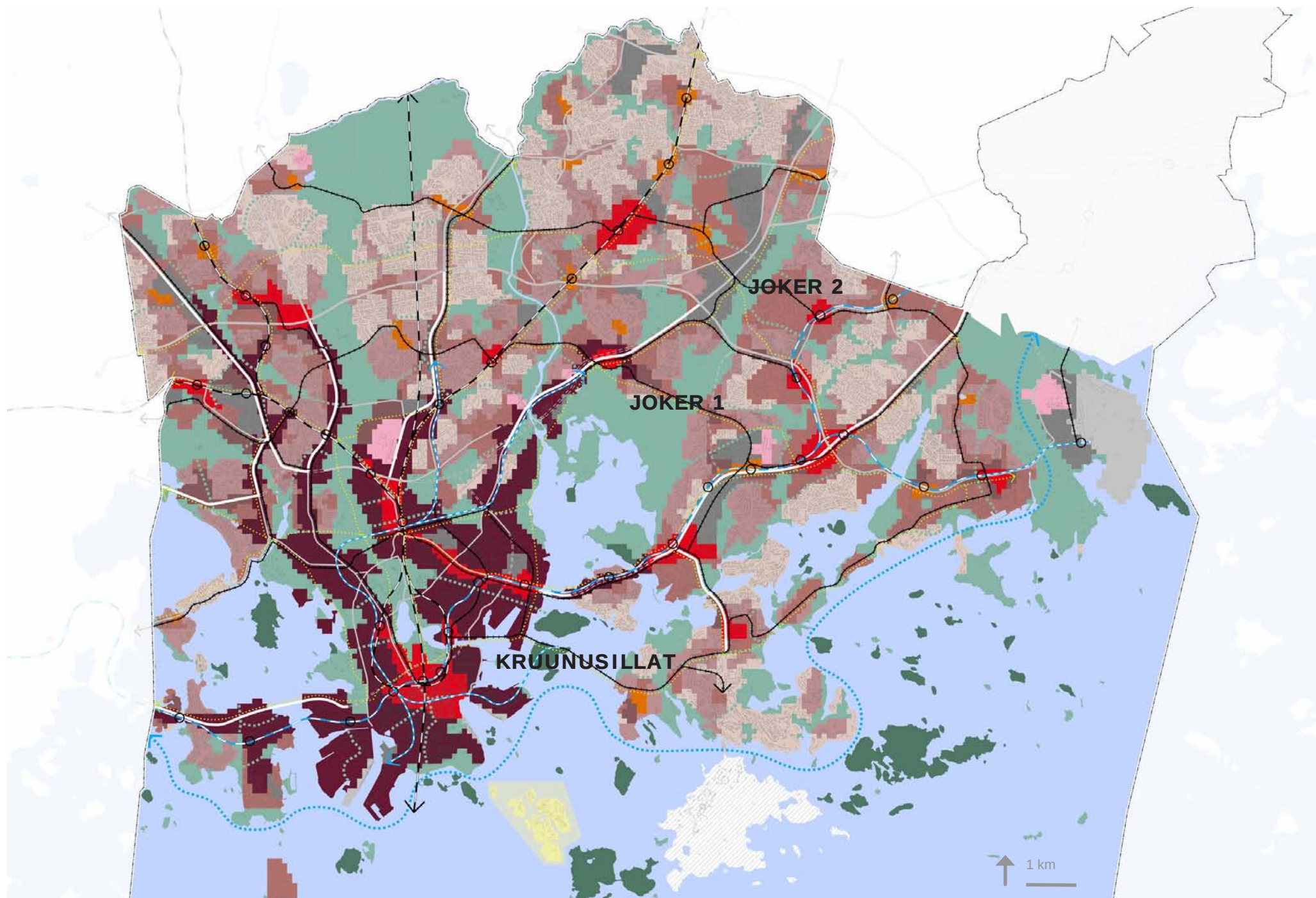
The city is seen as an international player. Helsinki wants to be seen as one of the northern, important cities in Europe and the world. Urbanity is one of the themes, through which the city may grow into something interesting worth developing.

(Helsinki City Planning Department 2015)

Picture:

Partial take of Helsinki Strategic Spatial plan (City plan).
(Helsinki City Planning Department 2016)





4 Helsinki layers - five cases

In Helsinki's three strategic level plans we find several aspects that encourage tensile membrane construction development in the city. Why should we suggest a particular type of structure to the city? And then again, why not? If a city is growing at the speed it is, there should be room for experimenting.

In this work, Helsinki Soft is a vision for a city that encourages experimenting with design for tensile membrane construction. The aim to build a city of impact requires ideas fresh to the city. The vision enables prototyping and tries to implement new ways of construction and new kinds of hardware in addition to developing services for the city. The brand concept of Helsinki has found an attitude for the future city: "Hel of an impact". In this work part of the impact is created with a tensile membrane construction strategy.

From the City plan and the city itself we can find physical targets to consider as platforms for tensile structure development. These are places that suit tensile membrane construction along with other types of new structures. On the following pages, the places are proposed as cases for future experimentation environments, places in which to consider fresh, new languages of design.

Helsinki develops each side of the city with varying policies. Below we collect places and themes to consider for tensile membrane construction. There are five cases in total.

4.1 Squares and market places – temporary Helsinki

The City plan has a growing center area and multiple other centres envisioned in the plan, colored in red. They are environments with multiple functions, housing, working places, services, shops and restaurants, parks and often, good traffic connections with several modes of transport. They are the urban stages of the city. (Helsinki City Planning Department 2016)

Helsinki is becoming more animated in terms of urbanity. Urban culture is booming and people are arranging happenings more and more, often spontaneously. Along urbanity, internationality is one of the desired aspects in the city development. More and more foreigners choose the city to study, work and live in. Urban culture is one of the aspects that make the city worth a visit - or a stay.

The City plan has thirteen center areas. Especially those areas and their central market squares could be places suitable for temporary and stable tensile membrane constructions, pavilions and shelters. Helsinki's parks, squares and market places are natural meeting points for people. Those places could each have their own pavilions to house different happenings and gather people together. Bigger center areas have several squares, the smaller ones just one, but all of them could be enlivened with shelters designed for the place. Temporary or permanent structures are both interesting options. The construction could take part in branding the place through its form designed for the particular place.

Movable membrane structures are versatile in potential uses for public purposes. They have the potential to be easily transported, assembled and disassembled. They are light structures that can be built to be modular. They can easily be used for urban activities, fairs, markets and happenings of different sorts. From small cafes to bigger concerts for example, tensile mobile construction can house multiple kinds of gatherings. It can take part in elevating the everyday experiences in the city.

Chanel's mobile pavilion is an example of urban activity housed with a particular construction. Helsinki could have something more humble but still interesting enough to attract groups of people. Another suitable application is Vienna City hall's travelling roof, which suits closed courtyards, common in the urban context.

4.2 Joker 1 + 2 and Kruunusillat

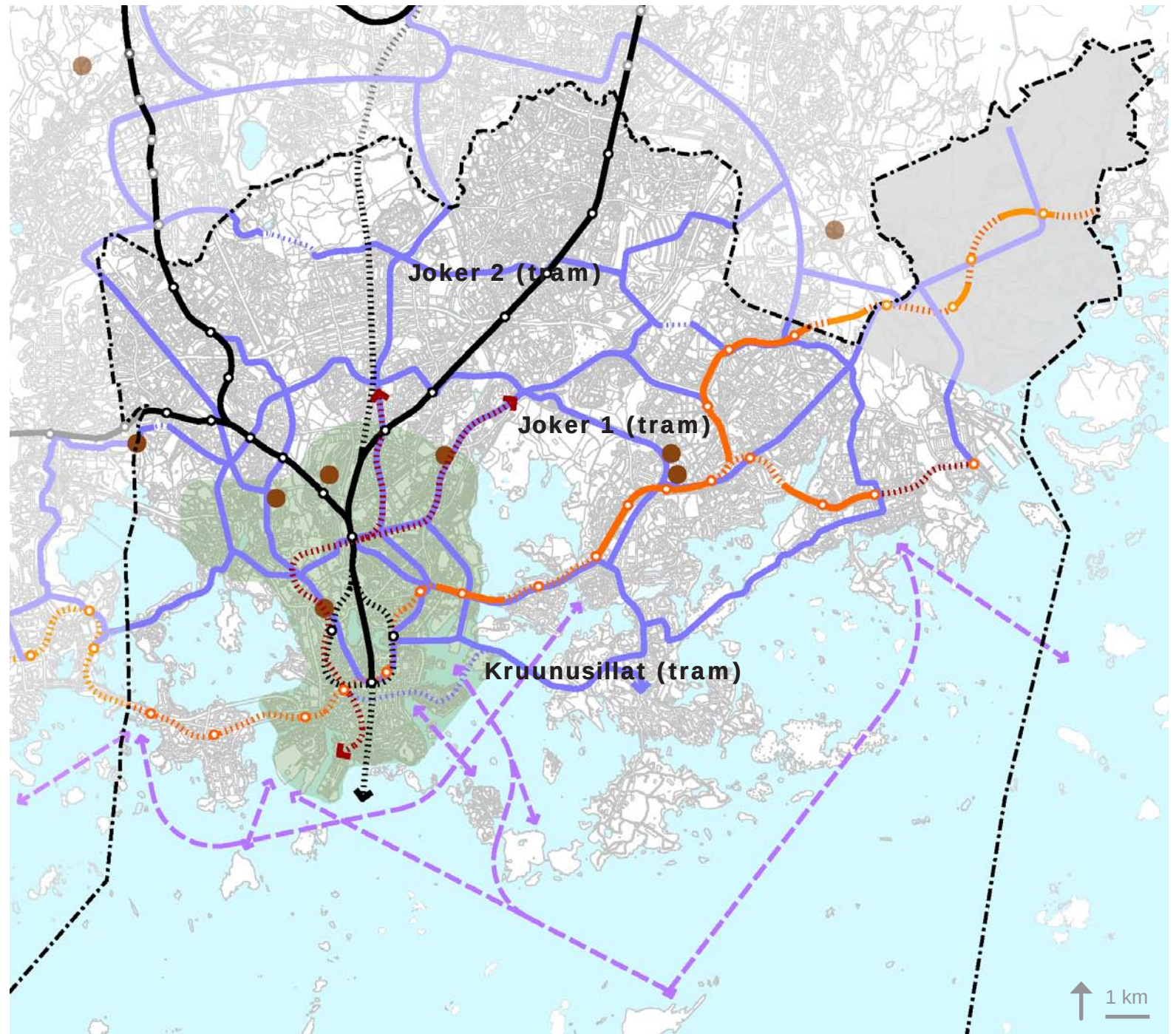
The city development plan has several new tram connections. The next ones to be realized are the Joker-line 1 and 2 and the Kruunusillat connection. The two Joker-lines traverse the suburban areas of the city tangentially. They form new connections to the radial rails and complement the existing rail network. Kruunusillat is a new radial connection from the eastern city center to Laajasalo island on the eastern side of the center. Kruunusillat is also a new bridge connection for trams, pedestrian and cycle traffic. (Helsinki City Planning Department 2016)

