



# URBAN SYMBIOSIS

## INCLUDING NATURE IN HISTORICAL BUILDING'S LIFE

EMILIO LORENZATO  
MASTER THESIS AT CHALMERS ARCHITECTURE  
MASTER PROGRAMME DESIGN FOR SUSTAINABLE DEVELOPMENT  
GOTHENBURG, SWEDEN. JUNE 4<sup>TH</sup> 2015



**CHALMERS**  
UNIVERSITY OF TECHNOLOGY

EMILIO LORENZATO  
URBAN SYMBIOSIS, INCLUDING NATURE  
IN HISTORICAL BUILDING'S LIFE

SUPERVISOR: ANNA KACZOROWSKA  
EXAMINER: LARS MARCUS

30 CREDITS MASTER THESIS FOR THE MASTER  
PROGRAMME IN DESIGN FOR SUSTAINABLE  
DEVELOPMENT AT CHALMERS  
GOTHENBURG, SWEDEN. JUNE 4TH 2015



DEPARTMENT OF ARCHITECTURE  
CHALMERS UNIVERSITY OF TECHNOLOGY  
SE-412 96 GÖTEBORG  
SWEDEN  
TELEPHONE + 46 (0)31-772 1000

## ACKNOWLEDGEMENTS

To start, I would like to thank...

Johanna Lange at Lindholm Restaurering AB, for the precious materials and information about the Artilleristallet building without which this work would have looked completely different.

Lars Marcus, for the productive comments during the seminars and the precious feedbacks I will include in the work as soon as possible to complete it.

Anna Kaczorowska, for the dedication and attention paid tutoring my work, her feedbacks and inputs motivated and helped me achieve this (almost) final result in which I recognize myself as a soon to be architect.

Lena Falkheden and Maja Kovács, for the coordination of the MPDSD programme and the master thesis process, as well as all the teaching staff I met and learned from at Chalmers.

Friends and fellow students that accompanied me through the two years of my master and made meaningful and joyful the time spent in Sweden so far. Special thanks to Pinelopi, for always finding some time to share views and opinions on this work, Paige, Jonathan, Hasan and everyone who somehow took care of me in this stressful semester while bearing my moodiness and grumpiness.

Last but not least, my family for always being supportive and understanding throughout my whole studying career allowing me to become the person I am today. Words cannot express my gratitude and what you mean to me.



ABSTRACT

Natural and urban landscape are often perceived disconnected from each other. Today’s environmental challenges call for a friendly and more harmonious coexistence between ecosystems and mankind. Reacting to this call, current trends in architecture show different approaches aiming to bring a closer connection between them, from planning to the small scale of buildings. Dealing with the built environment though doesn’t always allow this. In the process of historical buildings’ transformation other important issues related to their protection and conservation, often limit any possibility of bringing nature close to people’s lives, adding another level of complexity in aiming for a symbiotic urban landscape.

This work examines contributions from a number of disciplines on why to pursue an ‘inclusion’ of nature in cities while reflecting on historical buildings conservation. Biology, ecology, psychology, philosophy, ethic and architecture all

investigate motivations and grounds supporting this stance, developing together the human-nature relationship.

The goal here is to redevelop an historical building providing a better living environment through the use of natural elements. Plants and animals may add quality to buildings’ life when “hosted” in the often human exclusive habitat of buildings. Addressing the ongoing transformation of Gothenburg’s Artilleristallet, this thesis work strives to reach a synthesis between research on nature related benefits, building’s background and architectural design.

The resulted explorative design aims to inspire but also reflect on the relation between nature, people and historical architecture. A connection between the cultural values of the built heritage and today society’s can be pursued through the relevance of nature, exploring the possibility of a human-natural symbiosis inside the urban habitat.

INDEX

1. INTRODUCTION	1
1.1. PROBLEM STATEMENT	2
1.2. RESEARCH QUESTIONS	3
1.3. METHOD CONTENTS AND DELIMITATIONS	4
2. BUILT ENVIRONMENT AND NATURE INCLUSION	7
2.1. HUMANS, NATURE AND THE CITY	7
2.2. RELATION BETWEEN HUMANS, ARCHITECTURE AND NATURE THROUGH HISTORY	11
2.3. RELATION BENEFITS	14
3. HISTORICAL BUILDINGS CONSERVATION AND NATURE PRESENCE	21
3.1. HISTORICAL BUILDINGS AND CONSERVATION	22
3.2. HISTORICAL BUILDINGS TRANSFORMATION AND NATURE PRESENCE	24
4. RESEARCH SYNTHESIS	31
5. PROGRAMMING THE SITE DEVELOPMENT WITH NATURE	35
5.1. LOCATION	36
5.2. BUILDING HISTORY, CULTURAL VALUES AND PROTECTION	42
5.2. BUILDING CONSTRUCTION, PHYSICAL CONDITIONS AND NORMS	53
5.3. BUILDING-NATURE POSSIBLE RELATION BENEFITS	57
6. DESIGN	63
7. DISCUSSION AND CONCLUSION	91
REFERENCES	98

# 1. INTRODUCTION

As humans, we are part of nature. We evolved and developed in connection with the rest of the natural system. We reached a point where we can pretty much control or affect most of the natural aspects surrounding us. Through urbanism, with cities and buildings, we use the space to create our own habitat. We act as all the other living creatures do, in other words we ‘find’ our place on Earth. Plants find their access to sun, water and nutrients. They spread their roots to anchor to the ground. By doing so, they modify the landscape, creating shadows and altering the soil. Animals create their living spaces, birds build their nests and beavers create dams. They find a place and modify the landscape they live in. They do that in the same space and at the same time as other species. They take and give resources to the landscape. In this way the landscape becomes the place of sharing, making life possible for its inhabitants.

This thesis work takes this initial instance of landscape sharing to achieve a symbiosis in the urban landscape and more precisely in historical buildings. Historical built heritage is a very

important part of cities and is growing continuously. Everyday values attached to building develop concurring to define the identity of their inhabitants. The importance of the respect of nature, meaning the rest of the biosphere we live in, can be reaffirmed with a close relation between the natural and human habitats. Historical buildings so can enhance the values they embody connecting and relating them to the value of nature and, by extension, life. Symbiosis as coexistence providing each other benefits and sustain a healthy relation.

The work develops through interdisciplinary research and a design exploration on a specific case. Grasping from different subjects and stances to sustain and motivate an historical building transformation process that aims for this symbiosis. Grail will be to verify, through reflecting on the explorative design, if an extensive understanding of nature-mankind relation can be a guiding instance through a design process that already has to take care of significant aspects such as preservation of cultural values.

## 1.1. PROBLEM STATEMENT

Seven billion people live on planet Earth today, half of them in urban areas. World's urban population grew from 220 million to 2.8 billion over the 20th century. The 21st century will, of course, see this growing pattern continue as it is estimated that by 2050, eighty percent of the world population will be living in cities. This rapid urbanization is radical, and will increasingly change the economic, financial, social, and ecological landscape of our planet. It is the single greatest development challenge and opportunity for the 21st century. (UN-Habitat, 2012) If we consider the environmental impact of the urbanization process, we cannot ignore its scale. The concentration of people in dense urban areas requires a great modification of the landscape. A modification that has been done by no other single species on the planet before the booming of urbanism due to our technological development. We used, use and will use an incredibly wide amount of materials and resources to shape our urban habitat.

Because of this stance in cities and buildings, the presence of nature is becoming more relevant because of what it brings to the table in terms of spatial quality and liveability while addressing

the environmental challenges for human society. Cities are morphing and transforming themselves through many different means to address these challenges. Technological innovation, people's actions and behaviour, policies and architectural interventions are just few of them.

But how is this process reflected in dealing with historically and culturally relevant buildings? How can these methods, that see a pervasion of natural elements and processes in the cities' patterns, be applied to the delicate and sensitive spectrum of the historical buildings?

In today's cities, new buildings with a wide range of natural features pop up every day. Green facades, roofs and walls, urban agriculture and ecological functions find place in connection with newly built architecture. Transformations of existing buildings follow this will of inclusion of natural ecosystems as well but a big gap sits in the application of this approach to historical buildings. The delicate issues of material preservation, identity and cultural values of the built heritage often act as a strong constrain, almost preventing the human-nature relation in these

kind of buildings. Needless to say, these constraints are rightfully relevant in dealing with such sensible objects. In architecture and buildings of the past, a strong relation with natural elements and processes has not always been possible even though, to some extent, some form and use of nature can be traced throughout history.

But, is it possible, combining the scientific and technological knowledge already applied in contemporary buildings, to identify strategies and solutions to adopting nature presence and its benefits in historical ones?

As a consequence, due to the delicate balance of natural systems and their strong connection to landscape features, it is important to explore how the sharing of the landscape between humans and nature applies in a determined geographical context. In this thesis work I will explore how this approach can be taken in dealing with the transformation of the Artilleristallet building in Gothenburg, within the West Coast Sweden context.

## 1.2. RESEARCH QUESTIONS

What can the coexistence of nature in human habitat bring to the evolution of the historical built environment?

What are the viable methods of habitat sharing regarding the scale of an historical building transformation case?

How to include nature in buildings' life in the West Coast Sweden context, and more particularly, to the case of Gothenburg's Artilleristallet transformation?

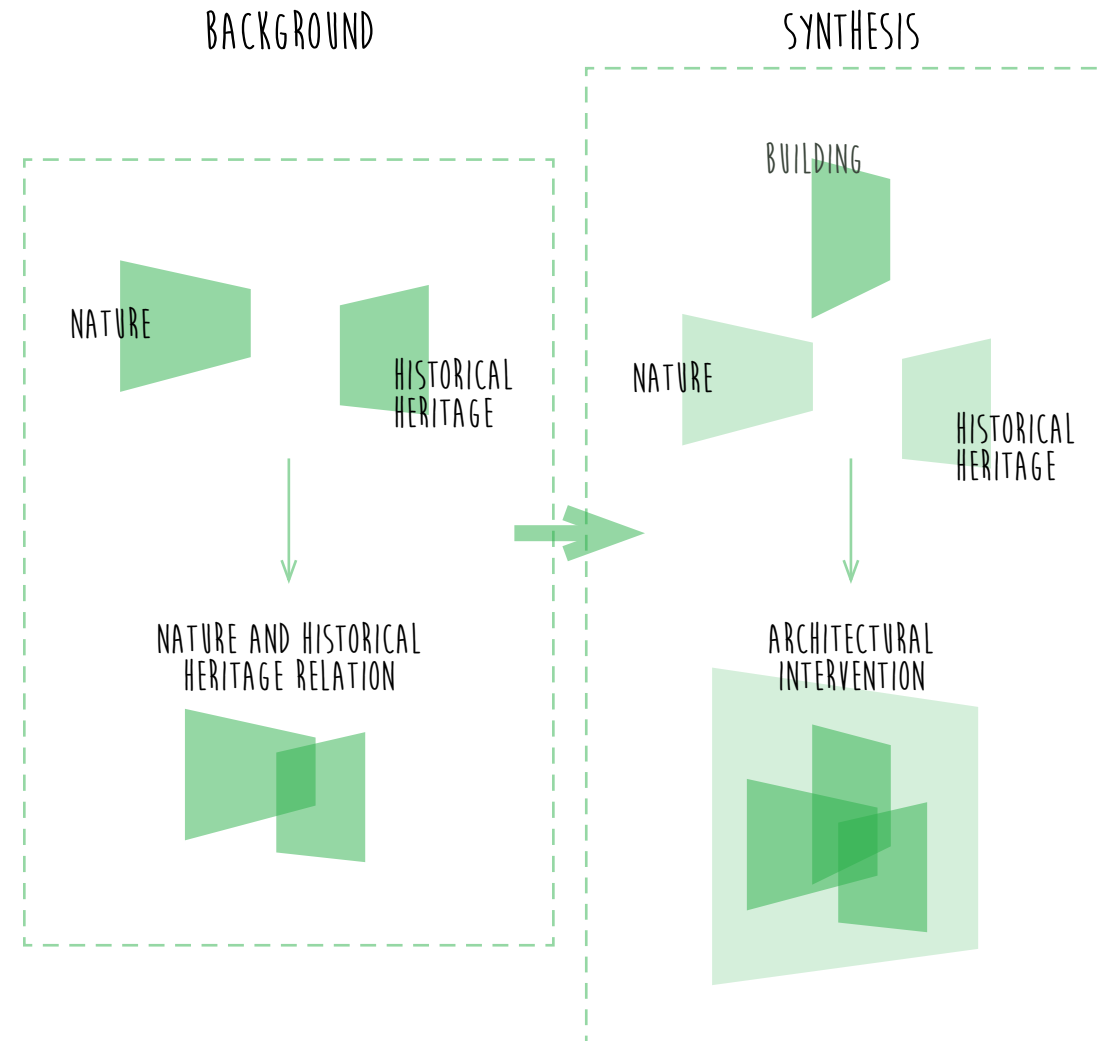


### 1.3. METHOD CONTENTS AND DELIMITATIONS

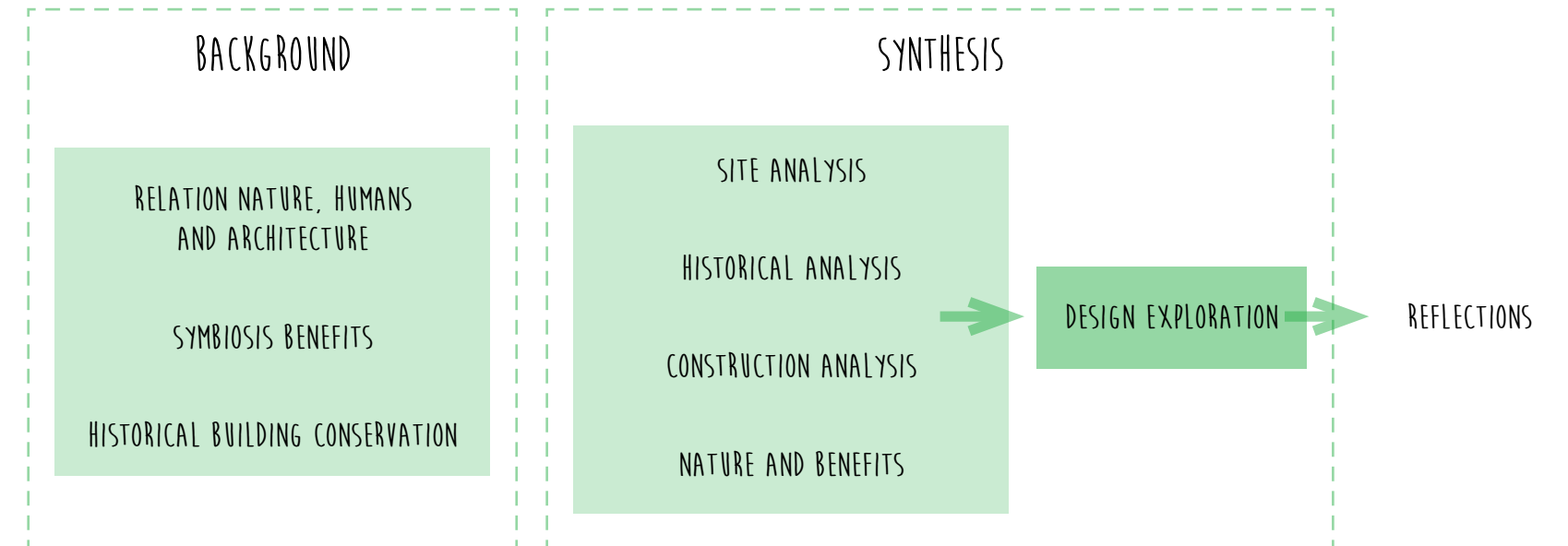
#### METHOD

The method applied here is research for design.

The work develops first from recognizing the elements involved in answering the research questions. From those, relevant concepts, theories and facts are extracted and researched with the goal of bringing them together. This synthesis is then explored with an architectural intervention for a specific case study.



#### CONTENTS



The work articulates in two main parts, a background study and a synthesis.

The background represents a research exploration of the broader context of nature inclusion in historical buildings. The two main elements there are nature and historical built environment. The research strives to go through different fields in providing perspectives on their coexistence.

The present days' ethical concerns, philosophic notions evolution in history, scientific references for biological and economical importance of ecosystem functioning, and nature benefits for people life are investigated to relate to the built heritage conservation discussion and practice.

These interconnected subjects' synthesis is then dealt in the second part of the thesis work through

the development of the historical building transformation case of the Artilleristallet building in Gothenburg.

To conclude reflections follow the design exploration trying to draw out results and relevant findings while considering the whole work process.

DELIMITATIONS

Defining the limits of this research for design thesis work has not been easy at first. The wide spectrum of relevant contributions that interest historical buildings transformation process alone could take a whole thesis to be even partially explored. Adding nature and its implications as a relation term makes it overwhelmingly complex at times. Therefore the subjects treated in this research reflect the final summarizations of the contributions I found relevant and of which I could handle and elaborate, hopefully correctly, in the work process. It feels to me that the economical sphere is a major subject only hinted at and not explored, even though relevant in my literature study process. Theories and concepts presented might also be only limited due to time and entity of the thesis exploration that can only provide a general overview of the topics.

2. BUILT ENVIRONMENT AND NATURE INCLUSION

2.1. HUMANS, NATURE AND THE CITY

IN THIS CHAPTER...

THE ROLE OF SOCIETY AND ARCHITECTURE FOR THE FUTURE DEVELOPMENT OF THE RELATION BETWEEN HUMANS AND NATURE

THE EVOLUTION OF THREE PYLOSOPHICAL NOTIONS DEFINING THE HISTORY OF THIS RELATION

REASONS AND MOTIVATIONS COMING FROM VARIOUS DICIPLINES SUPPORTING THE INCLUSION OF NATURE

If we follow the already mentioned predictions of population growth (UN-Habitat, 2012) and put them in relation to urbanization, we could assume that new cities will be created, small cities will get bigger and metropolis and megacities will continue to expand in the not so distant future. The urban landscape is destined to keep growing not only in its scale but also at a fast pace. In many ways urbanization becomes the main foreseeable way possible for us to live on this planet. We don’t have the tools to identify other options, especially if we consider the societies we live in. We will have bigger and denser cities.

With densification cities become a way too altered landscape for being populated by other species. Denser and denser cities with growing population demand space for people subtracting it from the surrounding landscape. By creating an environment that suits just human needs, the habitat becomes disconnected from the wider ecosystem. The sharing of resources in the system becomes difficult, and the natural cycles get affected. We create resources and energy demanding buildings and cities that do not fit in relation to other elements of the biosphere. They do not give resources to animal or plants and they alter

even soil, air and water conditions of the surrounding environment. By replacing plants with aseptic buildings we prevent the natural solar harvesting and production of food for other species. Hard surfaces also alter the local and micro-climate. Wind, temperature, water cycles and air quality are just a few elements that are altered with urbanism. They affect other species as they affect us. If we separate us from the environment, creating this mono species habitat, we stop getting the benefit of an inclusive environment.



figure 1. Street Art cricizing natural environment destruction due to uncontrolled building and urbanization.