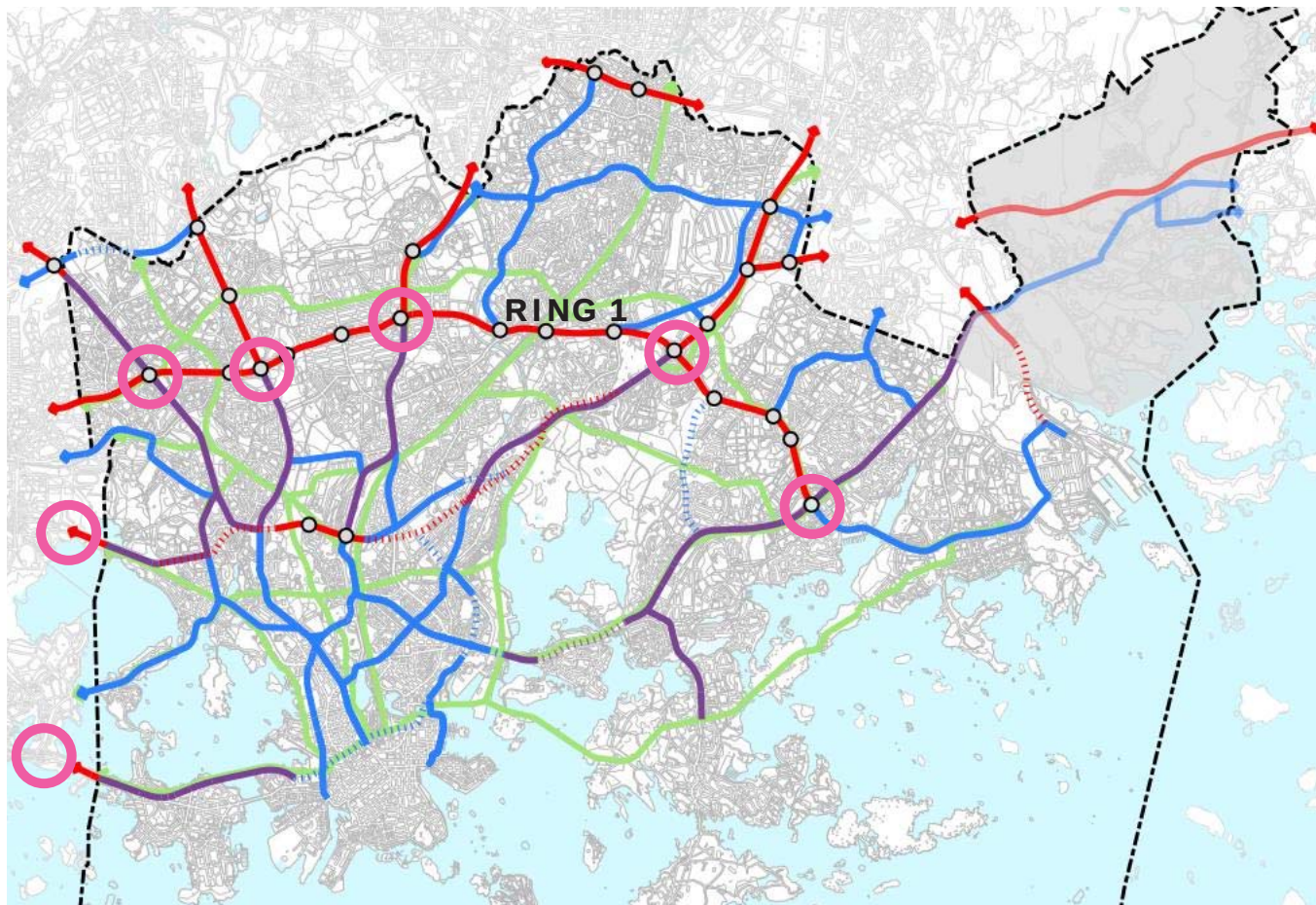
The new tram connections will add to the public transport route selection and widen the net significantly. Helsinki will have to build several new stations and transit nodes along the development of public traffic in the future. Already the Joker-line 1 will have over 30 stations, from which over 20 in Helsinki. And together, the Joker-lines and the Kruunusillat -connection will have close to 90 station and stop areas to be built in the future. There are many possibilities for different kinds of structures — and for tensile membrane construction in particular.

The Leipzig airport train station's shelter is an example of a rail traffic structure which could be applied for tramline construction in Helsinki. Detroit's Rosa Parks Transit Center is a design that could be applied to places with traffic nodes and different transport modes. The tensile membrane construction could be used to underline and mark the area. These two are types of uses that suit public traffic cases and could be applied to the construction of Helsinki's future public traffic network.

Picture:

Partial take of Helsinki public traffic network 2050. The lilac marks the tram network of 2050. (Helsinki City Planning Department 2016)





Nationally important highway or road
Valtakunnallisesti/ seudullisesti tärkeä tie tai katu
 Tie tai katu, joka palvelee pidempimatkaista liikennettä ja on valtakunnallisesti tai seudullisesti merkittävä väylä.

Kaupunkibulevardi City boulevard
 Tie- tai katualue, jota kehitetään laadukkaana urbaanina kaupunkiympäristönä tiivistettävässä kaupunkirakenteessa. Kaupunkibulevardi palvelee autoilijoita, joukkoliikennettä, kävelijöitä ja pyöräilijöitä. Pituus ja liittymäratkaisut ratkaistaan tarkemmassa suunnittelussa.

Pääkatu Principle road (Main road)
 Kaupungin pääkatu, joka yhdistää paikallisen liikenneverkon seudulliseen tai valtakunnalliseen verkkoon.

Tien tai kadun tunneli tai katettu osuus Tunnels
 Tunnelin sijainti sekä pituus ovat ohjeellisia. Liittymäratkaisut ratkaistaan tarkemmassa suunnittelussa.

Baanaverkko Swift bicycle lane "baana"
 Pyöräilyn nopea runoverkko, joka mahdollistaa sujuvan ja tasavauhtisen pyöräilyn. Suunnitellaan koko kaupungin alueelle esitettyä verkkoa mukaillen.

Eritasoliittymä Multiple level junctions
 Liittymä, joka voi sisältää eritasojärjestelyjä. Liittymäratkaisut ratkaistaan tarkemmassa suunnittelussa, liittymä voidaan toteuttaa myös tasoratkaisuna.

Suggested toll junctions

4.3 City boulevards

In Helsinki's city development plan, there is a strong desire to change the type of motorways heading to the city centre. In the future, instead of highways, the thoroughfares are transformed into "city boulevards" with tram tracks in the middle and housing and work places constructed right next to the sides of the boulevard. It has been found out in research that this transformation would enable a lot of land to be freed for constructing offices and housing.

The streams of highways to be changed are especially inside the Ring 1 road circulating in the current suburban areas of the city. The radial motorways, thoroughfares, are seen as future boulevards, with pedestrian and bicycle lanes, green lanes, two lanes for cars in each direction and tramways in the middle. This is planned along the eight radial motorways penetrating the city. (Helsinki City planning office, Strafica, 2013)

The future would potentially see the establishment of road tolls along the junctions of the suburban areas and the centre area of Helsinki. There are several suggested models to consider, but here, I have suggested my own version, which can be seen in the picture. The positioning of the toll stands works together with the boulevardisation and the construction of new tramlines along the boulevards. These junction area toll stations would be natural structures to consider for tensile membrane construction. Relatively easy portability of tensile structures could prove useful in this context.