“ ‘Ecological urbanism’ forces us to not only consider the workings of the landscape but to understand more specifically how the landscape functions within the city. We start to better comprehend the interrelated systems that influence the use, governance, economy, and social structure of a society that is underpinned by a specific urban landscape. As with the study of ecology, unless we truly embrace all of these systems – human natural – we will not be able to design optimal cities for people. Ecological urbanism shifts the focus of the profession from the suburbs to the city, to include human systems as part of ecology.” – Martha Schwartz, Ecological Urbanism and the Landscape (Mostafavi & Doherty, 2010)

In ecology, resilience is the capacity of an ecosystem to respond to a disturbance or an altering factor by resisting the damage and recovering in a short time. Such perturbations and disturbances can include events such as fires, flooding, windstorms, insect population explosions, and human activities such as deforestation and the introduction of exotic plant or animal species. If the magnitude or the duration of these disturbances are relevant enough they can profoundly affect the ecosystem, forcing them to reach a limit of no return, modifying its predominant regime of processes and structures. (Folke et al., 2004)

“Human activities that adversely affect ecosystem resilience such as reduction of biodiversity, exploitation of natural resources, pollution, land-use, and anthropogenic climate change are increasingly causing regime shifts in ecosystems, often to less desirable and degraded conditions.” (Peterson, Allen & Holling, 1998)

In building the cities of the future these issues could be the key to reach a more resilient landscape where we must consider ourselves as part of the ecosystem. New areas’ development projects and land modifications can be compared to redevelopment of built areas, mobility plans, building renovations and public space modifications. Resilience on all levels, from socio-economical to environmental, for the whole – human natural – ecosystem.

“Interdisciplinary discourse on resilience now includes consideration of the interactions of humans and ecosystems via socio-ecological systems, and the need for shift from the maximum sustainable yield paradigm to environmental resource management which aims to build ecological resilience through “resilience analysis, adaptive resource management, and adaptive governance.” (Walker, Holling, Carpenter & Kinzig, 2004)

Being able to rely on resilient systems allows us to face critical situations and high stress levels in different areas. Social resiliency inside human society gives us the ability to keep on focusing on economical and environmental aspects at the same time. If our social landscape is able to sustain itself and resolve internal problems in a short time lowering the general stress on its long term functioning, people will still be able to live and develop in connection with the environment. The environmental concerns can still be faced in sociologically challenged situation having them connected and integrated, providing each other reliability and strength through their relation.



figure 2. The rainwater retaining and flood prevention ability of Barigui Park in Curitiba, Brazil, matches the social importance of urban greenery and public parks concurring to the city resiliency.

Considering the city as part of a resilient ecosystem, the planning and design process of architecture must follow its needs. Integrating “natural” and artificial elements in our habitat is the way to achieve the diversity and richness of a landscape that can sustain life in general. The potential to integrate human habitats with other habitats can be found everywhere. Building integrated energy sources work economically but they also partake to the natural energy cycles, avoiding the exploitation of natural delayed energy resource like oil and coal. Smart water management provides us more accessibility to water but also regulates our pressure on the hydrosphere system. Plants and greenery are also very important. Their air filter capacity is well known and of course very important for us, from the pollutants, dust and poisonous elements reduction to oxygen production. They affect the microclimate creating shadows, mitigating temperatures and winds. Their presence in the city gives us many benefits on all levels (Almusaed, 2011) . They participate in shaping our habitat. They find their place on the planet, they live, and they contribute to the life of other biotopes.

Furthermore the health and integrity of wildlife and vegetation are a priority for our future. Not only are there many benefits humans can gain from their presence but also protecting existing

biodiversity, indigenous or endangered species, wetlands and the tree canopy, are all a necessary aspect for securing a healthy natural system. Through the way we live on this planet we are affecting them. Enabling them to live also in the urban landscape will provide assets to their richness and continuity in time, making the city a much healthier habitat in the ecosystem.



figure 3. The Wonder Forset proposal by Studio Invisible for Beirut, Lebanon, envisions a forest over the city to increase the scarce urban vegetation, image of an urban landscape giving back spaces to natural habitats.

An interesting and inspiring concept combination I think expresses an ethical instance, borrowed from ecology, is the autogenic ecosystem engineer definition.

“An ecosystem engineer is any organism that creates, significantly modifies, maintains or destroys a habitat. These organisms can have a large impact on the species richness and landscape-level heterogeneity of an area.” (Wright, Jones & Flecker, 2002)

As a result, ecosystem engineers are important for maintaining the health and stability of the environment they are living in. We humans, are ecosystem engineers too. Every single living element on the planet could be defined as one. Having a place on this planet means affecting the biosphere in some way, as small as that influence can be. We respond though to the sub definition of allogenic engineers.

“Allogenic engineers modify the biophysical environment by mechanically changing living or nonliving materials from one form to another. We shape our habitat modifying organic and non organic matter, altering other habitats.” (Haemig, 2012)



In our evolution the lesson that we can take from plants is very important. We can shape our habitat, the city, in order to be an integral part of the landscape in connection with every other element of the biosphere. We can become autogenic engineers, like the flora itself, if we consider the city as our way to exist on the planet. We make use of ecosystem services coming from other living creatures and we rely on them. These services are a way for the ecosystem to sustain its elements, and a constant exchange is crucial. The urban settlements can evolve and adapt to the needs of the whole ecosystem. Adapting constantly and efficiently, seeking and fulfilling human needs while at the same time providing ecosystem services to the surrounding living landscape. Developing ourselves into providers of ecosystem services becomes a strategy to enhance the whole system reliability and resiliency.

Being part of the nature is the essence of living in it, and because of our relevance we cannot ignore what is around us. From the biggest scale of regional planning to the smallest of a balcony or a room, we have to consider the complete and complex system we are acting in. Can we reach a synthesis between human and natural habitats? Can historical buildings adapt to natural systems and continue to hold their cultural value while innovating the urban landscape?

*“To achieve a green revolution, we need to take risks and give innovation a front seat again”* (Maas & Thackara, 2010)

*“We will never achieve an ethical architecture that is beautiful and sustainable until nature is integral and at the core and at the substance and being of the architecture, not added to it. If it ain’t beautiful, it can’t be sustainable. Buildings must shelter and inspire.”* – Steven Kieran, architect (from the lecture ‘Toward an Ethical Architecture’ Yale University School of Forestry and Environmental Studies, New Haven, CT, February 3rd, 2005).

It is not only a matter of science and ecology, being an integral part of nature and taking care of it is also, and maybe firstly, an ethical instance to embrace moving forward for a better future.

After this first introduction of the nature inclusion topic, it is relevant to juxtapose a brief exploration of the different dimensions that develop in parallel with this ethical claim for better cities and buildings. Philosophical notions, scientific, psychological and spiritual references are summarized in connection with the nature inclusion concept.

## 2.2. RELATION BETWEEN HUMANS, ARCHITECTURE AND NATURE THROUGH HISTORY

It is interesting, in treating the relation between nature and humans and architecture, to explore its evolution in philosophical terms to connect to a bigger discussion that does not take place only in the architectural and urbanism dialogue, but in a wider cultural evolving landscape. Understanding how society sees nature and defines its identity could help to explain where we are in relation with it and to foresee how it can develop in the future. Main reference, in discussing this topic in this subchapter, is taken from *Estetica dell’Architettura* (Chiodo, 2011).

In the first place we can recognize that to go through the development of the relation between architecture and nature means also to go to the founding principle of architecture. The word architecture comes from Greek *arkitekton* (ἀρχιτέκτων) an association of *arché* (ἀρχή), meaning beginning, origin, source of action and by extension power, command, control; and *tekton* (τέκτων), meaning construction, building, from *tekne* (τέχνη) art, craft, skill. So architecture is the art, intended as skill, craft, by which humans exercise their control and their power and construct, build. This craft of power/command represents how humans separate and go from *chaos*, disorder, insecurity and unknown, to *kosmos*, order, control and safety. What we can extract from this originary definition is that

in ancient times, when civilizations started their evolution, nature was seen as wilderness, unsafe and dangerous for humans. Architecture was the way people could separate from this unsafe environment to get shelter and protection. Shaping buildings and cities, where the control of natural elements could happen easier, humans could separate from the hostile natural manifestations, like climate, weather and wildlife. Nature was seen as negative, malign, for humankind and the creation of controlled was the way to escape the nature dominated landscape.

Oswald Spengler in the first decades on the XX century writes, in talking about the relation between natural and human space, that the major shift between ancient and modern civilization could be understood as a change in direction between interior and exterior. Ancient architecture starts from the exterior, dangerous and unsafe, going to the interior, creating a safe space on which it focuses its energy. Modern and contemporary architecture though, starts from the interior, from the perception of its security, to get to the creation of the exterior equally safe and important, dedicating effort and energy to both. For example the building of the city mutates, going from an introverted and close configuration to an extroverted and open one. Architectural objects change as well. The *naos* of the ancient

temples, a dark and small space originally built with perishable materials, stands like an eggshell containing a moment while in the gothic cathedrals, with the eternal domes, the openings and the pillars, represent a dissolution of the enclosed space defined by luminal perceivable surfaces. For Spengler, the evolution throughout history of the window is symptomatic. When architecture is focused on the interior, the window represents its negative and gets minimized. When architecture is focused on the exterior the window is one of its most relevant expressions. (Zecchi,1991)

If it is true that the perception of nature outside the human space changes, it is also true that architecture, being the art separating human and non human space, starts to find a way to unite with nature and we can say even invade the natural space.

The notion of space, in connection with nature's, changes in a similar way. Space changes in a radical way though western history, from discontinuous to continuous. In ancient times space was defined by different spatial identities. An interior space was considered disconnected

from the exterior and the two do not relate. While the continuity of space, where there is only one continuous space as interior and exterior relate and are unified, is a modern and contemporary notion. This is reflected also in the spatial representations. Once limited and discontinuous, also its imagination was not relying on rules of unification and homogenization of its parts, becomes more understanding of relations and connections between elements, as Descartes' studies allowed scientific and mathematical frames for the control of space and its components. In the most recent times Einstein's elaboration took the continuity of space to its synthesis with time, unifying the two dimensions.

The result of this evolution is that going from ancient culture to modern and contemporary culture means a complete modification of the relation between actual space and possible space and the relation between human beings, and their constructions (architecture), and nature. A connected philosophical notion in discussing this relation is the one of landscape as it embodies an important synthesis of it.

## LANDSCAPE

The western conception of landscape in ancient times and in modern and contemporary society are very different. As already portrayed in the previous paragraphs, the first refers to a nature superior to human production, being dangerous and which humans need to humanize and control. On the other hand, the second refers to a nature overpowered by human and artistic production, which is not so dangerous and unknown anymore that humans don't need to control and humanize. These two different relations are condensed in the landscape concept of their time. Example is how we perceive nature nowadays being as meaningful and appreciated as wild, virgin and uncontrolled it is, while for centuries and millenniums the only appreciated nature was the one forged by human activity, nearby and friendly.

This transition leads modern human beings, partially autonomous from nature, to look strongly for nature through the landscape perception. At the same time the autonomization from nature means a change in the dangerousness of the

relation. From a nature dangerous for humans to humans being able to endanger nature.

The relation between the polarities have two possible interpretation, the landscape could be a "found" nature, meaning already existing in which humans find a "sense", or a "searched" nature, not existing yet, through which humans with their modification find a "sense".

The philosophical elaboration of landscape is mainly contemporary and it is focused on the correlation between contemplation, and its consequences, and action, and its consequences that are practical and so ethical as action is a transformation of a contemplation requiring a theory, a vision as it's based on a choice coming from human needs.

Assunto underlines something significant in the '70: the contemplation of the landscape is different from other contemplations, for example from the artistic contemplation of a landscape painting, because the first, and not the second, is characterized by something that is irreducible to

*theoria*, namely its practical dimension given the existence of human beings in the landscape and not outside of it.

The contemplative dimension then almost becomes active dimension even though they both come from a dichotomy relation: if it is true that to contemplate means being passive in front of the landscape, it is also true that the positivity of the contemplation, and the height of its theoretical results, is determined also by the actions human beings exercised on its nature, namely by the landscape that has been, at least in part, composed also by humans themselves.

All these stances give enrich the idea of nature, and the landscape by extension, being not something outside of the human world but intrinsic component of our life itself. We cannot separate ourselves from nature because we are its members and we concur to its existence, finding our own identity in it.

2.3. RELATION BENEFITS

Now, coming to a practical, or at least less theoretical, dimension, to understand what the exchange between nature and buildings could bring to their coexistence in the same space, it is important to define the benefits that one give the other and vice versa. In doing so, it is important to understand how both of them work on their own first. Starting from the nature side of this dichotomy, to explore how natural systems work is important to properly identify how a well functioning coexistence could take place in cities and buildings.

In nature, there are different species of different plants, animals, microbes and fungi, and they all interact in their environment to create what we call ecosystems. The word ecosystem is coined from Greek eco- (οἶκος) meaning “house” and system. We could say that it is a system that takes place in a house. Organisms living in the same space interact and behave together. Some eat each other, some eat what remains of the decomposition of another and they all (defined as biotic components) with the physical environment (abiotic components such as soil, water, air, temperature and sunlight) constitute an ecosystem. (Odum, 1971)

ECOSYSTEM SERVICES

Humankind benefits in many ways from natural ecosystems. Clean air and water, food, timber and pharmaceutical products just to name a few. People can hunt, pick fruits and vegetables to fulfil their nutrients need. By cutting down a tree the natural fibres derived can be burnt for heating or used to build utensils and houses.

All these benefits are defined as ecosystem services. In ‘*The Economics of Ecosystems and Biodiversity*’ initiative glossary (TEEB, 2015), they are defined as “the direct and indirect contributions of ecosystems to human well-being.”

We could asses that ecosystem services were, are and will always be the way nature sustain human life and provide us with essential resources, from clean water and nutrients to energy and materials. The complete gamma of services is provided by the completeness of nature and the biosphere, powered by solar energy and acting throughout the whole planet and during different time scales. (Chapin, Matson & Mooney, 2002)

With the development of society and the technologic progression, humankind learned how to interact and modify natural ecosystem to exponentially improve the availability of specific resources. We started defining ecosystems that



figure 4. Ecosystem services classification following Millennium Ecosystem Assesment (MEA, 2005).

best suited our needs. Alteration of landscapes to host defined managed ecosystems is the basis of the development of agriculture for example. Controlling what kind of plants grow in a specifically altered geographical area allows us to collect food easily and efficiently. But the control is not limited to the abiotic elements, like soil properties and water, and the plants growing; to obtain the maximum production capacity we control pests and viruses and we provide nutrients taking them from other places in the landscape as the local sources diminish over time. We make use of an ecosystem that relies on both independent natural processes, like pollination and nutrient cycle from soil to food, and human managed processes, substituting what is not available due to manmade alterations.

Life supporting services though have not always been appreciated for their true value and the role they play sustaining human civilization. Air and water filtration and purification, local and global climate regulation, soil fertility, waste decomposition and detoxification and biodiversity maintenance or production for example they all play a big role in our food production enterprises, as well as for the pharmaceutical and industrial ones. Waste disposal, involving microorganisms’ lifecycles breaking down and cycling chemical elements like carbon and nitrogen, could be worth



trillions of dollars annually. But, most of these kind of benefits are not economically accounted and traded in markets. They have no actual price tags attached showing to society what they're actually worth, not making directly understandable what and how human interferences on ecosystems affect the services provision. (Daily et al., 1997)

Until a few decades ago, for understanding and evaluating these services a big role is given to whether they do or do not have a monetary value or if they're established as economical assets. Needless to say, the more direct and tangible the benefits are the more appreciated the services. Some services we've been getting tangible and direct benefits from, like seafood or fuel for example, have a well established economical relevance in society, playing a big role in global economy.

With global threats to this complex interplay arising due to the entity of humankind behaviour, identifying and monitoring ecosystem services, including them in decision making processes, has become crucial for the future of the planet.

Having a clear understanding and definition of these benefits helps us to identify and quantify how specific natural processes and their intricate

balance make possible the continuation of life on earth. The biggest synthesis regarding ecosystems and their services so far has been reached with 'Millennium Ecosystem Assessment's and 'The Economics and Ecosystems and Biodiversity's documents, the latest especially regarding the connection with the economical sphere (TEEB, 2010). Following these two documents, ecosystem services can be grouped into four broad categories: *provisioning*, such as the production of food and water; *regulating*, such as the control of climate and disease; *supporting*, such as nutrient cycles and crop pollination; and *cultural*, such as spiritual and recreational benefits.

*"Ecosystem functions are defined as a subset of the interactions between ecosystem structure and processes that underpin the capacity of an ecosystem to provide goods and services."* (TEEB, 2010)

Sometimes ecological systems remain in an apparent or relative constant state but the properties and functions people consider useful might not follow the same trend and might change over time.

It is important to distinguish between ecological functions, or the biological phenomena, services, the direct or indirect contribution to welfare, and benefits, the actual welfare gains generated.

This is because the risk of double counting, as it might happen that one service could be an input to the production of others, could undermine the complex evaluation of the whole system (Boyd & Banzhaf, 2007). Many times people benefit from ecosystem services without realizing it, failing to understand and consider their value and what they mean to the bigger picture.

Conclusions based on scientific evidence (Daily et al., 1997):

- Ecosystem services are fundamental to sustain human life.
- The intricate relations in the ecological balance of ecosystems and the different scales in which natural functions provide services, having in mind the fact that their complete and holistic understanding is not possible yet, make it not possible to replace most of the ecosystem services with technology.
- Human actions on the planet are already affecting ecosystem service flows, and have been doing so for a long time.
- If ongoing trends continue, the growing stress on natural ecosystems may dramatically impair the planet's landscapes and habitats in a short time span, affecting their ability to sustain life.

Considerations, not completely proved but realistic (Daily et al., 1997):

- Human activities that modify and deteriorate ecosystems may negatively affect ecological services whose value could exponentially overcome the economical benefits of the same activities.
- A large number of species and their population are required worldwide to sustain ecosystem services.
- Restoration of ecosystems may recover their functioning if actions are taken in time.

Now, considering the extension of the anthropic landscape of urban settlements and its probable future growth, could the cityscape be an added resource for ecological systems and concur to their resilience?

## ECOSYSTEM SERVICES IN THE URBAN LANDSCAPE

The urban landscape has strong potential for including ecosystems, especially ecosystem services, making it possible to benefit more from nature to improve its living quality. Regulations, planning, urban design and buildings have the possibility to embrace nature presence in the city and get benefits from it. In fact, this is already happening in contemporary architecture. More and more often green goofs can be spotted looking over cities. The importance of parks, trees

and greenery in public spaces is becoming more recognized both environmentally and socially. Green houses, green walls and facades integrated in building design is becoming more of a trend. The city's hard surfaces and structures can be shaped and transformed to be more useful to the ecosystem they are located. Many natural elements could find place over and inside buildings, bringing with them their services and benefits. We could envision buildings and cities working as a "natural" ecosystem.



figure 5. Oyster-tecture, by Scape studio, represent a vision for the future redevelopment of Brooklin harbours areas based on oyster cultivation. It helps reconstruct the marine habitat reactivating socially and economically the waterfront.