Picture:

Helsinki roadmap 2050.
The future boulevards are
marked in violet. The potential
toll areas are added
on top of the map in red circles.
(yleiskaava.fi 2015)

1 Pikku Huopalahti
1990's

2 Aurinkolahti
2000's

3 Arabia
2000-2014

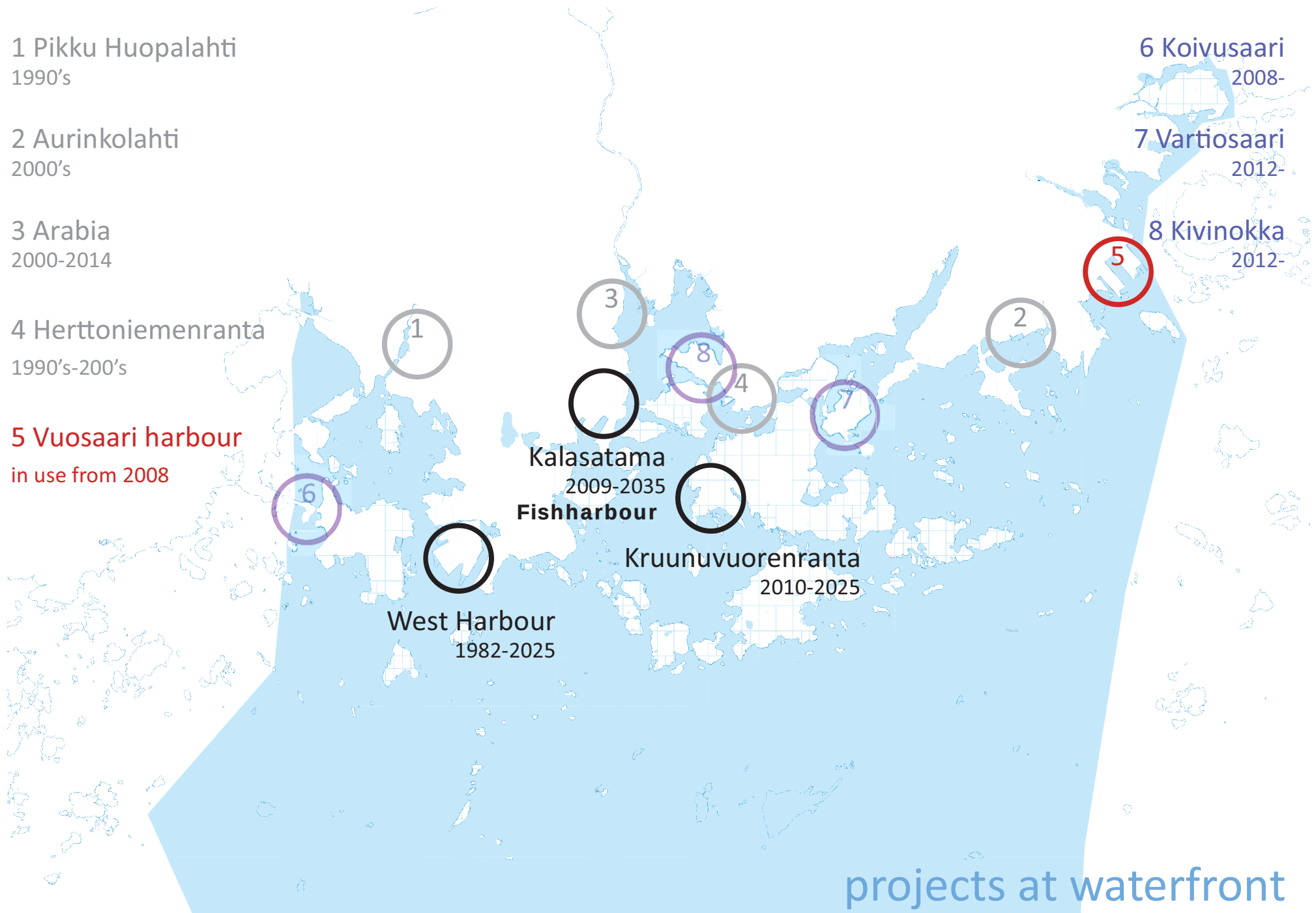
4 Herttoniemenranta
1990's-200's

5 Vuosaari harbour
in use from 2008

6 Koivusaari
2008-

7 Vartiosaari
2012-

8 Kivinokka
2012-



projects at waterfront

4.4 Helsinki Waterfront

Helsinki is beginning the work to develop its waterfront as a strong, continuous element in the city. Three former harbour areas, Fishharbour, West harbour and Kruunuvuorenranta are being transformed into housing and working areas. They cover over ten kilometres of freed waterfront right in the city centre for everyone to access. These areas are not the only ones developing along the coastline; also Vartiosaari and Koivusaari are being planned at the moment. Along these bigger areas, several smaller planning areas along the coastline are being prepared. (Helsinki City Planning Department 2014-15)

The new strategic spatial plan has found several new areas to develop along the coastline. This means opening a possibility to design the waterfront as an important, continuous and fresh element in the city. First of all, the waterfront has possibilities for WOW construction. Also, several private and public boat harbours may develop their functions along the waterfront development. There is place for new entrepreneurs along the coastline. And again, tensile membrane structures can naturally find their use along the coastline, next to the sail boats and different maritime places of interest.

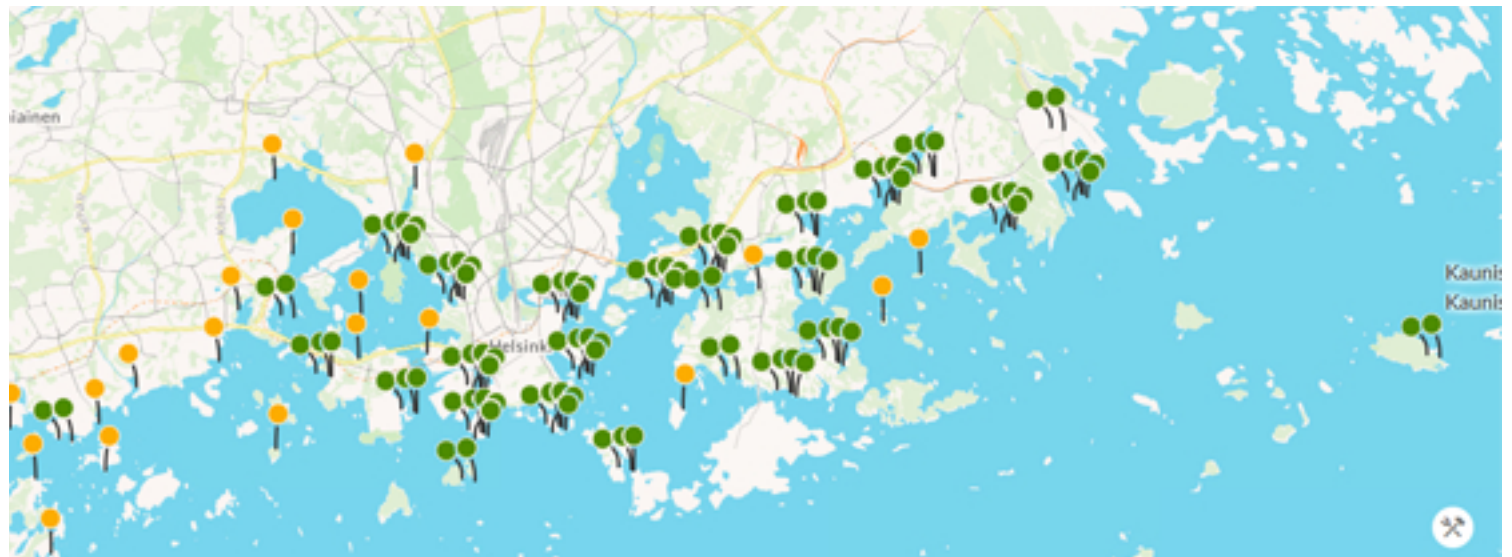
The East River 24th street Ferry Terminal is an example that shows how to develop waterfront traffic hubs. It is a pleasant station under which to wait for the next ferry, buy a ticket or have ice cream and watch the sea. - and a use that could be applied in Helsinki.

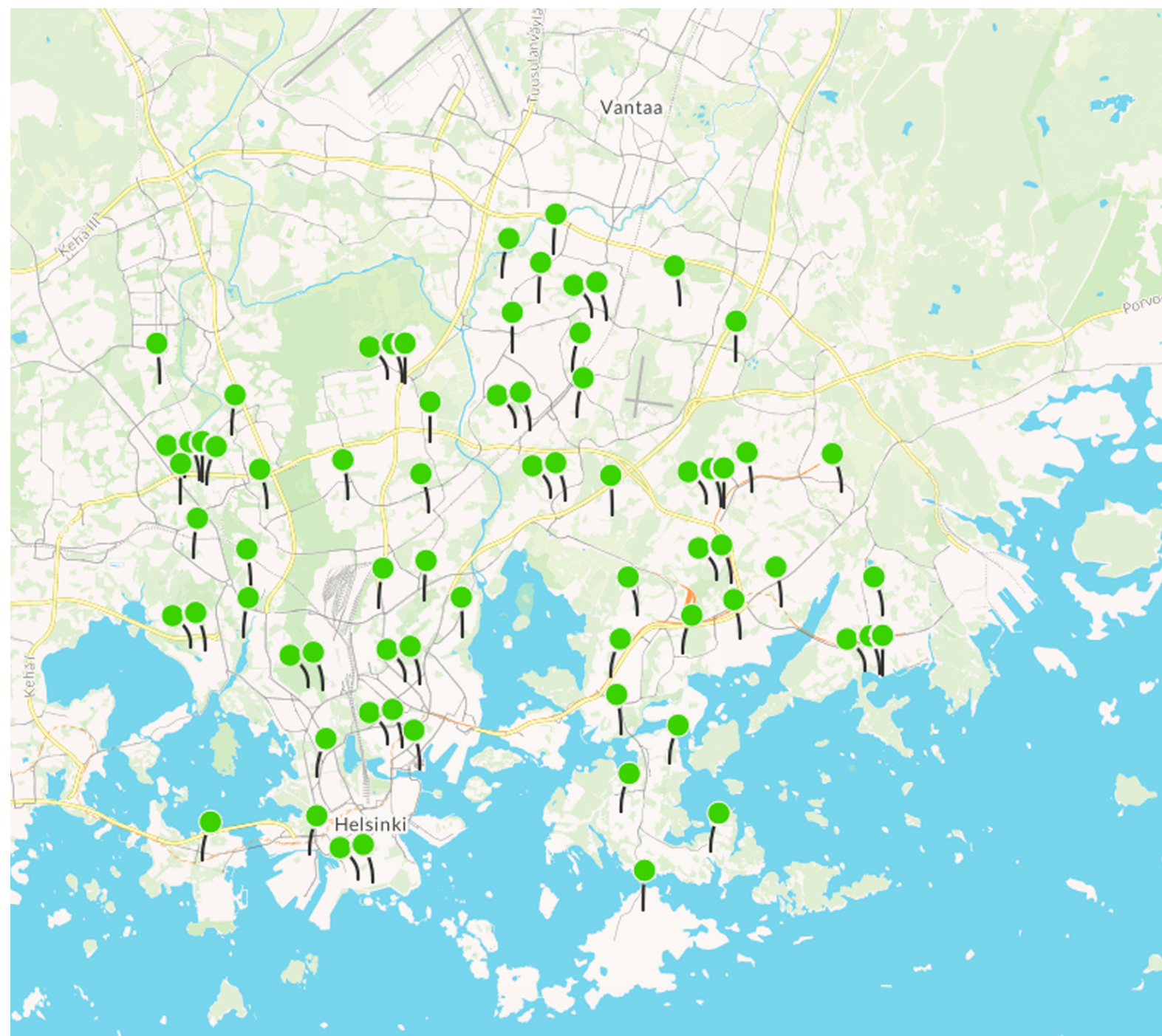
Picture left:

Projects at Helsinki waterfront, situation 2014. In black, the former harbor areas; in violet, the potential future areas. (Helsinki City Planning Department 2014)

Picture right:

Harbors, piers and quays in Helsinki 2016, both private and public. (servicemap.hel.fi)





4.5 Recreational areas and playgrounds

In Helsinki, there is a special public treat for children called “play park” in Finnish. There are a total of 73 of these playgrounds which offer safe and meaningful playing activities as well as possibilities for meal services during the office hours. These playgrounds are also free to be used in the evenings but without service at those hours. They are very popular among families with children. (Public Works Department 2016)

The play parks are equipped with playground structures, sand boxes for little children, swings and playing fields, sometimes ponds etcetera. The areas are frequently taken care of and are usually in a neat condition to spend a day or an evening. (Public Works Department 2016)

Among the playground furnishings, tensile membrane structures would be a good addition to diversify the selection of structures and to give something special and WOW to each different park. They could serve as shades but also as shelters against rain and snow.



Pictures:

Playground activities 2016.
All the 73 “play parks”
in Helsinki.
(servicemap.hel.fi 2016)

Playground in the winter in
central Helsinki.
(T Kuusisto)

5 Helsinki *soft*

When building strategies, we talk about vision, mission, values and the strategy. Vision is the wished position to be in the future. Mission answers to the question “Why are we here?”, it brings motivation to the strategy. Values are lenses through which we look at parts of our strategy. And the strategy is about how to get to our goal, the vision. (Tekes 2001, Limor Oy 2010)

In this work, the vision “Helsinki soft” is backed with the mission “to build a world league city”. The strategy here to do so is through a niche field of construction, namely, tensile membrane construction. Here, Helsinki is viewed a potential place of experiments with tensile structures as part of its swift growth.

We consider “Helsinki urban planning” and “tensile membrane construction” together. Tensile membrane construction is only one way to develop the city – there are several other ways as well of course. But as the city is one of the fastest growing cities in Europe, there should be room for bringing fresh ways of construction to the city. Tensile membrane construction could be seen as a soft, liquid layer of construction next to the more traditional building materials and structures. It would diversify the language of architecture and engineering in the city.

The values that suit our tensile membrane construction strategy are many and they are stated in the three strategical papers of the City already. The values are aspects through which we look at the vision, mission and strategy. They are the following: creative, open, powerful, ambitious, successful, transforming, flexible, original, attractive, internationally known, fun, business friendly, co-operative, development and experiment environment, design city, renewing, personality, quality, versatile, fluid, hub for culture and design, art, urban, international, networked.

Our strategy involves aspects we want to take advantage of in order to build a world league city. We have chosen a specific way to achieve our goal, the vision for a world league city, and this is with membranes. What are the aspects of membranes we could best work with? What are our aims more specifically? What do we do at the same time when we introduce an idea of building more membranes? The strategy to build membranes includes several aspects with influence. We could consider them as ladders towards our vision.

Picture:

Strategy in its simplest form.
Mission to build a world league city with membranes in order to achieve the vision for softer Helsinki.
(T Kuusisto)

HELsoft

MEMBRANES

Helsinki grows (world league city)

We want to build membranes and at the same time (the ladders):

- Challenge the weather
- Bring competition to the types of building
- Vary the structures and materials of building
- Diversify the language of construction
- Raise the awareness for membranes
- Widen the markets
- Open the markets
- Learn and educate more
- Increase the amount of know how
- Experiment and develop
- Bring interesting design tasks to the specialists
- Attract visitors
- Enter the international discussion
- Be international and think big
- Build a world league city

With membranes, there is a possibility to think big. With membranes added to the list of other technologies, the language of engineering and architecture will be more diverse. Discussion on membranes can attract enthusiasts from around the world, and we can challenge the weather conditions and bring new materials and structures to be tested in the Finnish weather.

With membranes added to the picture, there would be more competition between different building techniques. The markets would widen due to novel tasks of construction. We would possibly have international players joining the process. Realized membrane structures would help in building a world class city with internationally interesting construction solutions.

Picture:

Strategy ladders, that we create by building membranes, towards our aimed position, Helsinki soft - Helsinki with membranes. The colored values, lenses, give depth to the process.
(T Kuusisto)

HELsoft

Enter the international discussion
Build a world league city
Be international and think big
Attract visitors
Bring interesting design tasks to the specialists
Experiment and develop
Increase the amount of know how
Learn and educate more
Open the markets
Widen the markets
Diversify the language of construction
Vary the structures and materials of building
Bring competition to the types of building
Challenge the weather

Helsinki grows (world league city)

development and experiment environment

internationally known

international

co-operative

business friendly

art

fluid

hub for culture and design

design city

urban

networked

open

creative

attractive

powerful

ambitious

successfull

transforming

flexible

versatile

original

fun

personality

renewing

quality

5.1 How to operate?

How do we realise a strategy like this? What are the operational steps we should take? What should happen after a strategical approach has been created?

First it is important that the different players in the game welcome the idea. This means the City of Helsinki, the designers, architects and engineers, construction companies, material suppliers, third sector players and private actors. They should of course first understand the idea. This means we need to share and distribute the information on membranes in general.

To proceed further from the information distribution stage, we would need to realize the first new membrane construction examples. One possibility to increase the use of membranes could be the Finnish system of architecture competitions. The country offers many such competitions annually, organized by SAFA, the Finnish Association of Architects, together often with the public sector and also the third and private sector (SAFA 2016). One possibility would be to offer competitions using membranes as a suggested solution to the competition task — if not the only solution, then one solution among others. More writing, design and execution examples and thus, growing expertise, could be a good strategy towards a softer future.

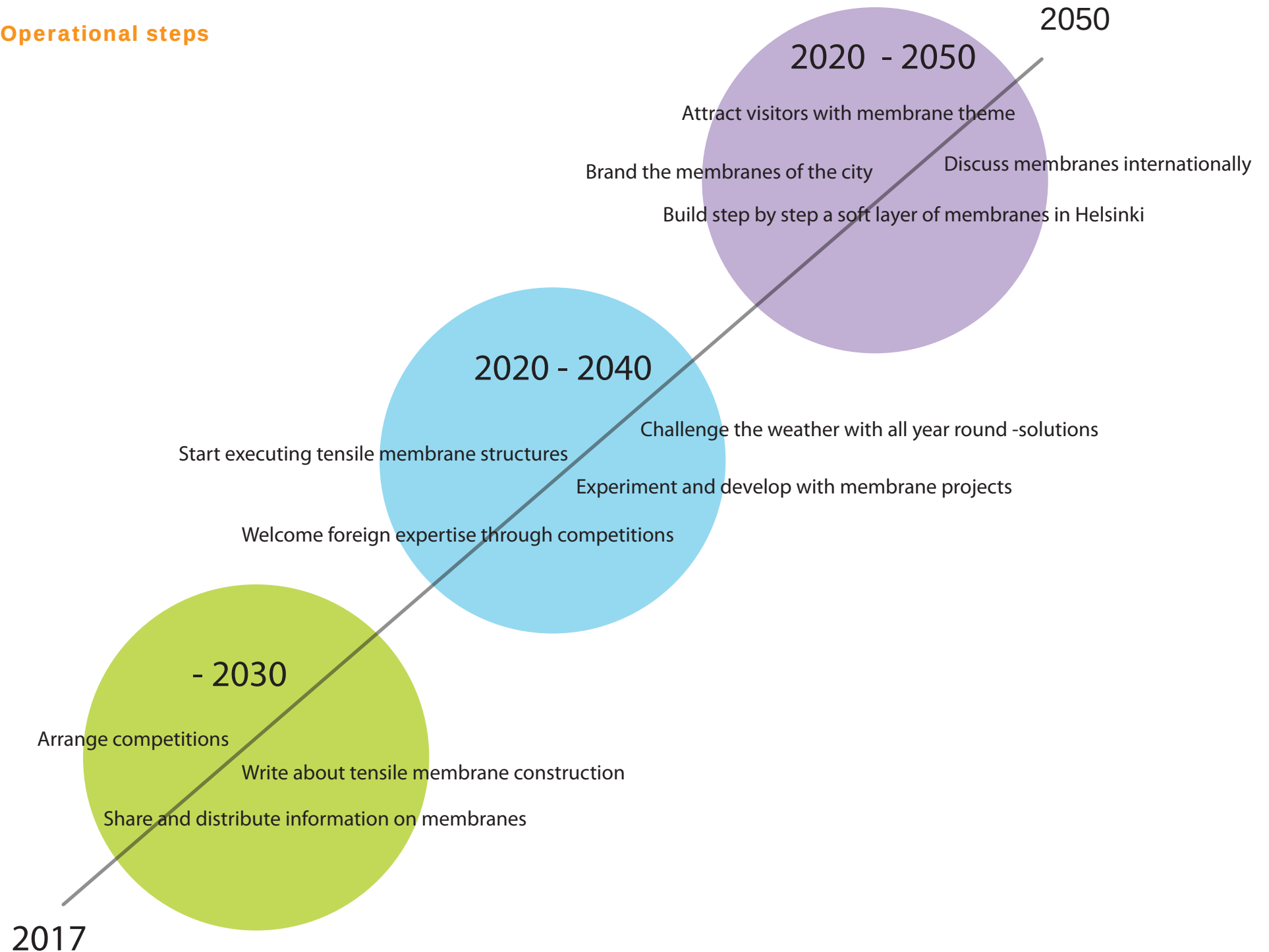
The third stage after informing, developing and competing is to realise structures in practice. As we do not have too much related expertise in Finland, we should welcome foreign knowhow to the country. This could encourage novel interaction and freshen the market. Through the projects, we could learn more and widen the areas of knowhow. Experimenting and developing would increase through actual execution of membrane construction. And the specialists would have the possibility to extend their existing knowledge as well.