But all ecosystem services can be introduced, or function, in cities. Some require different landscapes with peculiar features, like water availability and low pollution. Some might require a location far from urban and human settlements due to the disruptions connected to human activities. Some could even be detrimental to the functioning of the city itself and the health of its inhabitants, like having biological hazardous processes happening close to people. A bundle of ecosystem services and a well thought ecological diversity should be studied for different locations and conditions. We know through numerous studies which plants bring us the most useful benefits and they might come from very different geographical areas and completely different ecosystems. Understanding how local ecosystems work is crucial in pursuing the natural service provisioning. Limitations should be set in protecting the urban landscape surroundings and very important is also the control we must have in containing the collateral effect of human introduced non native species.

## HUMANS AS SERVICE PROVIDERS

If we escape from the human-centric approach the ecosystem service term embodies, the ecological services and goods are the benefits arising from the ecological functions of healthy ecosystems. Such benefits accrue to all living organisms, including animals and plants, rather than to humans alone.

Therefore, another way to look at nature inclusion in cities and buildings is to investigate what human production can offer to natural ecosystems. Humans, as part of the biosphere, have a role in the functioning of ecosystems as they are part of them. With being in relation with other members of the environment, comes that mankind, and mankind activities, have a consequence on the rest of the species balance. We do act as a sort of ecological services providers for defined species, concurring to ecological systems. Relevant for this case is the notion of Service Providing Unit (SPU). SPU are a defined population of a specie considered depending on the service they provide to the ecosystems they belong.

*“The delineation of a service-providing unit (SPU) will vary depending on the ecosystem service being considered, and any temporal or spatial variation inherent in the species of interest and the service itself. For example, the entire popu-*

*lation of a given tree species might provide the global service of carbon sequestration. Regional populations of the same tree species might provide a water filtration service that benefits local communities.”* (Luck, Daily & Ehrlich, 2003)

It is possible so to identify humanity as, or at least as part of, service-providing units, and the urban landscape can be seen as a mean which services can be provided to ecosystems. Atrophic modifications of the environment and the landscape can be seen as an extension of human’s ecosystem role as through it they can provide different forms of benefits for other species, potentially helping the functioning of connected ecological systems, concurring to a possible exchange between them.



figure 6. Building supporting vegetation in Paris, France.

## NATURE AND PEOPLE EXPERIENCE

Other than an ethical or ecological and economical scientific reasons to look for in order to improve life quality through the presence of nature in urban landscape, another important trait is given by the intangible and psychological effect that nature has on human beings, often connecting to a spiritual dimension. The psyche of people is both formed by conscious and unconscious processes (Jung), with experience being the major influence defining its acquired traits that combine with the innate characteristics of human minds. The complex range of benefits that nature brings to people’s minds is difficult to prove completely with scientific sound methods, but certain claims



figure 7. Nature easy accessibility of Vancouver, Canada, makes it often rank high in cities’ life quality lists.

can find some support to promote the importance of nature on people’s well being.

## NATURE CONNECTEDNESS

Nature connectedness represent the degree to which people identify nature, and all its components even the unpleasant ones, as part of their own identity. P. W. Schultz, in his *Psychology of sustainable development* (Schultz, 2002), describes the components shaping this connection with nature, needed for a healthy relationship with it, are:

- Cognitive component, describing to which extent we feel an integral part of nature;
- Affective component, the sense of care that people have for nature;
- Behavioural component, the degree to which we commit to the natural environment protection.

Research found that being in contact and connected to nature, and so being exposed to it, provides many benefits to well-being, for example reducing stress, improving self-awareness and influencing moods (Browning, Ryan & Clancy, 2014) (Kellert, 1997) as well as affecting life problems dealing with socioemotional processes (Mayer, Frantz, Bruehlman-Senecal, Dolliver, 2009) among others. Schultz, as well as S. R. Keller, claims that one individual feeling connected to it, maybe

by spending time in it, might pay higher attention and care to ecosystems and the environment and works for its protection (Schultz, 2002) . Nature connectedness can also be intended in other forms like love for nature, the degree people perceive themselves as being an integral part of nature or the emotional connection each individual can have with it.

As we have seen with the definition of Ecosystem Services, we humans get many benefits from nature but modern society have created nature disconnected lifestyles as we spend significantly amount of time indoors. It has been estimated that we spend up to 90% of our life inside buildings (Evans & McCoy, 1998). The possible consequences can negatively influence our lives as we fail to receive the beneficial effects nature provide. It also implies that, while being disconnected, we take less responsibility to protect the environment and solve the problems we bring to it (Wilson, 1984). Ecopsychology is a relevant discipline regarding nature connectedness. This psychology branch try to analyze and understand how people’s well-being relates to the health of the natural environment (Roszak, 1992). It means that the founding idea is that the needs of nature and humans are interconnected, as a suffering nature results in people unhealthiness and vice versa (Conn, 1998).



BIOPHILIA

A concept developed in close similarity, representing somehow a synthesis of nature connectedness, is the Biophilia hypothesis. The term Biophilia, meaning love of life or living systems literally, represent the innate need of human beings to connect and unite with other living beings like animals and plants. It means people posses an inborn will to live, thrive and be nearby the other members of nature surrounding them. E. O. Wilson, author of the founding and major diffuser summarization of the concept *Biophilia* (1984), hypothesizes that this congenital desire is a consequence of human evolutionary history

being almost entirely spent in close connection to nature. Biophilia is conceived as a genetic trait as humans living close to other living nature throughout their evolution could, presumably, access more easily food and other natural resources. The evolutionary theory can be opposed as it’s difficult to verify but the popularity of human activities based on closeness to nature, like hiking, camping and diving, bring support to the hypothesis. (Wilson, 1984)

Biophilic design is the architectural movement that tries to take the Biophilia hypothesis into buildings and cities. It embodies for some extent the whole nature connectedness idea, trying to

relate human and nature. It tries to minimize the negative consequences of the expansion of the built environment in the natural landscape while promoting positive interaction between the two, improving life quality.

*“A rich sensory environment surrounds us, not just with visual delight, but also with sounds, haptic sensations from the feel of wood or stone, and variations in temperature and light as we move through a space.”* (Kellert, Heerwagen & Mador, 2008)

These theories just presented can inspire architectural design that can be successful in positively affect coexistence of humans and the other members of nature. They can provide strong vision of an inclusive landscape that address sustainability issues of our life on this planet. Important at the same time, like with all theories, to always undergo a critical and rational process to fully express the qualities this approaches provide.



figure 8. Park in Portland, USA, bringing wetland like habitat in the city.

### 3. HISTORICAL BUILDINGS CONSERVATION AND NATURE PRESENCE

IN THIS CHAPTER...

SUMMARIZATION OF PRINCIPLES AND NOTIONS GUIDING THE CONTEMPORARY HISTORICAL BUILDING CONSERVATION

COMPARISON BETWEEN HOW NATURE WAS USED IN BUILDING OF THE PAST AND IN TODAY’S ONES

ARCHITECTURAL EXAMPLES DEALING WITH SUSTAINABILITY AND NATURE PRESENCE

Important now is to discuss how nature can relate to, and interact with, historical buildings. In the city landscape it can be found a record of human activity that is extremely unique and always evolving for each manifestation of the urban phenomena. People, with successive generations through time, developed this record responding and reacting to the surroundings, highlighting their skills and aspirations. It consists in the historical environment, connecting to their cultural and natural heritage, and which through they get their sense of identity showing traditions and knowledge as well as beliefs. Every single place we live in manifest a trait of this heritage, and the historic ones highlight it even more as the values strength and complexity tend to grow with the ticking of time. (English Heritage, 2008)

Given this consistent relevance,

*“each generation should therefore shape and sustain the historic environment in ways that allow people to use, enjoy and benefit from it, without compromising the ability of future generations to do the same”* (English Heritage, 2008)

In defining an architecture that works towards the inclusion of natural and human habitats, the built environment is crucial, holding most of the potentiality due to its actual extension. Historical buildings, representing its most culturally significant examples, could be seen as a specific part of it where the meaning of the human-nature relation can interact with the identity of architecture and society in a clearer and more identifiable way.



### 3.1. HISTORICAL BUILDINGS AND CONSERVATION

*“Modern conservation does not mean a return to the past; rather, it demands courage to undertake sustainable human development within the reality and the potential of existing cultural, physical and environmental resources.”* (Jokilehto, 2002)

Changes and modifications are inevitable for the built environment. Natural processes of material decay, the wearing out and tears due to use together with socio-economical and technological context, all manifest over the nature of historic heritage. Therefore, dealing with historical buildings means also to deal with the delicate subject of their conservation.

It’s important to relate the transformation of historical buildings, and the possible inclusion of nature through it, to the general discourse on heritage conservation. The conservation concept reached our days through numerous theories, charters and documents for assessing its meaning and defining what is the object of conservation. Even though we can roughly trace some general affirmed approaches, many critical and alternative positions can be found. The evolution through history of the concept of conservation, and restoration, has seen many changes in definition, forms and trends in dealing with the architectural heritage starting from the early major theoretical contraposition in the second half of the ‘800 between Viollet-le-Duc with the ‘stylistic restoration’, a fill-in-the-blanks practice allowing an artistic recreation in order to restore a completeness of the historical building, and Ruskin strong opposition in favour of an anti-restoration practice, as restoration *“means the most total*

*destruction which a building can suffer: a destruction out of which no remnants can be gathered: a destruction accompanied by false description of the thing destroyed”* (Ruskin, 1849). Very important has been Riegl’s contributions and his work defining a first systematic analysis of heritage values and of a theory of restoration and predicted the material authenticity to become one of the main concept in its future evolution. The formulation of *‘Restauro scientifico’* (scientific restoration) had a big impact delineating a practice that involves different expertise and modern technology approaching restoration as a *“cultural problem of evaluation, and the rehabilitation of historic buildings with respect to all significant periods instead of reconstructing them to their ideal form”*. With *‘Restauro critico’* (critical restoration) the emphasis of shifted over every historical object specificity, refusing preset rules and principles. A case specific restoration practice that depends on the critical sensitivity, the technical ability of the restorer and the specific historical object, based on profound historical and architectural consciousness as well as creative capacity of the restorer himself (Jokilehto, 2002).

Even though in the last decades many critical or alternative positions have found place in contraposition to the two most diffused theories, namely the new scientific conservation and the

artistic-value-based one, the latest documents and charters try to synthesize a contemporary approach to the historic heritage.

The most affirmed and characterizing principles associated with contemporary conservation practice can be extracted from these documents and they are sustainability, reversibility, minimum intervention and authenticity.

Sustainability association with conservation means that a conservation intervention is *“a process of managing change to a significant place in its setting in ways that will best sustain its heritage values, while recognising opportunities to reveal or reinforce those values for present and future generations”* (English Heritage, 2008)

Reversibility is very important in addressing the consequences and reducing the harm any intervention can bring to its object of application. The ability to reverse any change gives us the possibility to return to a previous better condition if the new one turns to be damaging to the relevant values of each case.

Minimum intervention means that there is the need of doing as much as necessary to take care of a place and make it useable but, if that isn’t possible, do as less as possible in changing it in order to preserve its cultural significance.

Authenticity, has been an integral part of the conservation, and restoration, concept through its whole development. If we consider buildings as documents of the historical evolution, we underline the importance of the historical heritage authenticity, condemning falsifications, subtractions and alteration that do not enable a clear and truthful preservation of the values it express (ICOMOS, 1964) . It is important to notice the latest expansion of the authenticity concept introduced by the Nara Document of Authenticity: *“Our ability to understand these values depends, in part, on the degree to which information sources about these values may be understood as credible or truthful - - Depending on the nature of the cultural heritage, its cultural context, and its evolution through time, authenticity judgements may be linked to the worth of a great variety of sources of information. Aspects of the sources may include form and design, materials and substance, use and function, traditions and techniques, location and setting, and spirit and feeling, and other internal and external factors.”* (ICOMOS, 1994)

It expands the focus to an important trait of contemporary conservation. For whom we conserve, and what values or specific meaning people give to an object can redefine what is considered heritage and what should be the object of

conservation.

*“Cultural significance means aesthetic, historic, scientific, social or spiritual value for past, present or future generations- -Places of cultural significance enrich people’s lives, often providing a deep and inspirational sense of connection to community and landscape, to the past and to lived experiences.”* (ICOMOS, 1999)

The scientific values are the most recognizable ones as they can be proved or documented, referring to history and scientific references. Sentimental and social meanings though are slightly more difficult to grasp. Ideological connections or the identification of groups in society in a specific object, as well as sentimental meanings single persons give to it are very difficult to be considered by a pure scientific approach. The ability of a restorer/conservator must overcome these difficulties as s/he has to be able to sense and feel the intangibles of a place in order to really fulfil the task of transmitting to the future generations the past and the present time values.

*“[Contemporary theory of conservation] is hardly a revolution, but if it were, it would be the devolution of common sense: the revolution of understanding why, and for whom, things are conserved.”* (Munoz-Vinas, 2012)

### 3.2. HISTORICAL BUILDINGS TRANSFORMATION AND NATURE PRESENCE

#### NATURE PRESENCE...

Important in exploring human-nature coexistence in historical buildings is to look into how this connection has been achieved in historical buildings in the past and how do we achieve it in today's ones.

In previous paragraphs, the evolution of the relation between architecture and nature through history already anticipates the way old and recent buildings dealt with natural presence. It becomes easy to see that in historical buildings the ways nature has been included in the buildings are fewer. As mentioned before the philosophical relation between humans, nature and architecture already introduced the difference between contemporary and ancient times from a conceptual standpoint. The examples we can find reflect this evolution from a nature use that shows the control and dominance of humans over plants and animals when mankind affirmed themselves as superior, to a more open coexistence in recent times where the control of nature is not extreme and more directed on controlling its consequences.

#### ...IN HISTORICAL BUILDINGS

##### GARDENS

Gardens represent the main nature presence in ancient buildings. Gardening goes back in time to the start of history and some traces can be outlined even in pre historical times. From Mesopotamian and Egyptian to modern times, even though the form and reason of the practice evolved and changed quite a lot. We consider gardening as part of natural presence “in” the building as they are often strongly related to a specific building and its functioning. In western culture development, some of the most striking examples are the baroque palaces' gardens and parks.



figure 9. Garden of the Palace of Caserta, Italy.

##### TERRACES AND BALCONIES AND PATIOS

From vernacular architecture to modern times terraces, balconies and small yards or patios function as connecting element with the outdoor spaces. Here presence of plants represent a way this connection between buildings and the outside world manifests. The meaning of the presence of nature in this case is very similar to the one of gardens but the spaces utilized are very different, representing a different architectural language.



figure 10. Pathio of the Generalife palace, Spain.

##### WINTER GARDENS

Building integrated greenhouses have been used also in non contemporary architecture. Winter gardens hosted species rich plants assortment working as an indoor garden and mainly giving nature the same function of those of gardens as people could collect and grow exotic plants acting as creators and regulators of a manmade natural landscape.



figure 11. Winter garden in Nice, France.

##### GREEN ROOFS

Green roofs are not a new element in architecture as well. Vernacular architecture has used green roofing for long time before present days. Sod roofs, traditional construction method of the Nordic countries, for example shows how grass rooting is used to stabilize birch bark roof structures, representing a precursor of contemporary, and technologically more advanced, green roofs.



figure 12. Sod roof of farm buildings in Norway.



## ...IN CONTEMPORARY BUILDINGS

### GREEN FACADES

Green facades are becoming an emblem of green buildings. The visual impact is also another reason for their use, attracting the label of green architecture, but sometimes, falling into green washing when used as façadism. Vegetation acting as smart shading systems, with leaves falling in winter season when sunlight is desired, is an interesting feature in specific climates.



figure 13. Growing green facade, Italy.

### GREEN WALLS

Green walls, different from green facades, are indoor green features and they differ in structure and management. Fixed or mobile solutions are available on the market with built-in watering systems requiring low maintenance. This strategy is often used to bring nature in usually large or aseptic buildings where nature is brought in to improve comfort, whether because of air cleaning capability of the species used, the noise level reduction or the effect of the plants themselves on people's minds.

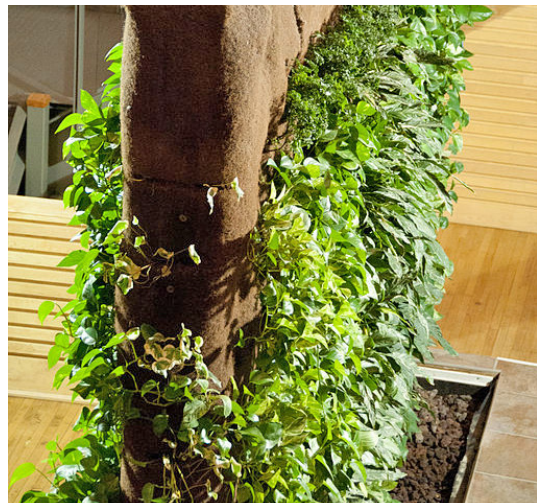


figure 14. Living wall display for educational purpose.

### GREENHOUSES

Modern greenhouses can be considered an evolution of winter gardens. The architectural characteristics are quite the same, mainly glazed or transparent surfaces to let light in. What has evolved is the use of them. While the indoor garden function is still present, food production or use of the greenhouse as part of buildings' ventilation systems are adding to their possible uses. Technical and material advancement define nowadays a different construction and functioning of greenhouses allowing flexible forms and shapes, making them easily implementable.



figure 15. Building integrated greenhouse, Netherlands.

### TECHNICAL SYSTEMS

Technological development and scientific knowledge allow us today to utilize natural processes in buildings' technical system. Water purification for building use through phytodepuration and algae bioreactors are two examples. Even though in some cases the advancement of these solutions has not reached the scale and relevance to influence the market, looking at the development other sustainable technologies had gone through it is possible to foresee future scenarios involving them.



figure 16. Exhibition of algae bioreactor application.

## ARCHITECTURAL EXAMPLES

If we look for architectural examples now, it is impossible to count or keep track nowadays of the diffusion of buildings where nature is integrated in their functioning. Green architecture is the most appealing of the current architectural trends. Everyone is talking about environmental sustainability. There are many different approaches to address the topic, but a shared landscape is not always what green architecture seeks.

Energy efficiency is a very relevant challenge for the future of architecture, as well as energy production. It can be affirmed that the effort of buildings trying to reduce energy consumption, with smart heating/cooling systems and materials, or producing energy on site, through wind turbines and pv-cells, works towards a better coexistence between humans and the rest of natural systems on a larger scale, reducing the exploitation of natural resources and habitats.

Moreover, what is highlighted in this work is the sharing of the architectural landscape with other living members of nature that are not humans. As already discussed many benefits can be brought in today's buildings.



figure 17. PlusEnergy 'Heliotrope' building by R. Disch.



## CALIFORNIA ACADEMY OF SCIENCES.

### RENZO PIANO BUILDING WORKSHOP.

While hosting one of the largest natural history museums, and so being directed to nature inclusion in its essential function, it embodies many aspect of sustainable architecture. It uses and integrate PV-cells and recycled materials, abundant natural light and rainwater management together with a large scale green roof. All these in com-



figure 18. California Academy of Sciences' greenhouse.

bination with the richness of the natural species showcased by the museum give an example of building integrated natural elements, both living and abiotic.

### BIQ HOUSE, SPLITTERWERK ARCHITECTS.



figure 19. BIQ algae bioreactor facade, Hamburg.

This ground braking architecture example in Hamburg, Germany, represent the first building having a algal bioreactor facade. The growth of algae inside the water filled glass panels covering the facade generates bio-fuel and biomass that powers the building. Natural processes are used to generate and store fuel energy. The whole energy production is considered carbon neutral.

## SERPENTINE GALLERY PAVILION, PETER ZUMTHOR.

The tranquillity and calmness deriving from experiencing this architecture is strongly dependant from the natural elements. The isolation of the space from the rest of the surroundings poses a strong focus on the vegetation in its centre and the open sky above it. The special function this architecture has though allows a much bigger freedom of expression compared to other more buildings.



figure 20. Zumthor's Serpentine Gallery pavilion.

The focus of this thesis work though is on historical buildings. The built environment is the main place where innovation should be achieved for a better future as newly built architecture cannot solve the problem of the enormous existing building stock. What is even more interesting is how also historically relevant buildings can adapt to today's and future challenges and how they can react to an inclusive urban environment where coexistence between humans and the rest of the ecosystem could easily take place. Can we trace how nature is included in historical buildings transformation?

Literature and references about "green" historical buildings renovations is getting richer every day but the green in these cases is mainly regard solutions for energy saving or production through



figure 21. Berlin Reichstag's dome, Germany.

renewable sources or even material reuse, and they all concur in reducing the impact of the buildings on the global ecosystems balance and their footprints. Berlin's Reichstag dome by Norman Foster for example provides natural light and is part of the new ventilation system of the renovated building.

But, as nature presence in the building is the focus, most of the projects to include living elements in existing buildings take place in non historical buildings. If we take a look at some of the most successful historical building transformations, we come up with almost none of them acting towards including nature in buildings life. Norms regarding protected buildings, technical or structural limitations, material preservation and common practice altogether pose a lot more boundaries to the possible interaction with other living organisms. Is the aseptic character of historical buildings' interventions a consequence of well documented facts or are these facts posing concerns on the possibility we have today to include nature in these peculiar buildings?

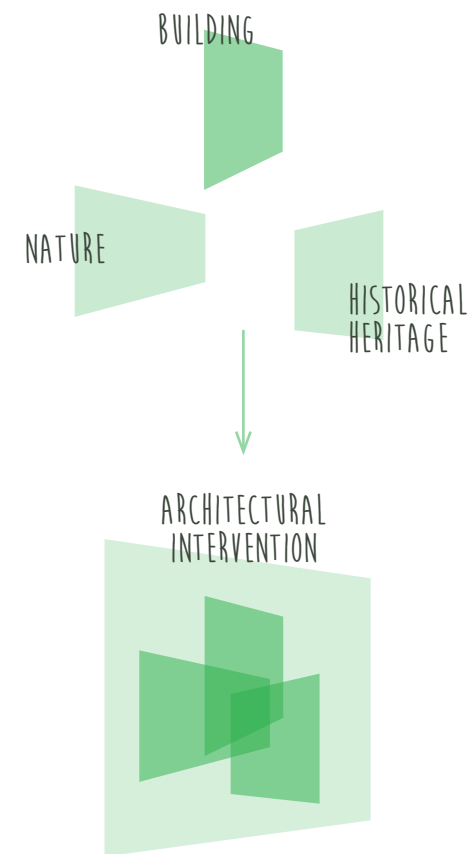
Few examples of historical buildings modified by the use of nature can be found. In Madrid's Atocha Station, in the reconstructed 1892 train terminal spaces, it has been integrated a botanical garden. The expansions of the complex railway

required a remodeling of the station and the terminal has been transformed into a concourse and the empty hall hosts now a botanical garden, with the new terminal built next to the original building. While in this case the ecosystem services side is not considered in its full complexity, the benefits nature brings are a value for the people's experience in the building. The missing link though is the shared functioning. If it's undeniable that the natural elements benefit from an indoor space found in the building, the ecosystem created is strongly dependant on manmade systems and care to sustain nature life.

Could there be a more balanced functioning of the natural and human shared habitat in buildings?



figure 22. Atocha station's 'Invernadero', Madrid.



## 4. RESEARCH SYNTHESIS

Concluding now the background research part, we've looked at notions, facts, data and reasons supporting or determining how nature inclusion in historical buildings can be achieved. It is difficult to sum up together all the guiding principles extracted from this research. Therefore a synthesis trying to bring together the knowledge explored is considered in this work the primary aspect of the site development process.

The role of developing the transformation of the Artilleristallet building, in English Artillery stable, in Gothenburg with an analysis of what are considered its most relevant aspects for this thesis work, is to strive to reach a real synthesis. The following chapters therefore are to be con-

sidered themselves synthetic of one way all the background information can be utilized in architecture. Adding the specific site, a building in this case, provides the third element of the relation to synthesize a possible nature inclusion in historical buildings. Having to deal with an existing and historical element of the built environment means to manage a special and unique case to which pre-set defined theories might clash with its identity. With its specificity and physical dimension, the building makes it possible to relate theories and practice, finding its own way to embody them.

The synthesis is seen therefore as a design approach that is carried out in the next pages.



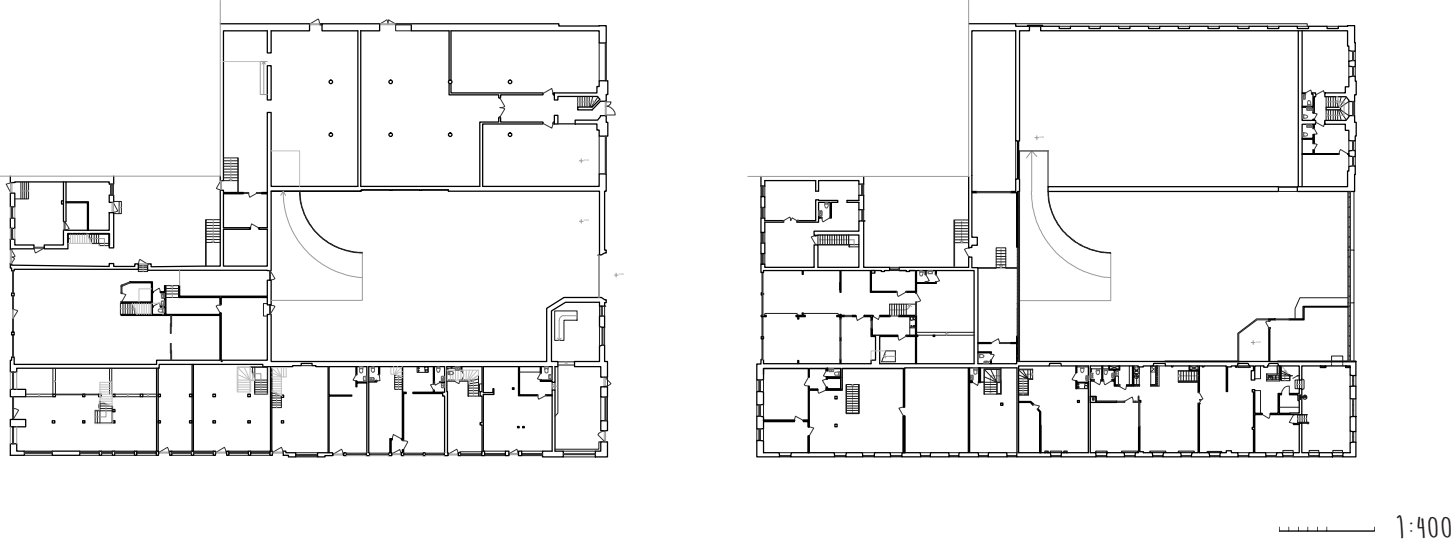
EXPLORATIVE CASE SELECTION

In selecting the case many factors had influence. First of all is the actual will of transformation being there as its process and discussion is taking place in the latest years. Second was the location. This historical building is located in a very central area of Gothenburg, inside the moat circle. Doesn't happen often that an old building memory of the city's past gets to be transformed to host new function right in the heart of the city. A third factor is the building spaces. It can

be criticized that selecting a building with large and empty spaces makes it easy to interpret the design task and apply more freely theories and concepts, thing that might not happen in other buildings typologies. This thesis work though wants to mainly provide an example of architectural transformation approach and the actual final design product is not the strict main focus or outcome. At last of all was a personal interest in this historical building. In a brief course last year,

Architectural Conservation and Transformation, I've been dealing with the nearby parking lot/ square and that bolstered my interest in this part of the city getting me to know the building and its historical relevance. It is important to state also that only part of the building, the one used as a garage, will be transformed therefore the focus will be placed there.

CURRENT BUILDING'S GROUND AND TOP FLOORS



figures 23, 24, 25. Artilleristallet building main facades.



figure 26, 27, 28. Diverse interior spaces.

## 5. PROGRAMMING THE SITE DEVELOPMENT WITH NATURE

### IN THIS CHAPTER...

LOCATION, SURROUNDING AND SITE ANALYSIS

BUILDING'S HISTORY

PROTECTION AND REGULATION

BUILDING STATE AND PHYSICAL ANALYSIS

ANALYSIS OF THE BUILDING'S POTENTIAL FOR  
HABITAT SHARING

To explore the possibilities and identify strategies of interventions, understanding the context becomes crucial in order to reach the best result or at least a realistic and concrete framing of actions to pursue it. Nature and historical buildings both require a context analysis and understanding and the layers of this exploration merge together blurring lines between usually distinct spheres of influence.

The site analysis and the urban context relate to the nature presence in the specific landscape and the socio-economical layers get influenced by nature itself. A brief picture of the surroundings is drawn to contextualize the historical building transformation process.

Building historical reconstruction follows then up, in order to properly grasp its identity and cultural manifestation while hinting at the values it embodies. The history translates as well into the present state where material, structural and technical specifications and limitation constitute the terms to be dealt with in the practical sphere.

Nature inclusion opportunities are then summarized relating to the building possibilities.

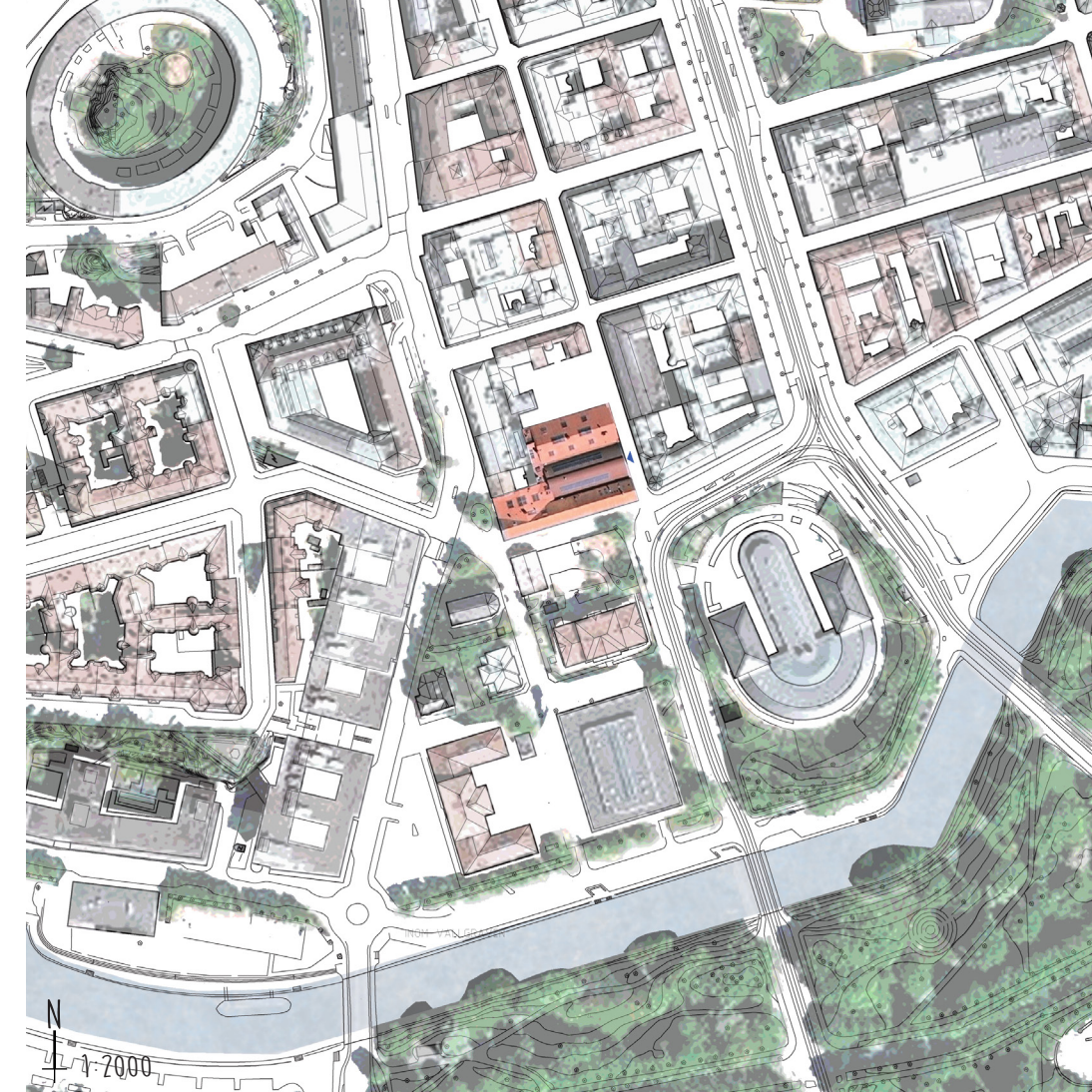


## 5.1. LOCATION

The building is located in central Gothenburg within the walls circle and its moat, more precisely in Magasinsgatan 19.



figure 29. Satellite view.



Access to the garage part of the building is only on from Magasinsgatan. The shops and offices in the building are accessible from Södra Larmgatan, Kaserntorget and Magasinsgatan with its parking lot, but none of this premises are connected nowadays to the garage. This implies that only one access is present nowadays for the garage premise.





## CLIMATE

The west coast of Sweden is characterized by stable climates with considerate precipitation during all months and few temperatures extremes. *Unlike their equatorial neighbours, marine west coast climates are located beyond the farthest pole ward extent of the subtropical anticyclone, and they experience the mid-latitude westerlies and travelling frontal cyclones all year.* (Weatherbase website, 2015)

741.7 mm is the average yearly precipitation amount in Gothenburg. As show by the graph precipitations are distributed throughout the year with a minimum 40mm in each month while autumn accounts for the major fluctuation. On average there are 154.0 days of precipitation, with the most precipitation occurring in November/ December. Late winter months usually account for the fewest rainy days. Very important in

analyzing the sun availability is to take a look at the sunshine availability percentage. Sun hours are unevenly distributed during the year with dark winters and light summers due to the latitude but the actual availability of sunshine accentuates it even more. The year average temperature in Gothenburg is 8.9°C. The average warmest month is July with an mean temperature of 16.1°C. The coolest month is usually December, with a temperature of 0°C on average.

The maximum temperature recorded in Gothenburg was in July and is 30°C. The lowest one is -20°C, record set in a December (Weatherbase website, 2015). In connection with temperatures, air humidity fluctuates yearly from an average low of 60% in May to the 80% of the autumn months. Wind speed is quite uniform during the year ranging between 4 and 5 m/s. (Windfinder website, 2015)

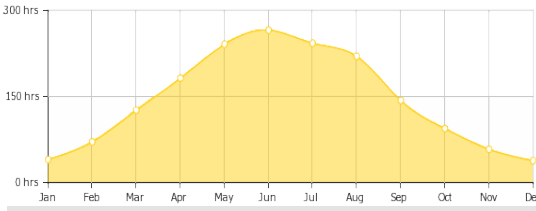


figure 23. Sun hours average over the year.

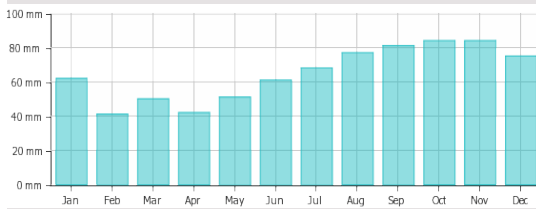


figure 24. Monthly precipitation over the year.

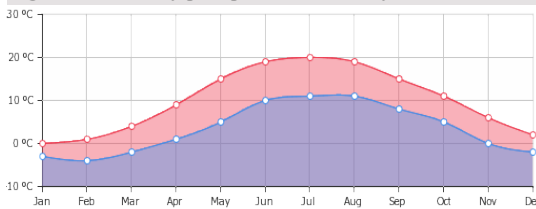




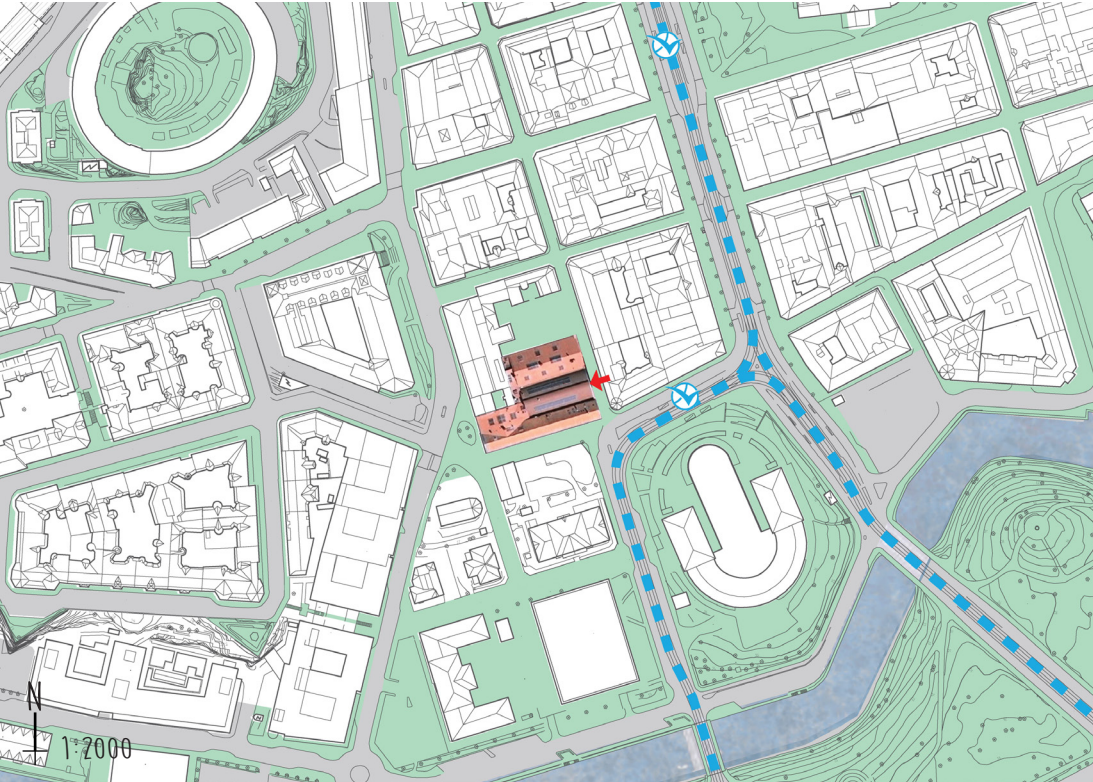


figure 25. Max and min temperature avg over the year.

## PUBLIC SPACES IN THE SURROUNDINGS

It is the last building of the pedestrian area of the street before reaching Gronsakstorget and its public transport stop. The pedestrian area is the extended commercial oriented zone stretching from the site to Brunnsparken and Nordstan. Domkyrkan is the other close by public transportation stop.