With executed examples we would have places of interest to visit in Helsinki. A soft layer in the city sounds interesting as an idea and might attract visitors from the country and abroad. The structures would create interest and discussions and Helsinki could establish itself as one of the membrane cities in the world.

Picture:

Operational steps to develop a softer Helsinki, 2017 - 2050.
(T Kuusisto)

Operational steps



5.2 Tensile timetable and investments

The time span for constructing tensile membrane structures in Helsinki soft extends from year 2020 to year 2050. We have estimated the number of possible tensile membrane constructions to be around 50 in total by considering the different Helsinki layers together and estimating a percentage of realized constructions case by case.

With all the estimated potential membrane construction cases, we come to an investment of over 60 000 000 euros in total. When all the projects are evenly distributed over the estimated time span, it makes more than three cases to build each year from 2020 to 2030, more than two cases from 2030 to 2040 and less than one from 2040 to 2050. The investment for the same division of time and the amount of cases to build would be almost 3 500 000 for each year from 2020 to 2040 and one million per year for the years 2040 – 2050.

Temporary Helsinki, city markets and squares investment of 50 000 – 500 000 euros per piece	built in 2020 – 2030	10 cases
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Joker 1+2 and Kruunusillat stops and stations investment of 500 000 – 2 000 000 euros per piece	built in 2020 – 2040	17 cases
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City boulevards tolls investment of 2 000 000 – 5 000 000 euros per piece	built in 2030 – 2050	4 cases
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Helsinki Waterfront, every 10 kilometer investment of 100 000 – 500 000 euros per piece	built in 2020 – 2030	7 cases
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Recreational parks and playgrounds investment of 50 000 – 100 000 euros per piece	built in 2020 – 2030	7 cases
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In total	2020 - 2050	45 cases
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PLACE/LAYER	AMOUNT of PLACES	MEMBRANES in	PIECES	PRICE à	IN TOTAL	EXECUTED in
City markets and squares	13	80%	10	500 000 €	5 000 000 €	2020 – 2030
Joker 1 + 2 and Kruunusillat	87	20%	17	2 000 000 €	34 000 000 €	2020 – 2040
City boulevards	8	50%	4	5 000 000 €	20 000 000 €	2030 – 2050
Helsinki Waterfront	130 km/10km=13	50%	7	500 000 €	3 500 000 €	2020 – 2040
Recreation and playgrounds	73	10%	7	100 000 €	700 000 €	2020 – 2030
All together in total	191		45		63 200 000 €	2020 – 2050

Picture:

Tensile timetable and estimated investments.

Pictures:

Tensile membrane structures
for Helsinki 2050, cases.

Yearly investments for the time
span 2020-2050.

INVESTMENT per year 2020 – 2040	2040-2050
3 445 000 €	1 000 000 €

LAYER/PLACE	CASES	PRICE à max.	IN TOTAL	EXECUTED in
City markets and squares	10	500 000 €	5 000 000 €	2020 – 2030
Hietalahti market place				
Hakaniemi market place				
Herttoniemi				
Itäkeskus				
Kannelmäki				
Kauppatori market place				
Malmi				
Myllypuro				
Viikki				
Pitäjänmäki				
Joker 1 + 2 and Kruunusillat	17	2 000 000 €	34 000 000 €	2020 – 2040
Falbacka				
Haaga				
Itäkeskus				
Etelä-Haaga				
Kontula				
Kruunuvuorenranta				
Kustaankartano				
Laajasalo center				
Malmi Airport				
Mellunmäki				
Kustaankartano				
Viikki				
Oulunkylä				
Pajamäki				
Pirkkola				
Tali				
City boulevards	4	5 000 000 €	20 000 000 €	2030 – 2050
Hämeenlinna boulevard				
Itäväylä boulevard				
Lahdenväylä boulevard				
Tuusulanväylä boulevard				
Helsinki Waterfront	7	500 000 €	3 500 000 €	2020 – 2040
Hakaniemi waterfront				
Hermannin waterfront				
Hernesaari waterfront				
Herttoniemi waterfront				
Koivusaari waterfront				
Puotila waterfront				
Vuosaari waterfront				
Recreation and playgrounds	7	100 000 €	700 000 €	2020 – 2030
Arabia				
Hakaniemi				
Laakso				
Munkkiniemi				
Lauttasaari				
Punavuori				
Töölö				
All together in total	45		63 200 000 €	2020 – 2050

5.3 Conclusion

Unexplored possibilities of the growing capital of Finland, Helsinki, and the near absence of tensile membrane construction, or textile architecture (in Helsinki and the whole country of Finland), were the catalysts of this study. The aim of this study was to bring together two separate fields, namely, urban planning of Helsinki and tensile membrane construction, and to build a strategy for them together. Through the strategy a new language of engineering and architecture could be implemented in the city of Helsinki.

The objective of the study was to look at the present situation in Helsinki, borrow ideas from abroad, consider possibilities in relation to different strategical documents of the City of Helsinki, and finally, find places in Helsinki where tensile membrane construction could potentially be applied. The last part of the work consists of a catalogue of possible solutions for the places found. It gives a pictorial conclusion for the drafted strategy.

Start and examples from abroad

The kota of Lapland is an example of textile architecture for harsh climates. It is part of Finnish history that encourages also contemporary developments in the field of textile architecture. The (few) examples of tensile membrane construction in the country show an interest that does exist in the country, but practitioners in the field are not many. The reason why the number of executed structures and specialists working in the field is small is quite probably due to the fact that there are few practitioners of the trade and the market is fairly closed. Also the weather is considered an obstacle. The SWOT analysis, however, found positive aspects in the situation; a growing city, enthusiastic designers, openness towards novelties and new places for experiments, to name a few. The studied five examples from abroad show tensile membrane structures in everyday surroundings and applications that could be used in Helsinki too: structures of public traffic infrastructure and uses for public happenings.

Helsinki in strategies and Helsinki layers

The three strategical approaches of the City of Helsinki are open to experiments and innovation in the city. Brand New Helsinki sees Helsinki as a city that makes “hel of an impact”. The Strategy Program of Helsinki wishes the city to be internationally known and attractive, even fun. In the program, Helsinki is desired to be famous for developments and experiments. The new areas and projects to be built are places for all this. The City plan, or the Strategic spatial plan of Helsinki 2050, situates the new development possibilities in physical locations in the plan. There are several possible themes and locations that tensile membrane construction could inhabit in the plan. Markets, public traffic structures, city boulevards, waterfront and playgrounds are example cases where tensile membrane construction could be applied.

Could we build more with membranes in Helsinki and Finland? The answer is yes. The city's strategies back up the idea of experimenting. In order to build a capital that makes an impact, there is room for a soft layer. There are ongoing developments that we see from the examples in section "Helsinki layers". As the City of Helsinki is so swiftly growing, there certainly is a need - or place - for structures with membranes. The idea to introduce more membranes is backed up by the need of new structures. Membranes should find their place next to timber, metal, glass, concrete and stone even in Helsinki.

Helsinki soft and catalogue

Helsinki soft builds a tensile membrane strategy. Our client is imagined to be the City of Helsinki and we consider tensile membrane construction together with urban planning. The strategy builds on the fact that the city is growing. The mission is to build a world league city and one way to do this is by building with membranes. The tensile membrane strategy is supported with values cherished by the city, for example values like "open, creative, design city, development and experiment environment, fluid and international". By building with membranes, several other aspects can also be established. We would for example increase competition between different materials, widen the construction markets, increase the amount of know-how of new specialists, and attract interest and visitors and thereby participate in building a world league city.

The timespan for the imagined tensile strategy is thirty years, from 2020 to 2050. In this study, we have found almost 50 cases possible for tensile membrane experiments. The estimated budget for all these would be around 60 000 000 euros in total. This would mean one to three structures to be built each year and an investments of 1 000 000 to 3 500 000 each year.

The Catalogue part of the study is the last part of this study and it investigates possibilities of tensile membrane construction in a pictorial form. It explores possibilities for membranes in the city. It is a conclusion to the study that discusses tensile membrane applications in Helsinki.

5.4 Catalogue

What are the possible applications in Helsinki to be build with membranes? We have earlier imagined places where membranes could be of use and here we suggest some example solutions. The catalogue part is a pictorial conclusion to the thesis and shows what and where we could build with membranes.

The picture on the right shows the 45 tensile membrane projects that can be found in Helsinki. They reside mostly in the center area of the future City of Helsinki. Each colour refers to a specific development project in the city. The icons are not in scale, but show approximately the place where the project could be established.