-  Pedestrian areas, sidewalks and public green
-  Vehicular traffic spaces and parking lots
-  Public transportation stops and lines
-  Access to the garage premise















# URBAN FUNCTIONS IN THE SURROUNDINGS

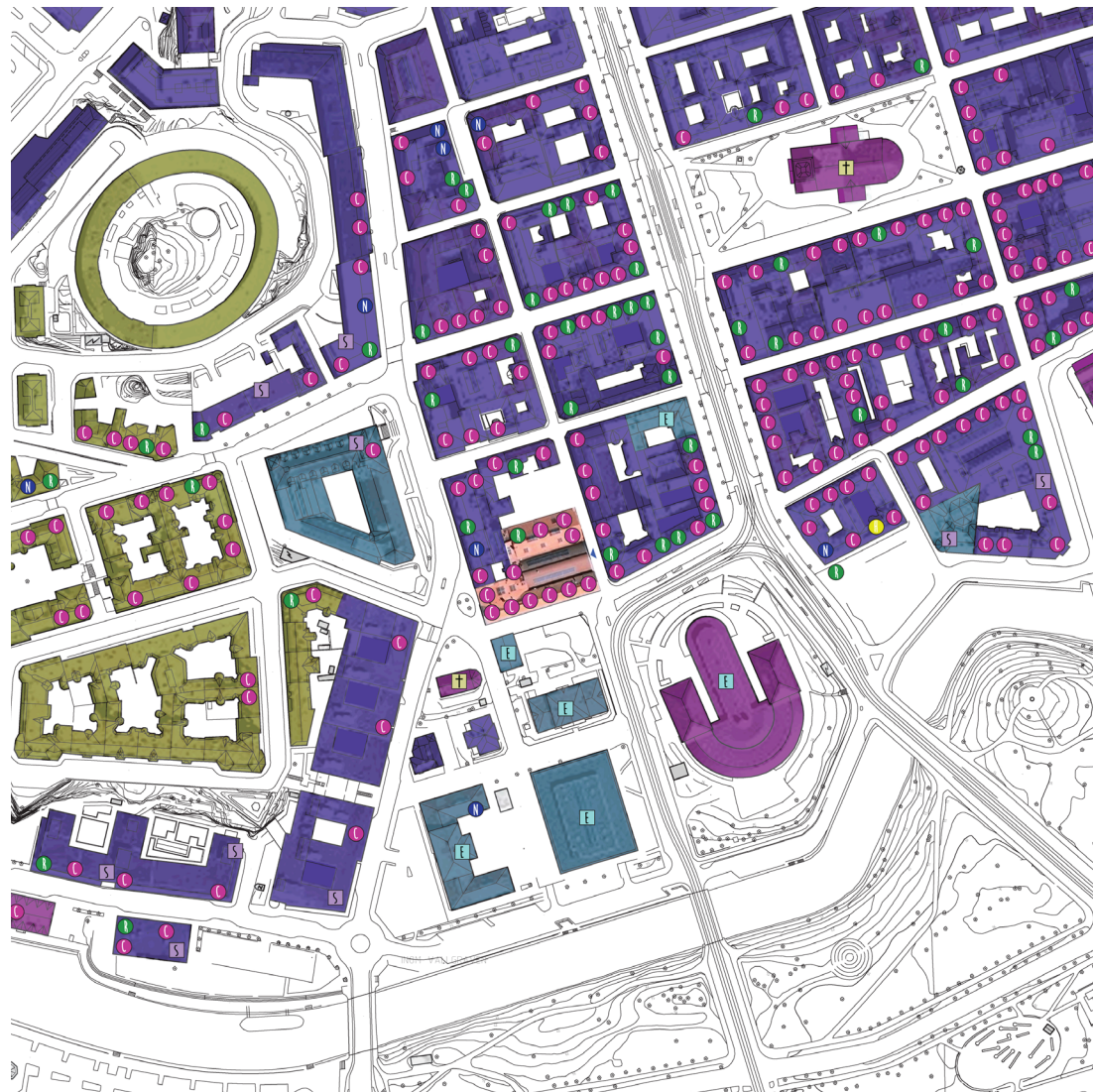
Commercial activities in the close surroundings consist mainly in retail shops, clothing and furniture among others, and cafes or restaurants mainly active during the day. The main function of the upper levels of the block in this part of the city is connected to offices, public services or institutions.

## STREET LEVEL FUNCTIONS

-  Commercial activities, shops.
-  Restaurants and caf  s.
-  Nightlife, pubs and clubs.
-  Public services and institutions.
-  Education, schools and universities.
-  Religious.

## FUNCTIONS OF THE ABOVE FLOORS

-  Mainly work place buildings.
-  Monofunctional buildings.
-  Prevalent residential buildings.
-  Landmark buildings.



# NATURE PRESENCE

Nature presence in the area is not scarce considering how central it is. The building though finds itself at the edge of an almost completely built zone. Trees presence stretch from Kungsparken with its deciduous tall trees and landscaped lawns, gradually reducing in tree size and grassland nearing the building.



figure 30. Semi isolated trees around Gr  nsakstorget.





5.2. BUILDING HISTORY, CULTURAL VALUES AND PROTECTION

An historical summarization of the building history in connection with the city development is fundamental for introducing the building historical and cultural values. The following two paragraphs try to synthesize its evolution and are translated from the report ‘*Artilleristallet: Kulturhistorisk beskrivning och inventering*’ courtesy of Lindholm Restaurering AB Johanna Lange (Lindholm & Lange, 2013).

**THE FORTIFIED CITY**  
Gothenburg began in the 1620s as a fortified town with the main objective to guarantee a port in Swedish hands on the west coast. The location of the new city was chosen with care at a natural harbour where several valleys were tied together and connected to an existing road network. Between two protective hills, Otterhällan and Kvarnberget, the marshy meadows have been

drained out and resulted in a net of channels for a grid plan prepared by Dutch engineers. Building blocks, streets and squares were then inserted in a Cartesian system. Around the city fortification walls were gradually built up in a zigzag pattern and beyond these a moat found place. To get in and out of town, you had to pass one of the three city gates guarded and kept closed at night. The city’s defence even had fortifications outside the

city walls - the closest were Skansen Kronan and Skansen Lejonet. During the 1700s defence policy and practice gradually changed and in early 1800s the fortifications became obsolete. Therefore the King ceded the area of the city wall to the city of Gothenburg in 1807. The fortification walls were torn down to street level during the first half of the 1800s and a new plan was drawn up for this area of the city by architect Carl W.

Carlberg. In the mid-1800s the crown regained Kungshöjd for military purposes, and here was built Göta Artillery Regiment arsenal for the storage of guns and munitions. In connection with this, it was chosen to preserve the city walls of this part, Carolus Rex, adjacent to Kungsgatan. (Herklint, Sedenmalm & Lind, 1992)

Current Kungshöjd was characterized during the 1800s second half of artillery regiment’s activities. At the top was the castle-like arsenal and below, where the old televerkets building stands today, was the artillery barracks building. In close connection with this, there was artillery stables and riding hall along Magasinsgatan.

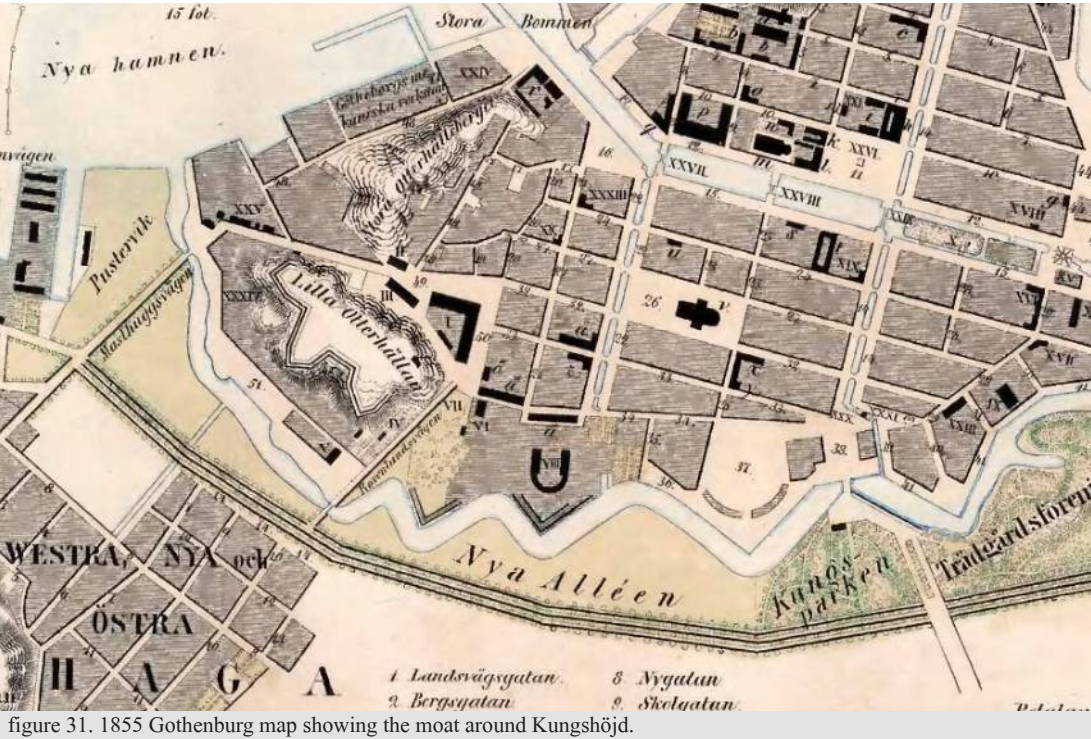


figure 31. 1855 Gothenburg map showing the moat around Kungshöjd.



figure 32. Artillery establishments and stables settlements in 1869.



STABLES AND RIDING SCHOOL.  
ARTILLERISTALLET BUILDING HISTORY

The regiment and the city authorities had initial difficulties to agree on a suitable site for the erection of stables and riding school for the Göta Artillery Regiment. The city suggested a place at Haga Heden, southeast of Hagakyrkan, while the regiment wanted to build stables on Hästbacken, current Ekelundsgatan. Finally, it was agreed to erect a stable for 68 stalls on a plot inside the bastion Carolus Dux on Södra Larmgatan. This first stable building was transferred to the city in 1898 and demolished the following year. Nowadays Grönsakstorget tram stop is located where this first artillery stables were built.



figure 33. First stable building in today's Grönsakstorget.

The first artillery stables were about 68 m long, almost 11 feet wide and about 6.8 m high. The stables were furnished with four fodder chambers. The house was walled with brick over stone base, trimmed with pale yellow stucco and the roof was covered with tiles.

In 1830 the regiment was reorganized resulting in an increase of 54 ordinary horses. This meant that a further stable building had been constructed and for this purpose an extensive plot was purchased, no 38 and 44 of the city's first rotating at Magasinsgatan and No. 9 at Kaserntorget. (Ljungberg, 1924).

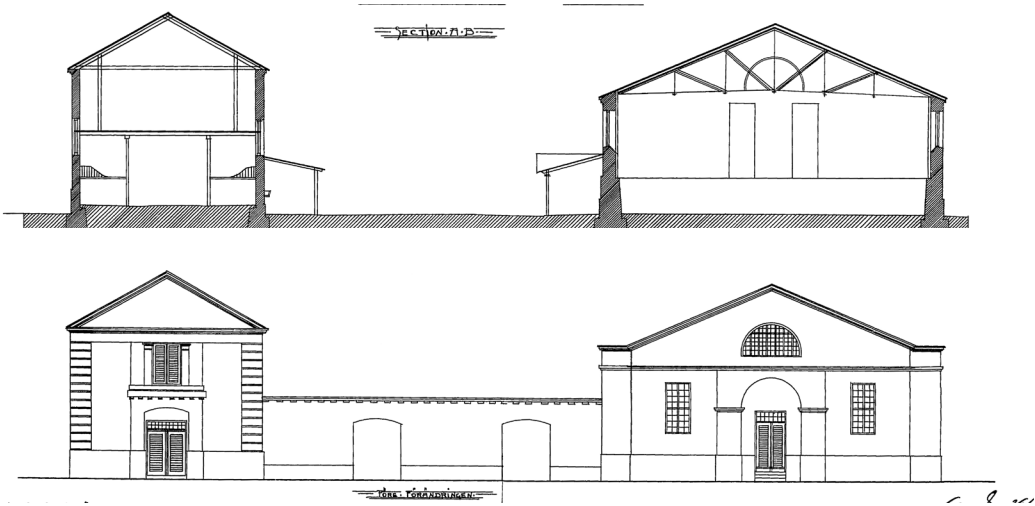


figure 34. 1898 building permit, original section and facade

The complementing stable and riding hall for Göta Artillery Regiment was built and designed by architect JF Weinberg and was finished in 1835. The new stables were similar in appearance and furnishing to the older ones. In Larmgatan it was built a house on two floors with 63 stalls in the ground floor and fodder room upstairs. Further into the neighbourhood was erected the riding hall.

The space between the buildings served as the stable yard and was roped with a stone wall toward Magasinsgatan.

In 1898 the stables and the riding hall were sold to Gothenburg Hyrverks AB, which commenced refurbishment of the premises for their business. The yard got built over with an arched metal roof supported by slender steel trusses. In the riding hall a new floor was added, transforming it thus into warehouse on the ground floor and stables upstairs.

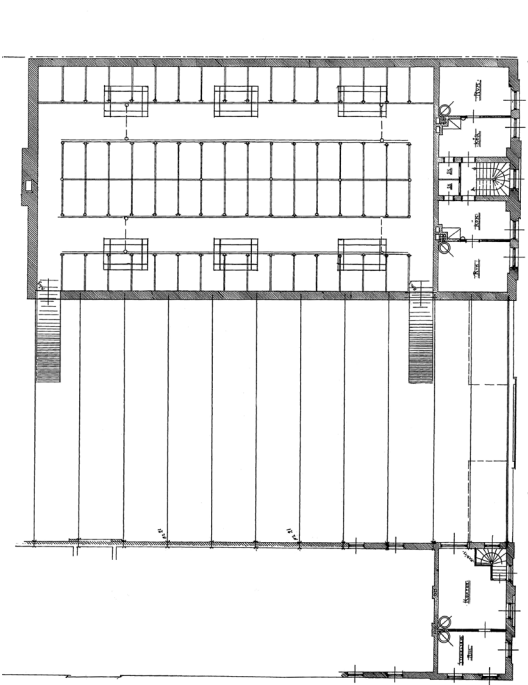


figure 35. 1898 building permit plan for the added floor.



figure 36. 1901, covered yard.

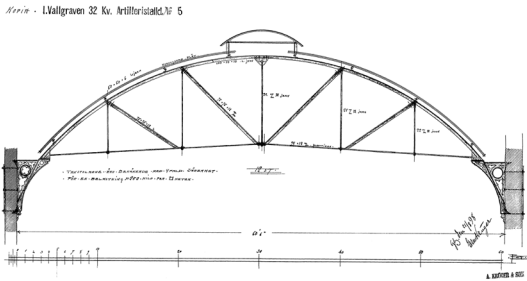


figure 37. 1898 building permit plan roof truss detail.

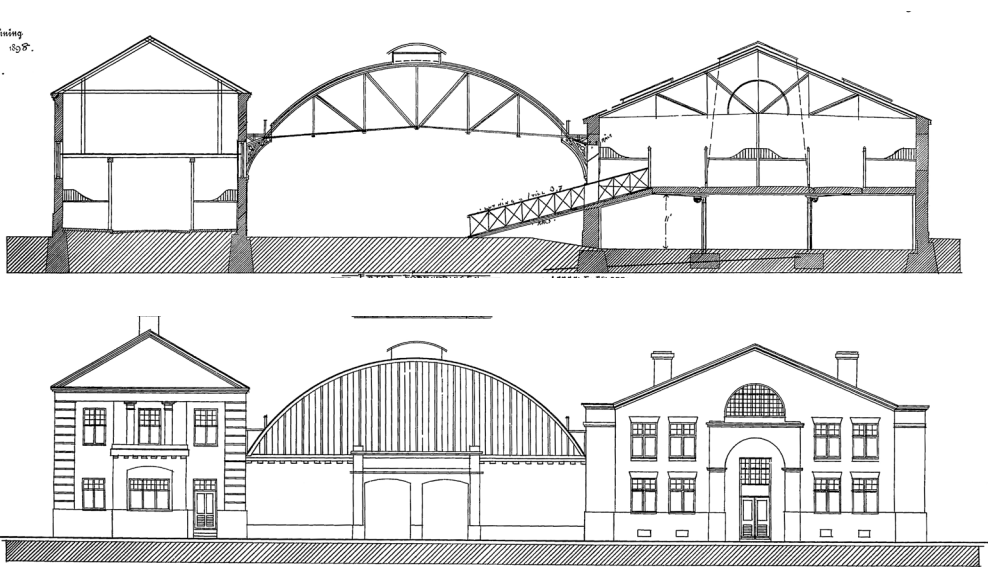


figure 38. 1898 building permit section and facade on Magasinsgatan changes.

Between 1929-1931 all the stables were then rebuilt into shops, warehouses or offices. A car ramp to access the top floor of the riding hall still present nowadays, was then built in 1939.

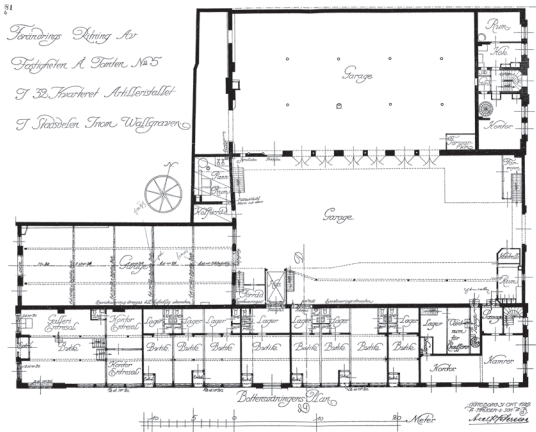


figure 39. 1929 ground floor transformation plan.

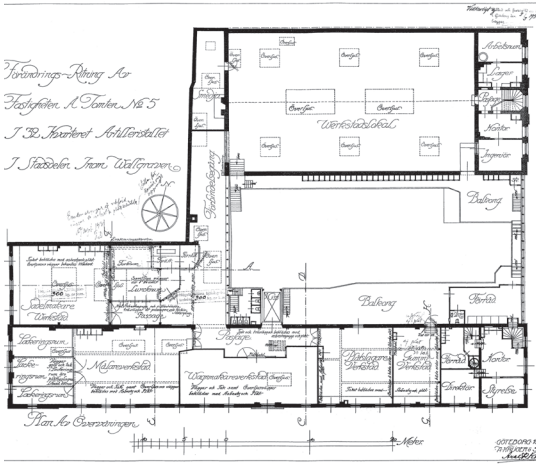


figure 40. 1929 top floor transformation plan.

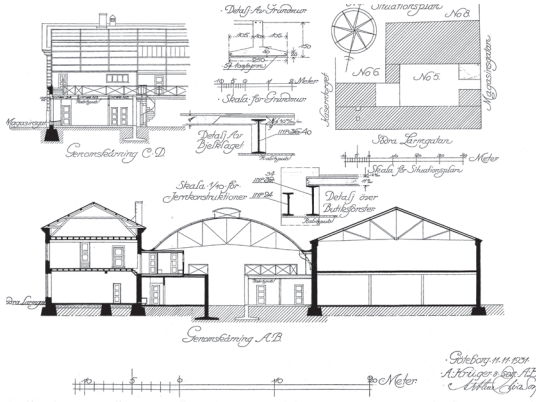


figure 41. 1931 section of the entrance area.

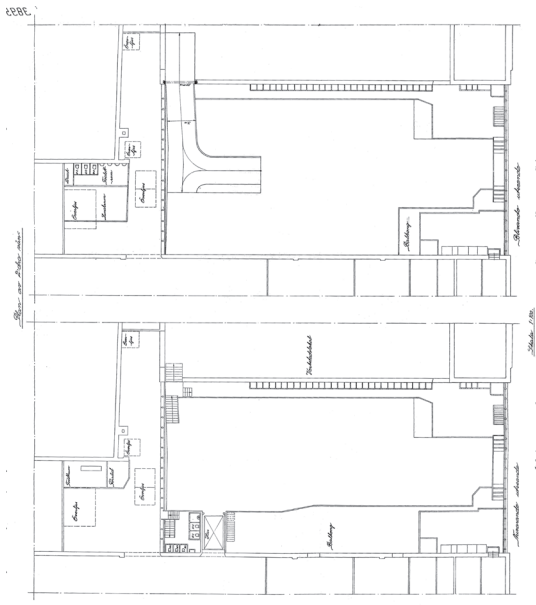


figure 42. 1938 building permit plan for the new car ramp.

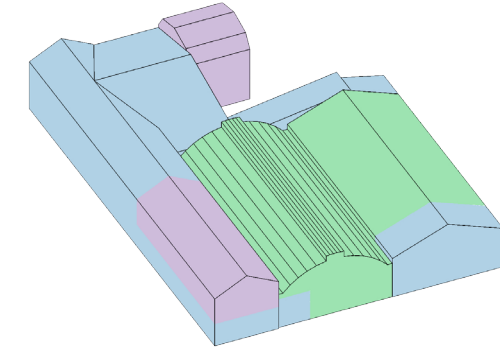
### MODIFICATIONS SUMMARY

- 1835 Newly built
- 1874 Extension of the stable with a new floor
- 1898-1899 Remodelling by Göteborgs Hyrverks AB. Construction over the yard.
- 1909 New entrance and window on Kaserntorget.
- 1917 Bigger windows at ground level on Södra Larmgatan. Rebuilding of the stables into workshops.
- 1929-1931 Rebuilding for retail premises, warehouses and offices.
- 1941 Car ramp to the upper garage.

### FUNCTIONS 1835-2015

- 1835-1898 Stable, ride hall
- 1898-1917 Stable, depot – garage
- 1917-1929 Workshops, stable, depot – garage
- 1929- Retail facilities, offices, workshops, garage

### TODAY'S FUNCTIONS



- Retail
- Workshops and offices.
- Garage



## HISTORICAL VALUES AND PROTECTION

The Artilleristallet has gone from being under demolition threat to being an established part of the inner city historical built environment. The area is highlighted as national interest in the description of Gothenburg city centre and conservation program for Gothenburg. A detailed plan focusing on conservation was also developed in the late 1980s. Here follows some citations from legislation and documents that protect buildings from demolition and corruption.

In the environmental code, *Miljöbalk* (Miljö- och energidepartementet, 1998), national interest for cultural heritage conservation is cited in chapter 3 paragraph 6 as follow:

*“Land and water areas, as well as the physical environment in general which are significant public interest because of their natural or cultural values or with respect to roam as far as possible protected against measures that may significantly damage the natural or cultural environment. The need for green spaces in urban areas and near population centers should be given special consideration.”*

In the national interest description of Gothenburg city centre there some passages concern Artillery stables and its heritage value.

*The early 1800s urban regeneration by city architect Carl W. Carlsberg’s neo-classical stone town in the moat and the belt of new settlements and plantations that occurred at the abandoned fortress area according to Carlsberg’s plan 1808th-Building tradition of dominant low buildings height, the yellow “Gothenburg bricks” with carl Bergska neo-classicism result of medieval romance in the mid-1800s, the richly shaped late 1800-century buildings in plaster and brick and with a large element of polychromy, governor houses and their different stages of development. Street character with cobblestones and once in Bohus granite outcrops and the abundant elements in the green in the cityscape.*

The city centre in Gothenburg’s conservation program is also identified as particularly valuable. This means the application of the Planning and Building Act’s rule for distortion prohibition in the processing of building permits. The area’s heritage values is justified as follows in the conservation program.

*City centre within the moat is a unique environment with a richly varied, mainly small-scale buildings. The area reflects the development of Gothenburg from the foundation to the present. Large parts of the original town plan with moat, canals, fortification remnants and street stretches*

*are preserved. Several street paths are characterized by older plot division and construction.*

The planning and Building Act (Socialdepartementet, 2010) regulates planning and building permit issues. It cites that historically valuable buildings shall be protected from adulteration. Falsification prohibition applies to both the exterior and interiors. Here below follows an extract from Chapter 8 paragraphs 13, 14 and 17.

*“13 § A building that is especially valuable from historical, cultural, environmental or artistic point of view must not be distorted.- 14 § An edifice to be held in tended condition and maintained as to its design and technical characteristics referred to in § 4 essentially preserved. The maintenance must be adapted to the ambient nature and the structure’s value from the historical, cultural, environmental and artistic point of view. If the works are especially valuable from historical, cultural, environmental or artistic point of view, it must be maintained so that the specific values are preserved.- 17 § Modification of a building - shall be carried out with care to take into account the building’s character traits and take advantage of the building’s technical, historical, cultural, environmental and artistic values.”*

## REGULATORY DETALJPLAN

The existing zoning includes block 32’s Artilleristallet and aims to preserve the buildings in the neighbourhood considered to have particular cultural and historical value. Since 1987 the buildings have been part of the municipality’s conservation program that includes street environments along the Södra Larmgatan and Magasinsgatan. City Museum suggested the former Artillery stables as heritage building as the building has a large urban historical and architectural heritage value. Therefore, in 1989, the current zoning plan was developed to protect the buildings that, until then, had no formal protection. The zoning plan was adopted and became final 1990. (Lindholm & Lange, 2013)

### The use of blocks of land

C Common areas such as theatre music venues, restaurantststc.

K Office

H1 Trade at street level

### Demolition Prohibition and protection

q1 The building may not be demolished. For exterior maintenance techniques shall be selected with respect to appearance and quality if possible in accordance with the original design or a design that is typical of the building’s date of origin.

q2 Mouldings, door scopes and other plaster decor is maintained. Original windows and glass partitions on the ends toward Magasinsgatan maintained. Towards Södra Larmgatan maintained red rooftop tiles. Room volume in former Hyrverksbolagets Great Hall preserved with visible roof structure.

q4 New buildings should in height, shape and material adapted to adjacent buildings.

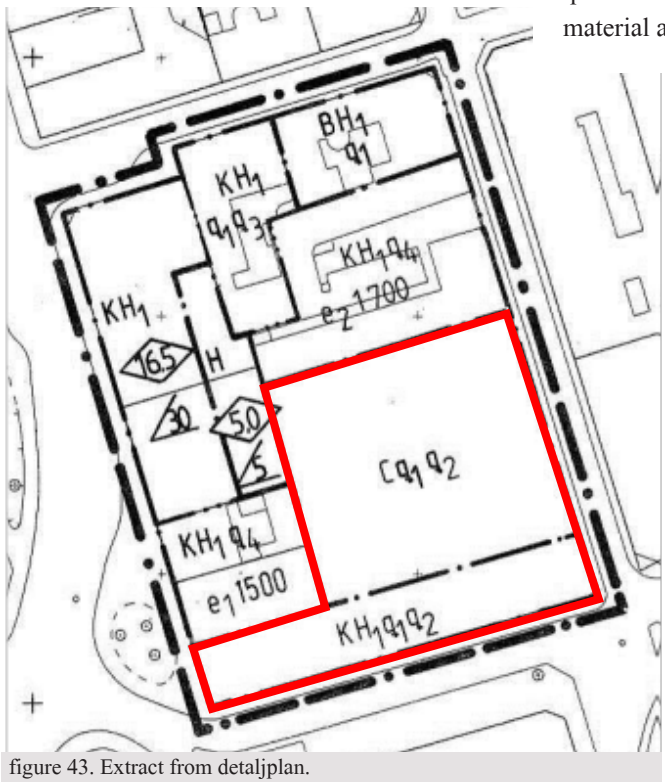


figure 43. Extract from detaljplan.

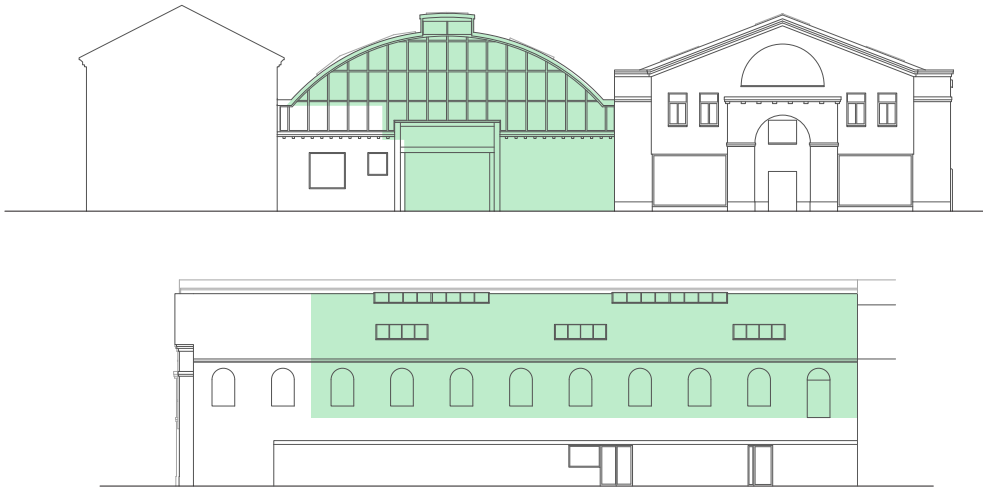
## ONGOING TRANSFORMATION PROCESS

The discussion about the building transformation is an ongoing process that in the last years has seen some changing factors and is still open these days. The previous owner Christer Harling, started back in the 90's to invest on the degraded area and buildings in Magasinsgatan, slowly revitalizing this part of the city. Many shops now are located in the Artilleristallet building as well as the surroundings. Patiently the small business activities altered the physical and socio-economical settings, appropriating and modifying the urban spaces.

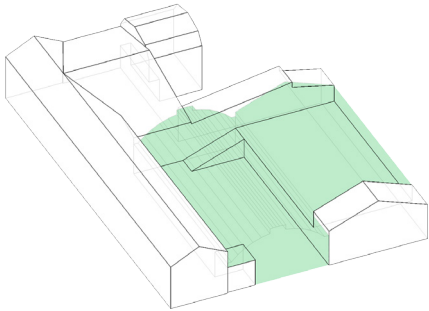
Today's discussion about the covered courtyard and the riding hall top floor, now temporarily functioning as a garage, started already under Harling ownership. Confronting with the municipality and Gothenburg Museum of Art representatives, and consulting different expertise collaborating in defining the possibilities, these spaces were designated to artistic exhibition spaces. Both Konsthallen, a contemporary art centre, or Hasselblad Foundation, photographic art foundation, are in need of bigger spaces than available at their current location in Götaplatsen (Löfvenberg, 2013).

In 2013 though, Harling retired and sold all his properties to Wallenstam AB which became the owner of the building together with the nearby plots in the block including the parking/square. Wallenstam is now re-discussing with their own terms the future of the building. The possibility of transforming the garage into exhibition hall is still there but new private investors showed interest in the premise as well but the nature of these other development proposal has not been made public or released through press.

LOCATION OF THE GARAGE AREA ON THE EAST AND NORTH FACADE



GARAGE VOLUME IN THE BUILDING



1:200

## BUILDING VALUES

Given this complex background, it's important in order to redevelop the building in a proper and meaningful way to identify what are the values to be preserved and considered in the possible intervention.

As the history of the building shows a great variation of uses as well as quite relevant and consistent modifications of the construction and the material body of the building, they can bring a rich testimony of the local urban area and city history development. Therefore, any future architectural intervention needs to take notice of the uniqueness of the artistic production consisting in the building but also of the traces of these modifications manifesting the evolution of the identity of the place. Regarding the part of the building interested by the transformation process, the roof structures, the spacious interiors and their rough 'industrial' character represent a major feature carrying the historic-scientific meaning, acting as a physical document, carrying identificative and sentimental value too.

The redevelopment of the surroundings, especially the city block containing the building, from depressed and abandoned productive and working class urban area into a buzzing social meeting place with numerous events and gathering happening during the year, made the site of the building one of the most attracting area for local folklore. The Artilleristallet building, together with the confining parking lot, represent a symbol of this successful urban redevelopment.

The peculiar social landscape of area so influences and gets influenced by the building itself and, considering its potential change of use, this relevance can grow in the future. The combination of Artilleristallet symbolic and sentimental values, as well as its scientific relevance and uniqueness for the city of Gothenburg, with an high degree of cultural richness an art exhibition space, can provide a reinforcement of all of these factors meaning.



CHARACTER OF THE PLACE



figure 44. Hip shops and café.



figure 45. Active neighbouring square.

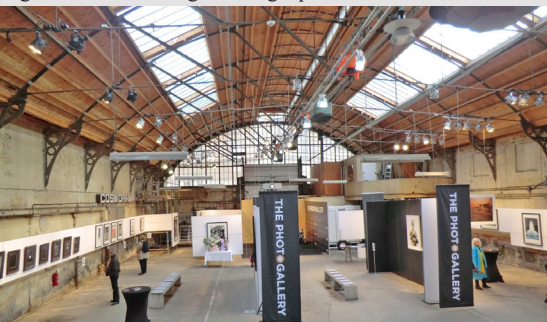


figure 46. Temporary exhibitions and events.



figure 47. Visible modifications .



figure 48. Big airy spaces with industrial look.



figure 49. Technical systems showing.



figure 50. Rough surfaces with marks of time.

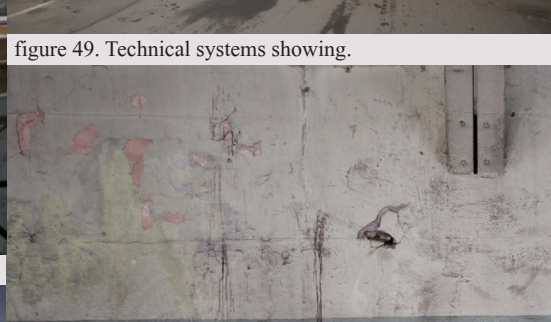


figure 51. Brick structural wall.



figure 52. Detail of the added floor structure (riding hall).

5.2. BUILDING CONSTRUCTION, PHYSICAL CONDITIONS AND NORMS  
CONSTRUCTION

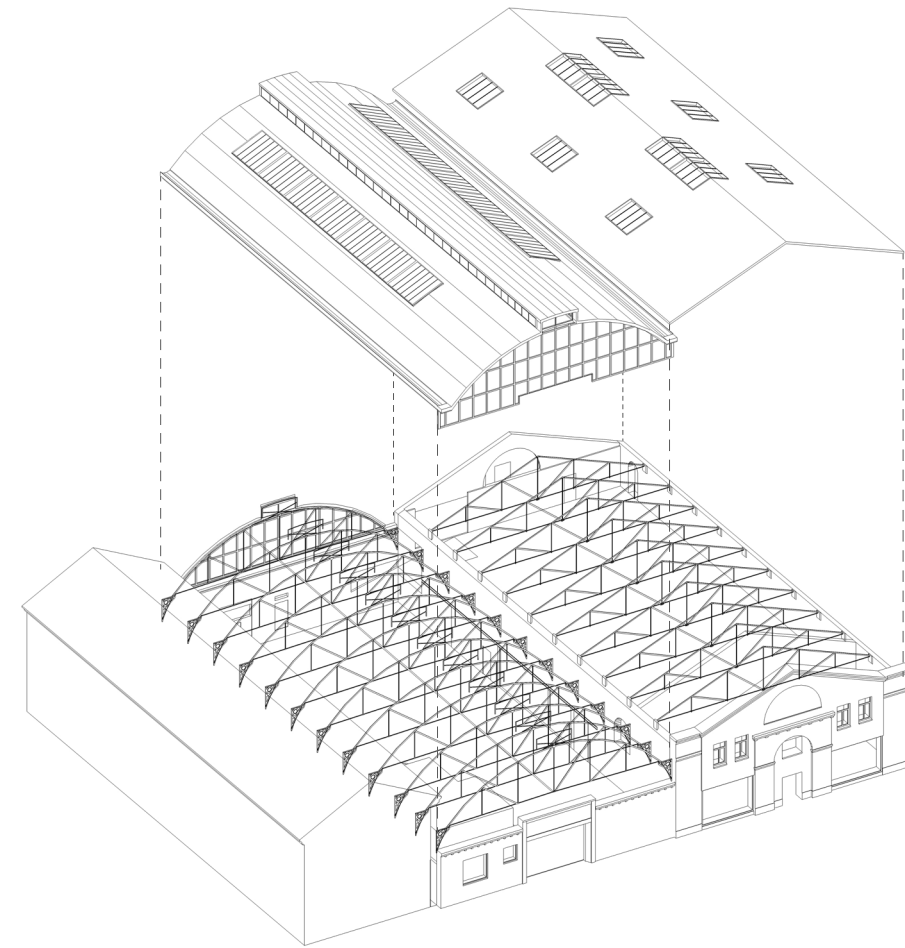
The overlaying traces of the different functions hosted in time has modified the original building construction. The following description is derived by photographic documentation and the previous building history reconstruction. Maintenance and some modification are not documented so some features of the buildings cannot be 100% verified in this work.

The two original separated buildings used both masonry walls as vertical structures. The stable house shows nowadays a roof construction that reflects the original one, wooden trusses and planking with red tiles exterior surfaces. Skylight have been added in time. The slab creating the two floors has been modified when the stable was transformed in retail and workshop spaces, adding staircases and a stronger structure, as the top floor was previously used as storage space for stable activity. The wall structure of the riding hall is still made of plastered bricks but, especially on the facade facing the ‘covered yard’ many modifications have inserted other structural components. The openings made to connect the two spaces, now walled, justify the steel pillars and beams visible on the wall surfaces, and the non plastered portion of it show the different time of its realization. These modifications can be connected to the

1874 floor addition in the riding hall to host more horses in the complex. The added structure consists in steel pillars and beams supporting a vaulted slab structure probably composed of bricks and concrete. The roof structure shows the original steel trusses supporting a light weight metal and wood slab. The skylights here have probably been added in time as well as they do not correspond to the practice of the time and due to the presence of numerous windows on the original building facades lighting the space. The access ramp to the added floor has changed position going from a smaller one passing through the arched opening close to the present ‘covered yard’ entrance, build probably with lighter structure and material, to a wide concrete ramp for car allowance in the west end of today’s garage.