Picture:

Tensile membrane icons



City markets and squares



Joker 1 -tram



Joker 2 -tram



Kruunusillat bridge connection



City boulevard tolls



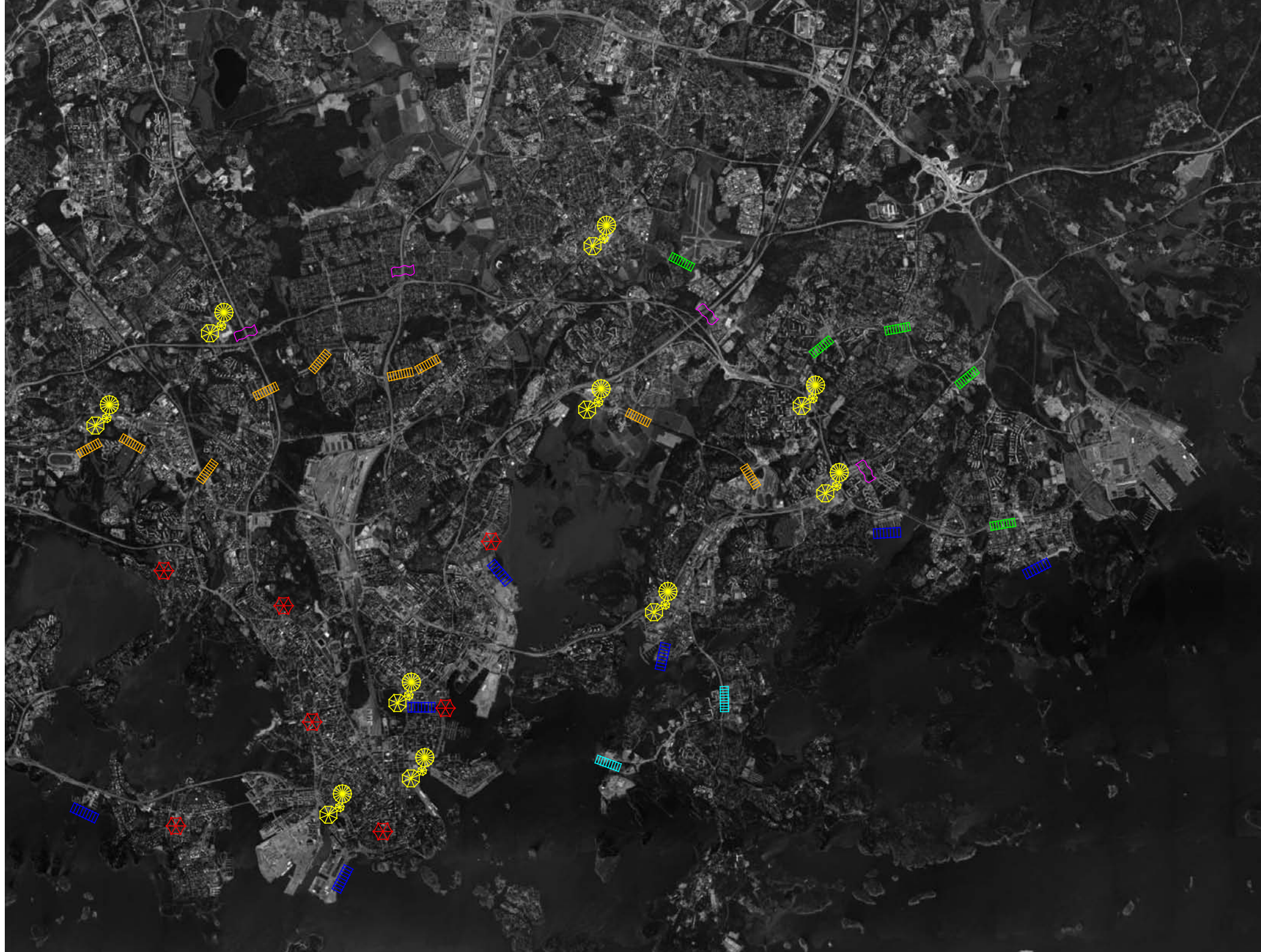
Helsinki Waterfront



Playgrounds

Picture:

Tensile membrane icons in
Helsinki.
(the base map: kartta.hel.fi)



5.4.1 Market tent - Squares and market places

Market tent is a typical simple cone. It brings character to the market square with different colour combinations. It reminds us vaguely of circus tent tops and brings joy to the everyday circus at the market places of the city.

The tent is held by a straight, pinned mast which is holding straight “arms” holding the tent with a cabled edge. The tip is circular beam edged. The sizes may vary; the basic measure is five meters of diameter. The tents may be joined to create a queue and surround a market area. The booths and market tables can be situated underneath the tents.

The densifying city of Helsinki will have more center areas in the future. Each of these areas has market places and squares where tensile membrane constructions may be applied to bring a special atmosphere to the surroundings.

Thirteen center areas are identified in the City plan. Some of them are bigger and include several market squares, some only one. In this work, we have estimated ten potential “membrane centers”, which is 80% of the center areas. If the investment for one tent structure was from 100 000 to 500 000 (depending on whether the solution is modular or an individual solution) the budget for ten applications would be from one million to five million euros. The construction of the new center areas continue until 2050, and at the same time, the existing center areas renew their faces, so the development of the center areas is ongoing.

Picture:

Tents of varying sizes placed in a circle on the Hakaniemi market place. (T Kuusisto)



5.4.2 Plain station - Joker 1 + 2 and Kruunusillat

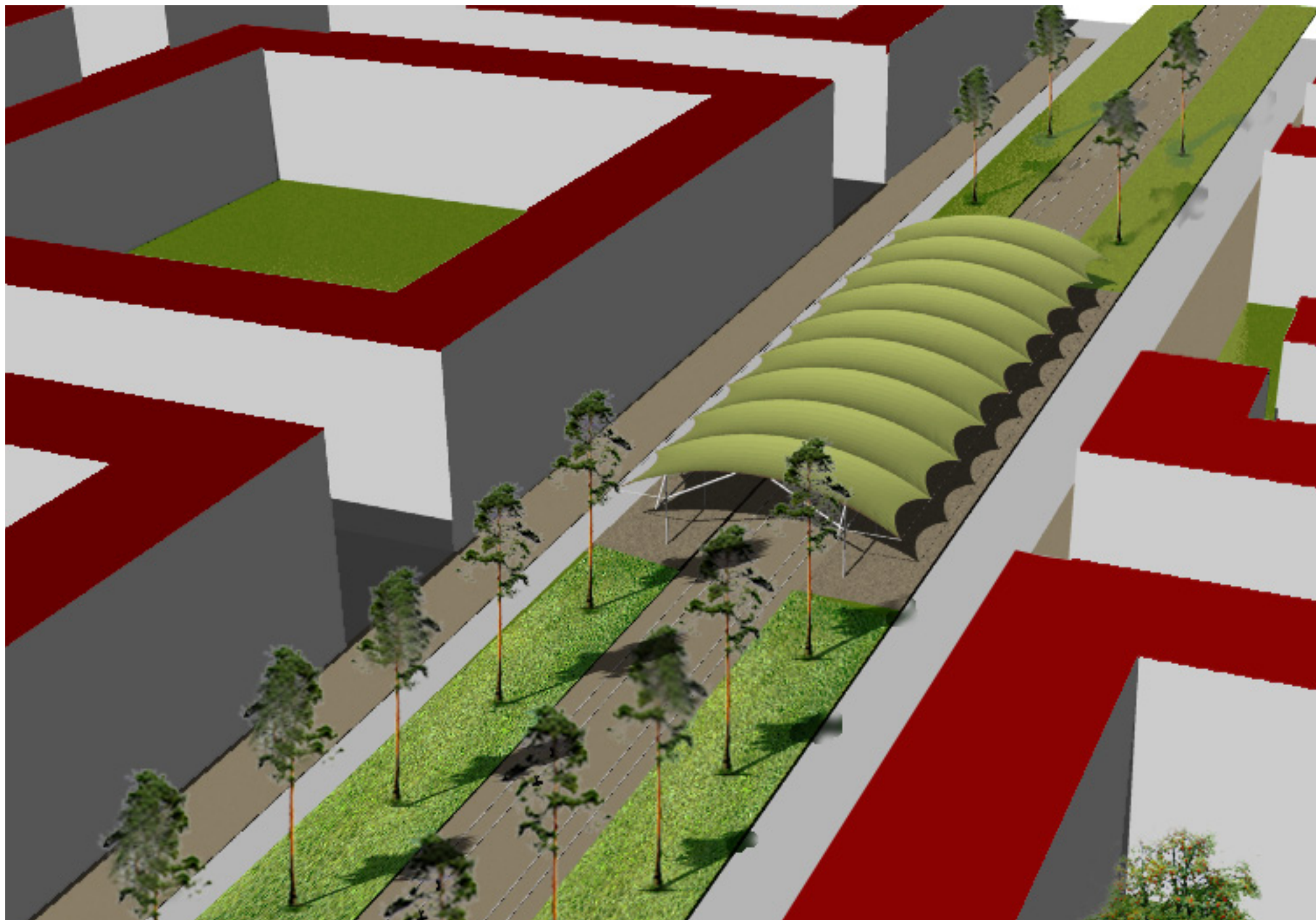
Plain station is the simplest design for a tram stop or a bigger station. It is built modular and repeats an arched vault over the station. The membrane stretches over the rails and provides shelter from the weather.

The structure of one arched vault is standing on two primary structure posts that carry a wheel like steel structure with three arms holding the steel arch which then in turn carries the membrane. This repeated creates a shelter for stops and stations.

Joker 1 and 2 and Kruunusillat -tram connections will be built during the future decades. There are approximately 90 stops and stations in total. The final figure is yet to be decided in the future. If 20 percent of these stops and stations were built with membranes, we would have 17 of them in total. If the estimated investment for one structure were 500 000 – 2 000 000 euros, we would have a price of 8 500 000 – 34 000 000 for the whole of 17 executed tensile membrane constructions. The applications could be designed modularly or specially to a particular station or stop area.

Picture:

Plain station shelter in imagined future city structure along Hämeenlinnanväylä.
(T Kuusisto)



5.4.3 Toll strip - City boulevard tolls

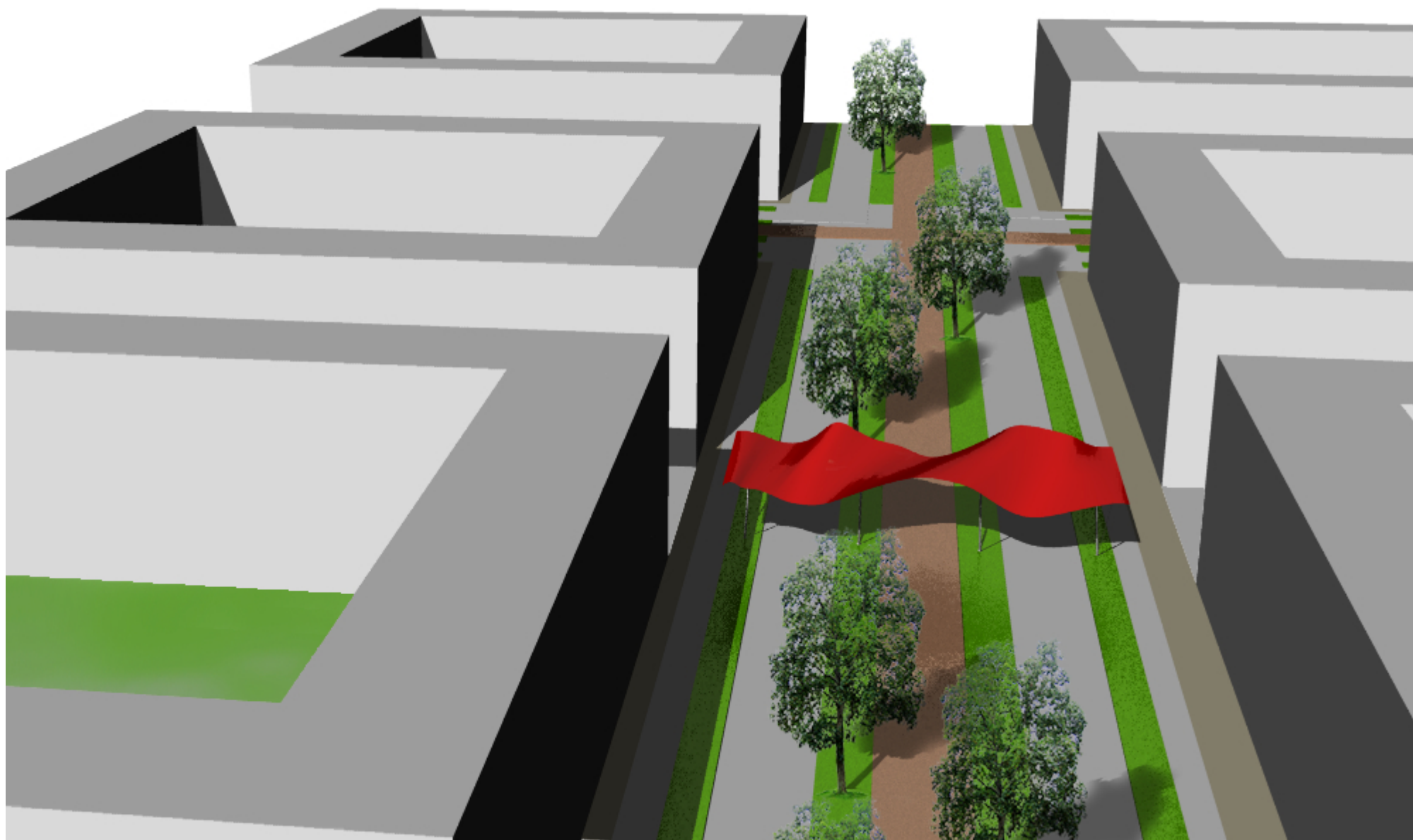
Toll strip is a shelter marking the place of the tolls when entering the Helsinki city centre area by car via the city boulevards. It is a tensile membrane structure with two different free form arches and a membrane spanned between them.

The structure of the toll strip is simple. Two free form arches are joined with a membrane. The arches are held by a pair of tilted masts at an even distance from the previous pair. The toll strip flows like a flying piece of fabric on top of the street.

The toll system for the City of Helsinki will be built, if ever, later in the future, maybe in the 2020's or 2030's. In our work, we have positioned the toll structures just outside Ring 1, along the radial thoroughfares which will potentially be transformed into city boulevards. We estimate 50% of the eight boulevard tolls to be constructed with membranes, which makes four cases in total. If one toll structure is estimated to be an investment of 2 000 000 – 5 000 000 euros and we propose four out of eight of them to be built with membranes, the investment would be from 8 000 000 to 20 000 000 euros in total. The toll strips should each be designed case by case to be suitable to their traffic environment.

Picture:

Toll roof structure in imagined future city structure along Hämeenlinnanväylä.
(T Kuusisto)



5.4.4 Wind valley - Helsinki Waterfront

The waterfront membrane structure is created to attract visitors along the waterfront of Helsinki. It marks the shore and creates a pleasant shadow to enjoy the waves nearby. It can also be used to house ticket sales and other booths under it related to waterfront activities.

The structure for the waterfront needs to withstand heavy winds. It is designed to stay in position all year round. The structure is created with an arched ridge and valley structure with tilted masts holding the arches. The outer edges are cabled.

If every ten kilometer stretch of Helsinki's waterfront had a point of interest constructed, and half of them were built with membranes, we would have seven membrane structures along the waterfront, which is over 130 kilometers long. If the price for one structure was from 100 000 to 500 000 euros, the total amount of investments for seven structures would be 700 000 – 3 500 000 euros.

Picture:

Hakaniemi Waterfront and a
tensile membrane construction
along the shore.
(T Kuusisto)



5.4.5 City umbrella - Recreational areas and playgrounds

City umbrella is an example of a modular tensile membrane construction used in recreational areas and playgrounds. It can be used to provide shelter from the sun in the summer and to protect from rain in the autumn and snow in the winter.

The structure is simple, imitating umbrellas we carry in rainy weather. It can be closed for the winter if the snow load becomes too heavy and opened again when the weather is permitting. It is however designed in order to be open all year round, so it is an experimental structure trying to challenge the winter season weathers and serve even in snowy periods.

If the city has over 70 playgrounds with services for their users, we have estimated ten percent of them to be equipped with our City umbrella. This makes seven playgrounds in total. We have proposed seven positions near the city center where to add such a structure to the existing park. If the modular structure were to be developed, it is estimated that the price could be approximately 50 000 – 100 000 euros per piece. Seven umbrellas together makes 3 500 000 – 7 000 000 euros worth of investments for the parks in total.



Pictures:

City umbrella's design in Töölö.



Sources

Archdaily, 'Rosa Parks Transit Centre', web page, viewed 24.10.2016,
<<http://www.archdaily.com/30880/rosa-parks-transit-center-ftl-design-engineering-studio>>

Architen Landrell 2016, 'Portfolio>Chanel Mobile Art Pavilion', web page, viewed 1.11.2016,
< <http://www.architen.com/projects/chanel-mobile-art-pavilion/>>

Best Hall Oy 2016, web pages, viewed 20.10.2016,
<<http://www.besthall.com/fi/yhteystiedot/?lang=en>>

Brand New Helsinki 2015, web pages, viewed 11.11.2016, <<http://brandnewhelsinki.fi>>

City of Helsinki 2013, *The strategy programme*, web document, City of Helsinki, viewed 2.11.2016, <http://www.hel.fi/static/taske/julkaisut/2013/Strategy_Programme_2013-2016.pdf>

Designboom, 'Top ten most viewed public spaces of 2011', web page, viewed 1.11.2016,
<http://www.designboom.com/architecture/designbooms-top-ten-most-viewed-public-spaces-of-2011/>>

Place n Ornament 2008, 'Architecture, Zaha Hadid's Contemporary Art', web page, viewed 1.11.2016, <<http://hampstead.tistory.com/category/Architecture?page=6>>

Helsinki City Planning Department 2015, Kaupunkikaava, Helsingin uusi yleiskaava, ehdotus 6.10.2015, Kslk 10.11.2015, web document, City of Helsinki 2015, viewed 11.11.2015, < http://www.hel.fi/hel2/ksv/julkaisut/yos_2015-7.pdf>

Helsinki City Planning Department 2014-15, *Meri-Helsinki yleiskaavassa*, Maritime Helsinki, web document, City of Helsinki, Finland, viewed 16.10.2016, <http://www.hel.fi/hel2/ksv/julkaisut/yos_2014-15.pdf>

Helsinki City Planning Department, Strafica 2013, *Osa A. Moottoritiemäisten alueiden tarkastelut*, web document, City of Helsinki, Finland, viewed 18.10.2016, <http://www.yleiskaava.fi/wp-content/uploads/2013/10/visio_oheismateriaali_liikennehankkeet_moottoritiealueet_Strafica.pdf>

Helsingin juhlaviikot 2016, web pages, viewed 19.10.2016, <<http://www.helsinginjuhlaviikot.fi/info/>>

Helsingin sanomat 2015, 'Huvila-teltassa tänään: Lovea ja huvia –konsertti', web page, viewed 19.10.2016, <<http://www.hs.fi/kulttuuri/a1439777837144#>>