## ROOFS AND TRUSSES OF THE GARAGE AREA



The central yard, covered in 1899, presents a roof structure spanning from the stable house to the riding hall building. The construction is composed by arched steel trusses supporting a wooden envelope covered with metal sheet. The trusses are connected to the facades with decorated corbels. The two longitudinal skylights are believed to be original of this roof construction while the lantern on top is not present in some historical pictures and can be attributed to a later modification. The covering of this space created two new building facades to the east and the west, the first one consisting in today Magasinsgatan. The yard limiting wall there have been surmounted with a glazed surface reaching the top of the arched roof. On the west side though, the later addition of other connected spaces modified and closed the ample glazed facade.



figure 53. Corbel sustaining the covered yard roof.



figure 54. Damaged ceiling in the riding hall.

## BUILDING STATE AND CONDITIONS

The part of the building interested by the transformation process is the great hall and the top floor of the riding hall building. In the remaining part of the building shops, workshops and offices are well functioning and there is no will for modification of the unique tenant composition. (Löfvenberg, 2013)

## CONSTRUCTION CONCERNS

The main concern for modification of the building's structures is concerning the roofs. The light weight trusses and slabs there give major concerns to the possibility of their modification without a structural reinforcement. This affects the thermal properties the building envelope can provide to the indoor spaces. Addition through the building history of skylights though can probably predict the possibility of modifying the roof envelope with light weight materials.

The pavement of today's garage has surely been resurfaced in time but, relevant to highlight structurally, the ground level floor structure is

potentially disconnected from the other structures being a result of additions in time, meaning modification in the floor level can be made paying attention to the structural stability of the surrounding facades.

## NORMS AND RULES

Especially in case of buildings with public functions, accessibility and safety are very important for the fruition of the building. Nowadays the building does not meet all the requirements.

The modifications of the building have to follow the requirements set by Boverket's Building Regulations (Boverket, 2012). While now only half of the garage space is accessible, toilets, walkways, doors and lifts must therefore be placed and dimensioned properly.

In order to host new functions safety issues must be addressed as well, especially regarding fire regulations. Safety routes and emergency exits must be positioned following BBR rules and requirements.

TECHNICAL LIMITATIONS

Roof structures are dated and not able to sustain added loads. Extraordinary maintenance is needed as wooden parts are damage and general decay is occurring. It is possible that new performance will be needed following the building re-functionalization and maybe a bigger restructuring of the roof envelope would be considered.

Toilets and water supply should be provided in the premise for the future function in case of public accessibility or economical activities.

The neighbouring rooms of the building complex are of course already provided with these technical supplies. Knowing where they are located can help identify cheaper options or convenient connections to already existing pipes.

LOCATION OF TOILETS AND KITCHENS



1:200

5.3. BUILDING-NATURE POSSIBLE RELATION BENEFITS

ECOSYSTEM SERVICES FOR THE BUILDING

With all the possible upsides provided by ecosystem services to human habitats, including them into man made landscape could help reduce the ecological footprint of cities and buildings and provide a more resilient environment.

But we can’t consider to include in every single case in the city landscape all the ecosystem services. Regarding buildings for example not all of them are suitable, some for health reason, like moulds and harming bacteria, and some for more technical matters, for example roots climbing plants deteriorating the buildings surfaces or structures, compromising the building use and functioning.

Therefore in bringing ecosystem services to the site, special care should be given to their selection, whether concerning the quality or quantity of the providing element.

The starting point, unavoidable and crucial to the success of the symbiosis, is to always pursue improvement of spatial qualities for people as shaping welcoming and healthy spaces could be seen as the main goal of architecture itself.

Consequence is that the provided services should fit to the purpose of the building. A bundle of services should be defined to fit the specific needs on site. An overall control on the integrated natural system should always be assured. As fascinating as nature overtaking the space could be, delimitating the freedom natural species have, can provide a much better reliable system to serve the building. At the same time, considering natural elements as mere tools executing a determined task means underestimating the complete value of a shared landscape.

The Artilleristallet building could use many different ecosystem services. The external surfaces, the ample and light indoor spaces but also the possibility of shaping new functions, allow to maximize functionality and the integration of a system of ecosystem services to fit properly into the building’s life. Depending on the functional program to be implemented in the building transformation, different layouts of the services bundle can be portrayed. In order to take an aware choice regarding their selection it is important to identify all the ecosystem services that could actually be introduced.



Hereby follows a summary of all possible categories of ecosystem services that could be used in the building transformation. This could be seen as a toolbox of possibilities and opportunities the building can take advantage of in its development. These services will be declined in the design process adapting to the function and needs for the future use of the building. The final design might not use all of these but as they are potentially implementable, it is relevant to consider each one as viable service to benefit from.

## FOOD

Food production could potentially be implemented in the Artilleristallet building. Both indoors, with the ample and naturally lighten spaces of the hall, and outdoors, with its roofs or the nearby square even though the possibilities are fewer, could host food provisioning services. Horizontal and vertical structure may support and provide good sun exposition, favourable temperatures and water availability. Aquaponics systems, combination between aquaculture and hydroponics, in urban contexts have seen a quick growth in the latest years, providing both fresh vegetables and fish could be considered. Questionable could be animal's life quality as they would be living and growing in a limited space with characteristics different from their own natural ecosystem habitat.

## FUEL

On site fuel production through natural processes is possible through biomass production, algae bioreactors for example. Problematic is the safety solutions and the buildings systems required to sustain this sort of production. Anyway, many possible uses of the building might not fit to host such services providers. The development of these technologies is for now limiting the actual use for this case but the experimenting and showcasing aspects can potentially be considered.

## WATER

The building's roofs surfaces are well extended, collecting a conspicuous rainwater runoff and canalizing it to the city rain water management system. With increasing precipitations connected to climatic change a big potential relies in the rainwater use. Naturally purified rainwater could replace mechanically purified water for building needs and uses that do not require drinking quality, preventing again the extra purification process. Economically speaking, as water is not a scarce resource in Sweden, monetary benefits may be erased by the costs of the system management, though the actual environmental footprint will be reduced.

## REGULATION OF WATER FLOWS

Water runoff delay is the main service the city could benefit from. How natural structures like soil and plants retain rainwater reducing the runoff helps relieving the urban rainwater management system. In particularly impermeable soil surroundings, due to extended construction, this service could improve the site resiliency, having to rely less on manmade problematic control systems

## MICRO CLIMATE REGULATION. SOLAR IRRADIATION CAPTURING AND SHADING

The current hard metal surfaces of the roofs concur to heat island effect on site and overheating in the indoor spaces of the building. Green roofs could capture the solar radiation reducing the surface temperatures affecting inside and outside temperatures. Lower temperatures and shading of roof sections concur to reducing heat gains of the building lowering the cooling demand. Shading of specific spaces filtering sun rays could also improve spatial qualities for specific building functions, providing different temperatures and light conditions.

## INDOOR AIR QUALITY REGULATION, FINE DUST AND CHEMICAL POLLUTANT CAPTURING

Numerous studies on air filtering and purification using plants have assembled a well established database of household plants favorable for indoor air quality improvement. Building could get relevant benefits in this area even though a more economical relevance of sustaining these plants life cannot be estimated completely. The filtering action takes place in the leaves so the quantity of pollutants absorbed, carbon dioxide removed and oxygen provided vary on the canopy extension. Other condition may affect the ability of plants to complete their function, like not optimal thermal

and light conditions or wrong water and nutrient supply.

## NOISE REDUCTION

Noise pollution on building site is not a big concern regarding outdoor spaces. Very limited vehicular traffic around the building and people presence doesn't create enough disturbance to the building as well. Main noise disturbance could be produced though by heavy rains showering the roofs, causing poor sound conditions in the spaces below. Special functions might need well controlled noise reduction solutions depending on the building use, like sound and visual installations rooms, silent areas and healing places. Green surfaces help also breaking down sound waves' bounce on walls for example, helping creating better acoustic conditions inside the building.

## POLLINATION

Pollination can be a very helpful service in association with urban agriculture or any type of cultivation as well as urban green features. Examples of using urban honey-bees over cities' roofs are quite diffuse nowadays. Care in identifying the exact place where placing hives, the possibility to check them and the contact they can have with people. Important is to consider the danger they carry with them for bee sting allergic and sensible individuals.

## OPPORTUNITIES FOR RECREATION & TOURISM

The attractiveness of an historical building like Artilleristallet in a city like Gothenburg could be a huge factor for tourism and recreational purposes. The uniqueness of a building culturally expressing the importance of nature and how people can benefit from it could potentially strengthen the socio-economical frame of the surrounding.

## ARTILLERISTALLET AS A SERVICE PROVIDING UNIT

Here now I try to identify how the specific building, its functioning and its features can potentially act as a service provider for the rest of the ecosystem it is located in. Relevant to notice, while all the services here can be seen in providing an habitat a may all be defined in habitat services, following the frame of the Millennium Assessment and TEEB document I tried to reuse their structure to separate clearly and easily the different nature of each service.

This again can be seen as a toolbox of opportunities the building provides for nature inclusion in its transformation. All these reverse services are considered then in the following design exploration.

### SURFACES AND STRUCTURES

Buildings in comparison to natural landscapes offer extreme amount of surface where living organisms could find place and concur to the ecosystem functioning. External and internal surfaces, roofs and pavements, walls and facades, vertical and horizontal. So much space is not used but instead available for supporting and hosting plants. Green roofs and outdoor plants can work also as a possible nesting site for seasonal birds.

### WATER PROVISION AND STORING

Natural water sources on site are constitute by meteoric waters. Sheltering from the weather is one of the main purposes of architecture. Protection from rainwater and its management requires specific characteristics and systems in the building but, at the same time, provide a possible resource to the building functioning itself. This resource can easily be shared in the building for human and nature needs. Food provisioning services could easily benefit from atmospheric water source as its quality matches their needs, reducing the amount of drinkable water provided by the city's system, avoiding not needed steps for the resource provision. The buildings systems can also act as storage assuring continuity to the provision of water for natural processes.

### SUNLIGHT EXPOSITION

As the volume of the building is quite compact, the exterior surfaces are quite homogeneous. Sun availability depending on the building is quite optimal, the shading elements though depend on the surrounding volumes. With that said, the building itself cannot affect much of the general sunlight availability on its external surfaces, but what can still be affected is the direct sun and daylight reaching the building's indoor spaces.

### NUTRIENTS PROVISION FOR NATURAL CYCLES

Building activities might result as well in material by-products. A typical consequence of human presence is solid "waste". In the case of restaurants, cafes but also partially in offices, food scrap constitute a relevant amount of the waste production. This specific matter can become, directly on site, part of the nutrient cycle. Buildings can provide nutrients as fertilizers for the integrated natural resources, overcoming the relative isolation from the natural ecosystem services reach.

### TEMPERATURES REGULATION

In regard to temperatures regulation and their control, buildings in general provide a relevant advantage for some species. Looking at the building potential, four different climatic zones can be identified for the possibility to include nature.

**Indoor heated** - Interior spaces of buildings in Sweden usually require a temperature of 19-20 C° for the comfort standards. These temperatures though are required only during the time the building is actually in use. Due to switching on and off of the heating system during winter, a fluctuation of temperatures from the desired minimum 19 C° will occur, slightly affecting the indoor climate. With this in mind the temperature profile of indoor heated spaces is easily definable and, with a small margin of uncertainty, is possible to asses a profile of biotopes that could be hosted in these spaces. This temperature profile is typical for commonly known household plants.

**Indoor semi heated** - Semi heated indoor spaces do not differ much from the heated ones. They could be heated to a lower temperature or receive indirect heating from other spaces. In this last case temperatures may be more unstable and oscillating depending on the adjacent spaces and exterior conditions.

**Indoor non heated** - Non heated spaces inside the building are characterized by a big annual thermal excursion and resemble more outdoor temperature conditions rather than indoor. The effect of the building envelope though stabilizes day and night variations while still protecting from meteorological events.

**Indoor-Outdoor** - Indoor-outdoor can be those kind of spaces that, depending on the external conditions and weather, can be temporary opened or closed. Green houses are a practical example for this case, as during summertime it is possible, and often needed, to open the external panels transforming into an exterior space.

### AIR HUMIDITY CONTROL

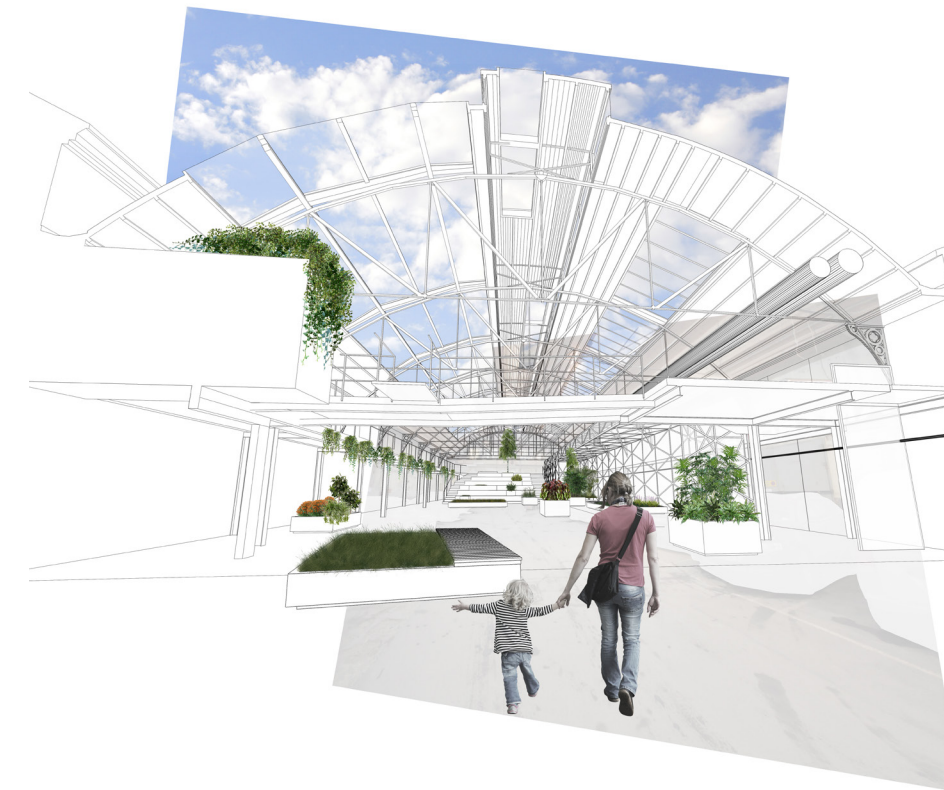
Another relevant feature of buildings is the control of air humidity. Buildings require to manage moisture level in the air as material decay and health hazard, moulds proliferation for example, may occur when this condition is ignored. Specific plants can benefit from this controlled environmental quality just like people.

### WIND AND STORM PROTECTION

People avoid extreme weather conditions through architecture and sharing the indoor spaces with other species translates this feature of the building to plants and animals. For this reason the building envelope can be considered itself a service providing unit for protection.



## 6. DESIGN



*“The light is differential within the comfortable two story space, as sunlight from above and behind casts a pattern on the wall and floor. The air inside is fresh. We feel a passing breeze and look to see a moving ceiling fan and open windows. The structure of the space is clear, much like a tree, as the forces of nature are expressed within the concrete columns and raw steel beams. The lobby’s wall have a subtle random pattern formed from wood with a bronze patina, and we see a small note about its origin from an old warehouse on this site. - we look forward across the native stone floor, and seeing our friend through the glass walled elevator, we smile. Another breeze, a warm ray of sun, and movement. Attributes of nature, inside.” (Kellert et al., 2008)*

## FUNCTION

It's important to specify first the function chosen to be implemented in the building and why. The decision made for the design part of my thesis is to develop an art exhibition space. This reflects the latest will of the previous property ownership, as it is the latest known opinion made public, the Detaljplan indication of public use for plot destination and my personal take on its best fitting function. Art and historical buildings, especially spacious and flexible ones in the city centre, can create a very intimate and profound relation being connected in one place.



figure 55. Photographic exhibition in November 2013.

The propensity of these spaces for hosting such a function is strengthened by the fact that temporary photographic exhibition have already taken place here, reaffirming the flexibility of these kind of venues.

The already mentioned Konsthallen and Hasselblad Foundation are thought to be hosted alternatively or contemporarily in the building. The nature of their exhibitions, changing over the year, are considered temporary and varying in needs. Office and storage spaces are, on my decision, limited or considered located in their current location and shared with Gothenburg's Konst Museum.

## CONCEPT

The concept of the design exploration I went through takes reference from the past history of the building and the flexibility it provides for new functions implementation. Two big open spaces to host a variety of activities having natural elements concurring to the quality of the place. They can relate the cultural values transmitted by buildings with the current artistic production somehow exhibiting themselves while exhibiting art. People experience of art gets enriched by the building itself. Nature presence in this case provides a third element of relation. As we've seen in previous chapters the benefit nature can potentially provide to buildings, if well planned and designed, can only improve the fruition of the building and art and, at the same time, these two can highlight nature presence on their own.

## CURRENT STATE OF THE TWO SPACES



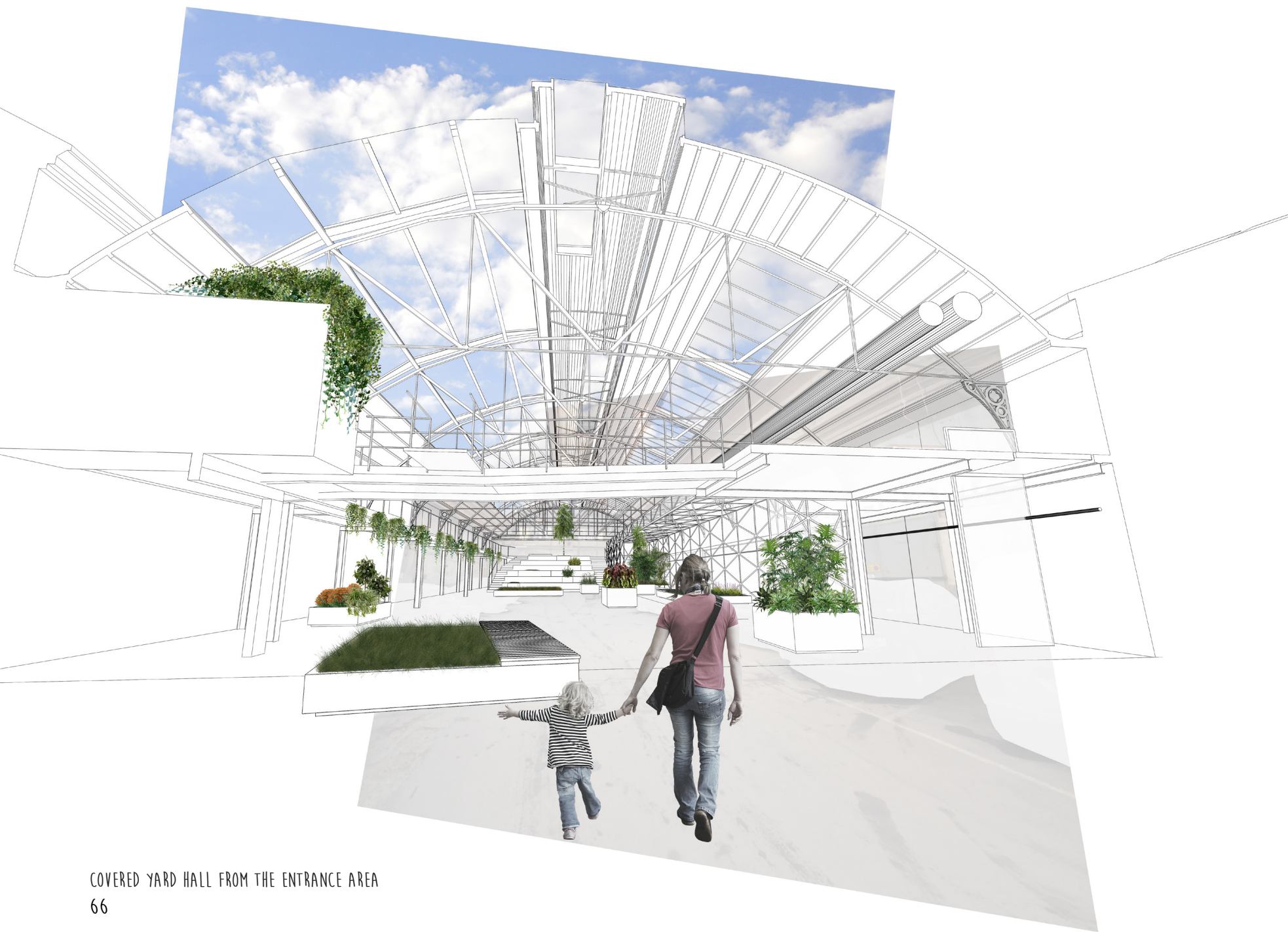
figure 56. Covered yard in 2013.



figure 57. Riding hall top floor in 2013.