Kansallismuseo 2016, 'Kivikauden asuinpaikat ja asunnot' web page, National Board of Antiquities, Helsinki, Finland, viewed 26.10.2016, <<http://www.kansallismuseo.fi/fi/kansallismuseo/opetus/opetuspaketit/esihistoria/tietoa/kivikausi/13>>

Janus Oy 2016, web pages, viewed 20.10.2016, <<http://janus.fi/>>

Lainapeite, web pages, viewed 20.10.2016, <<http://lainapeite.fi/>>

Limor Oy 2010, web pages, Martti Puohiniemi, Finland, viewed 1.12.2016, <<http://www.puohiniemi.fi/palvelut/arvot-missio-visio-ja-strategia.html>>

Museovirasto 2016a, 'Haminan linnoitus, Hamina', web page, National Board of Antiquities, Helsinki, Finland, viewed 19.10.2016, <<http://museovirastorestauroi.nba.fi/linnoitukset/hamina>>

Museovirasto 2016b, 'Olavinlinna, Savonlinna', web page, National Board of Antiquities, Helsinki, Finland, viewed 19.10.2016, <<http://museovirastorestauroi.nba.fi/linnat/olavinlinna>>

Nordic Hall 2016, web pages, viewed 20.10.2016, <<http://nordichall.fi/>>

Public Works Department 2016, 'Leikkipuistot ja leikkipaikat', Playground web page, City of Helsinki, Finland, viewed 18.10.2016, <<http://www.hel.fi/www/Helsinki/fi/paivahoito-ja-koulutus/leikki-ja-avoin-toiminta/leikkipuistot>>

Pyynikin kesäteatteri 2016, 'Hyvä tietää', web page, viewed 19.10.2016, <http://www.pyynikinkesateatteri.fi/hyva_tietaa/>

SAFA 2016, 'Kilpailut', viewed 24.10.2016, <<https://www.safa.fi/fin/kilpailut/>>

Sattler global 2016, web page, 'Railway station Leipzig', viewed 24.10.2016, <<https://www.sattler-global.com/textile-architecture/tension-structures-1296.jsp>>

Scanhall Oy Ab 2016, web pages, viewed 20.10.2016, <<http://www.scanhall.fi/>>

Scantarp Oy 2016, web pages, viewed 20.10.2016, <<http://www.scantarp.fi/>>

Sleich Bergermann 2016, web pages, viewed 24.10.2016, <http://www.10nyc.sbp.de/en/#>

Tekes 2001, Teknologiastrategian luominen yliopistoissa ja tutkimuslaitoksissa, web document, Tekes, Finland, viewed 1.12.2016,
<https://www.tekes.fi/globalassets/julkaisut/yliopisto_teknologiastrategiaopas.pdf>

Tensinet 2007, 'Retractable Membrane Roof in the Courtyard of City Hall Vienna 2000' in Tensinet Symposium *Ephemeral Architecture, Time and Textiles*, Milano.

Unesco 2014, web page, viewed 11.11.2016 < <http://en.unesco.org/creative-cities/helsinki>>

Zaha Hadid Architects 2008-2010, 'Mobile Art Chanel Contemporary Art Container', web page, viewed 1.11.2016, <<http://www.zaha-hadid.com/architecture/chanel-art-pavilion/>>

Illustration credits

Best Hall Oy 2016, web image, viewed 20.10.2016,
<<http://www.besthall.com/fi/yhteystiedot/?lang=en>>

Brahe stadion, web image, viewed 19.10.2016, <<http://www.venere.com/blog/helsinki-ice-skating-9822/>>

Chanel Art Container 1, Designboom 2011, web image, image © francois lacour, viewed 1.11.2016, <http://www.designboom.com/architecture/designbooms-top-ten-most-viewed-public-spaces-of-2011/>

Chanel Art Container 2, place n ornament 2008, web image, viewed 1.11.2016 < <http://hampstead.tistory.com/category/Architecture?page=6>>

East River 34th street Ferry Terminal, John Horner, web image, viewed 24.10.2016,
<<http://www.johnhornerphotography.com/34th-st-ferry-gallery/>>

Hamina bastion shelter 1, web image, viewed 19.10.2016,
<<http://www.visithamina.fi/fi/Kuvagalleria>>

Hamina bastion shelter 2, web image, viewed 19.10.2016,
<<http://www.visithamina.fi/fi/Kuvagalleria>>

Harbours, piers and quays in Helsinki 2016, web service map, City of Helsinki, Finland, viewed 18.10.2016, < <https://servicemap.hel.fi/search?q=harbours>>

Helsinki from aerial view, web service map. 2015, City of Helsinki, viewed 7.12.2016, <
<http://kartta.hel.fi/>>

Helsinki city plan logo, web image, Helsinki City Planning Department, viewed 15.11.2016,
<<https://www.bing.com/images/search?q=yleiskaavan+visio&view=detailv2&&id=FE2EE3D832A6BB5408AE738C41F6B51D3ECCC598&selectedIndex=1&ccid=sECa3Dle&simid=607997212307623655&thid=OIP.Mb0409adc321e923b1be616740ff2f357o0&ajaxhist=0>>

Helsinki strategic spatial plan, web document, Helsinki City Planning Department, viewed
11.11.2016, < [http://www.yleiskaava.fi/wp-](http://www.yleiskaava.fi/wp-content/uploads/2016/06/YLEISKAAVA_tarkistettu_ehdotus_Kslk_20160614_web.jp)
[content/uploads/2016/06/YLEISKAAVA_tarkistettu_ehdotus_Kslk_20160614_web.jp](http://www.yleiskaava.fi/wp-content/uploads/2016/06/YLEISKAAVA_tarkistettu_ehdotus_Kslk_20160614_web.jp)>

Helsinki public traffic network 2050, web image, Helsinki City Planning Department,
viewed 15.11.2016,
<http://www.hel.fi/hel2/ksv/Liitteet/2016_kaava/Yleiskaava_joukkoliikenteen_runkoverkko_20160614.pdf>

Helsinki roadmap 2050 2015, web document, page 6, Helsinki City Planning Department,
City of Helsinki, Finland, viewed 16.10.2016, [http://www.hel.fi/hel2/ksv/julkaisut/yos_2015-](http://www.hel.fi/hel2/ksv/julkaisut/yos_2015-5.pdf)
[5.pdf](http://www.hel.fi/hel2/ksv/julkaisut/yos_2015-5.pdf)

Huvila tent 1, web document, viewed 19.10.2016,
<<http://www.stadissa.fi/paikat/129/huvila-telтта>>

Huvila tent 2, web document viewed 19.10.2016,
<<http://www.hs.fi/kulttuuri/a1439777837144#>>

Janus Oy 2016, web image, viewed 20.10.2016, <<http://janus.fi/>>

Finnish Kota, web image, FINNA database, Sarvisto Soile, National Board of Antiquities,
Finland, viewed 19.10.2016, <<https://finna.fi/Record/musketti.M012:SUK619:30>>

Lainapeite, web image, viewed 20.10.2016, <<http://lainapeite.fi/>>

Leipzig Airport railway station 1 and 2, web images, Sattler global, viewed 24.10.2016, <
<https://www.sattler-global.com/textile-architecture/tension-structures-1296.jsp>>

Olavinlinna rain cover 1, web image, viewed 19.20.2016,
<http://visitsavonlinna.fi/en/shops/savonlinna-tours/>

Olavinlinna rain cover 2, web image, viewed 19.20.2016,
<<http://museovirastorestauroi.nba.fi/linnat/olavinlinna>>

Playground activities 2016, web service map, City of Helsinki, viewed 18.10.2016,
<<https://servicemap.hel.fi/unit?municipality=helsinki&service=27880>>

Projects at Helsinki waterfront 2014, slide show page, Terhi Kuusisto, Helsinki City Planning Department, City of Helsinki.

Pyynikki summer theatre roof 1, web image, viewed 19.10.2016,
<<http://www.pyynikinkesateatteri.fi/kesateatteri/>>

Pyynikki summer theatre roof 2, web image, viewed 19.10.2016,
<<http://moro.aamulehti.fi/2011/12/23/pyynikin-kesateatterista-tuli-avohakkuualue-miksi-puut-kaadettiin/>>

Rosa Parks transit centre 1, Archdaily 2009, web image, viewed 24.10.2016,
<<http://www.archdaily.com/30880/rosa-parks-transit-center-ftl-design-engineering-studio/5010790328ba0d4222002138-rosa-parks-transit-center-ftl-design-engineering-studio-image>>

Rosa Parks transit centre 2, Archdaily 2009, web image, viewed 24.10.2016,
<<http://www.archdaily.com/30880/rosa-parks-transit-center-ftl-design-engineering-studio/501078eb28ba0d4222002133-rosa-parks-transit-center-ftl-design-engineering-studio-image>>

Scanhall Oy Ab 2016, web image, viewed 20.10.2016, <<http://www.scanhall.fi/>>

Scantarp Oy 2016, web image, viewed 20.10.2016, < <http://www.scantarp.fi/>>

Strategy Program of Helsinki, web brochure, City of Helsinki, 2013, viewed 11.11.2016, <
<http://www.hel.fi/static/taske/julkaisut/2013/The-City-of-Helsinki-Strategy-Programme-2013-16-pocket-brochure.pdf>>

Vienna City Hall 1 and 2, web image, viewed 26.10.2016,
<<https://structurae.net/structures/retractable-roof-in-vienna-city-hall>>

Waterfront theme map 2016, web document, Helsinki City Planning Department, City of Helsinki, viewed 18.10.2016
<http://www.hel.fi/hel2/ksv/Liitteet/2016_kaava/Yleiskaava_merellinen_helsinki_20160614.pdf>