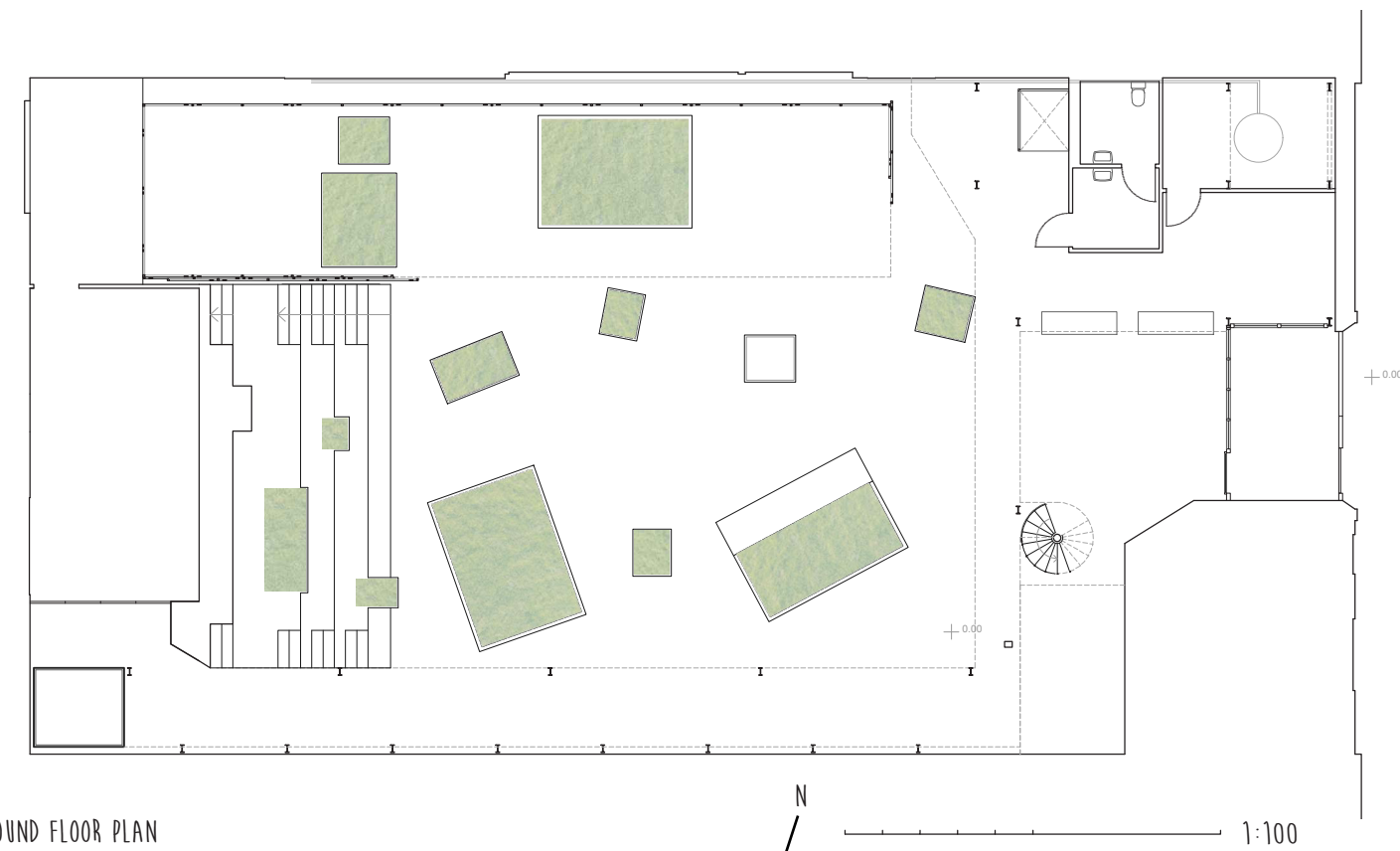
Connecting to the building history, the two spaces occupied by the current garage consist in the covered yard, originally open air space connecting the stable building and the riding hall, on the ground floor and the top floor of the riding hall. We have then two different spaces physically and historically connected that always related to each other but with different characteristics.





COVERED YARD HALL FROM THE ENTRANCE AREA

COVERED YARD GROUND FLOOR PLAN

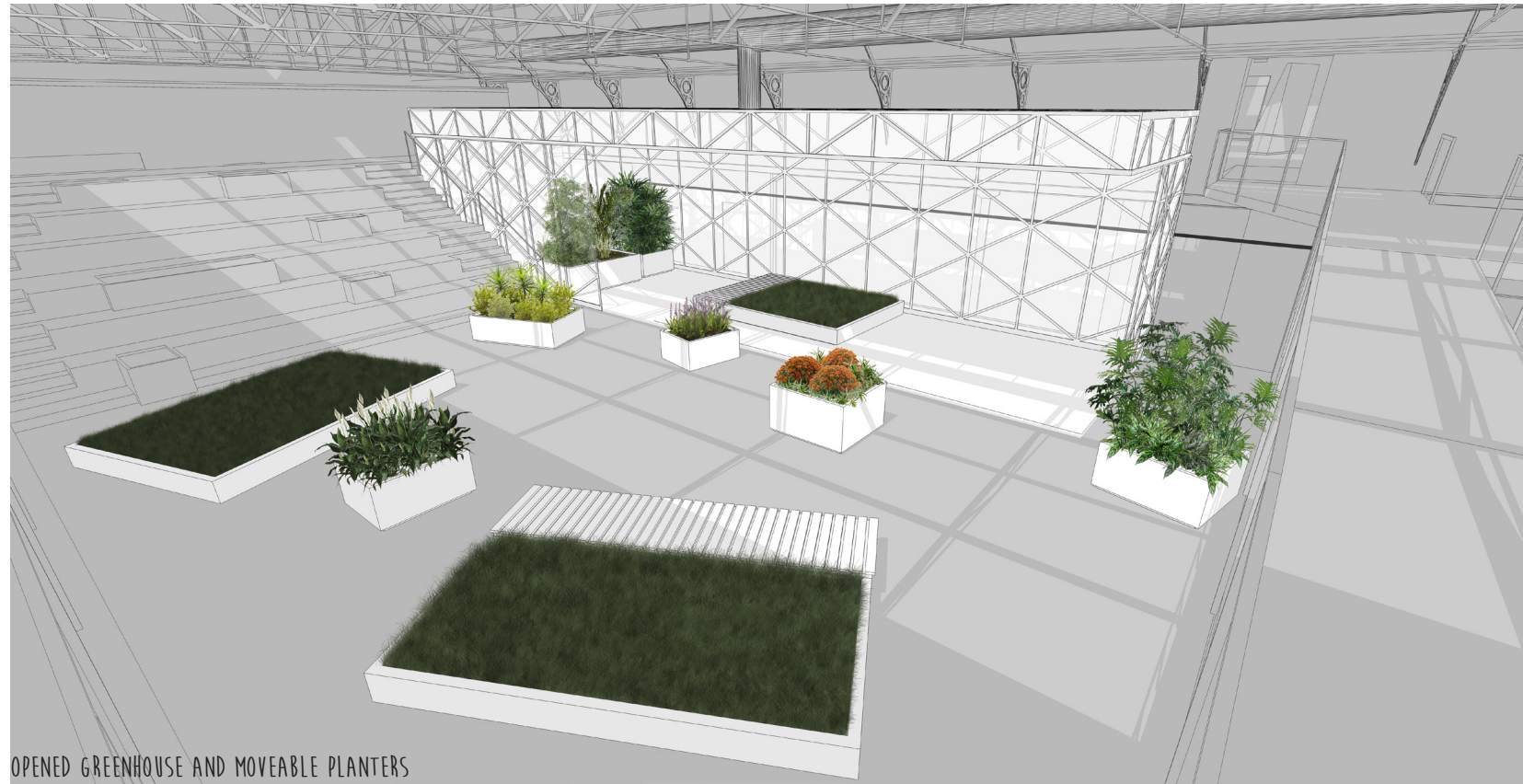


If we take the ground floor, the ‘covered yard’, we find here the only actual access to the premise. This means it has to function as entrance hall and welcome people into the building. This space consists of a big airy and light double height space with a roof structure and rough surfaces giving the main character to the space. It reflects an industrial attitude of the space with concrete

floors, plastered brick walls, showing technical systems, layering of small scale modifications determined by use needs and steel trusses supporting a skylights rich roof envelope.

The major relevant features needed to be preserved in the covered yard to maintain its character are the room volume, the roof structure and the

materiality. Keeping the space unite and flexible for use is the choice made to adapt the space to different activities. The central space is to be kept free allowing use flexibility and temporary installations.



OPENED GREENHOUSE AND MOVEABLE PLANTERS

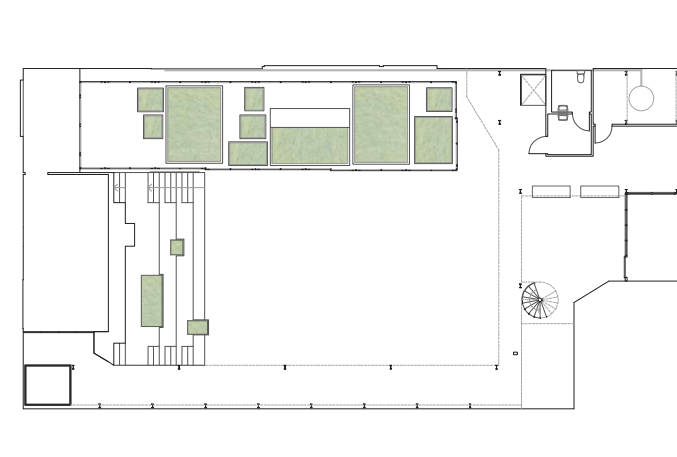
The main feature added to the ‘covered yard’ is a transparent volume. It stretches along the right side of the longitudinal central axis. This sort of indoor greenhouse with controlled internal conditions works in connection with seasonal varying conditions. Temperatures and humidity can be different than the rest of the covered yard being enclosed by the transparent surfaces made of lightweight plastic material with air chamber to avoid condensation and reduce weight loads. In winter, opening the longitudinal sliding panels, vegetation needing warmer temperatures can be ‘stored’ here and the space can function as a unique sensorial exhibition room with tropical-like

conditions. In summer planters can be moved out in the covered yard hall leaving the glass room free and available for other purposes. The possibility to leave open this transparent volume is also there, connecting it to the rest of the covered yard. If needed textile curtains can be drawn surrounding the volume limiting and diffusing the direct sun light reaching in to protect exhibited objects and providing a different sensorial space separation.

#### BUILDING-NATURE BENEFITS

The planters in this big central space concur mainly to enhance the quality of people’s experience, making the nature presence felt and plants and grass being main part of the sensorial experience. Some of this planters could also host some air purifying and oxygen providing species.

The greenhouse, the ample volume, the controlled climatic conditions and the available light together with the possibility to store rainwater in here represent the features nature can benefit from the building itself.



‘WINTER’ ALTERNATIVE LAYOUT



FREE GREEN HOUSE LAYOUT

1:200



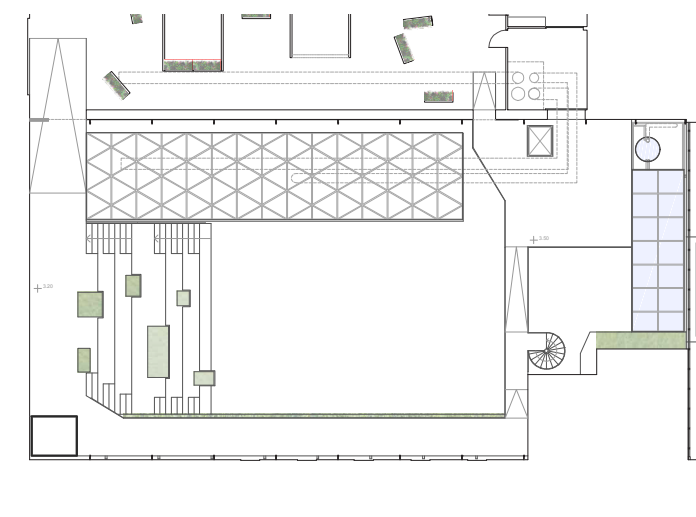


STAIRS/TRIBUNE SEEN FROM THE BALCONY

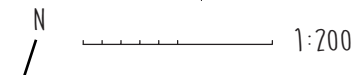
In the far end opposite to the entrance, where today's car ramp provide access to the riding hall space, the connection to the riding hall first floor is preserved but modified to function for people accessibility and not vehicles. A stair ramp functioning also as tribune facing the big open central space provide audience space for attending speeches, lectures and projections, as rolling screen could be hanging from the ceiling. The design of the tribune features grass and plants integrated in the stairs' surfaces. These stairs will work with this double function as well as providing sitting/resting place and hosting under it technical and storage spaces. Reaching the its top, on the right the main access to the riding hall is preserved with the possible addition of a door to allow sound and temperature independency. On the opposite side, in the left corner, an elevating platform allows accessibility and mayor material vertical movement without enclosing any volume. In the design the existing car ramp is removed but if technical and structural limitations are found, it is possible to keep it reducing the storage space underneath the stairs.

The double height provide the possibility of creating added floor area and connections to experience the space and the building features while increasing the exhibiting space. Looking at the history of the building, balconies and ramps have already been used in the building and, at a certain time they were almost going around the whole space. The proposal take this as a reference. From the top of the stairs/tribune, an elevated corridor stretches back towards the entrance, on the opposite side of the greenhouse, for then crossing the

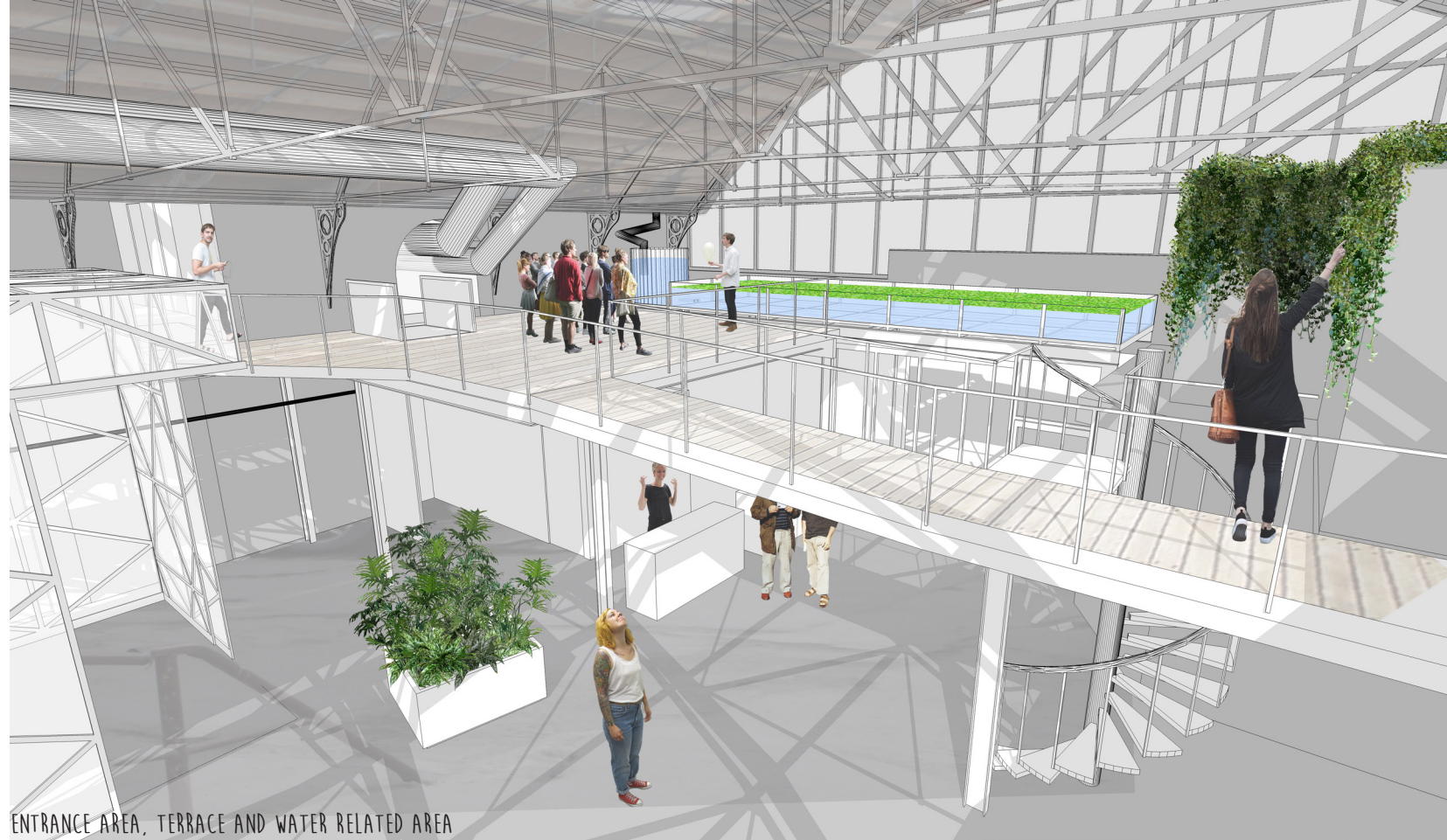
space and reaching its top. This sort of balcony embraces the central open space strengthening its importance and centrality while adding exhibiting area as art works can be exposed all along. Pots and planters, hosting plants that do not demand high amount of light, can find place on the edge of this suspended passage and vegetation could climb down towards the ground floor. This suspended pathway will end connecting to the riding hall room with a new opening made in the building's wall before the greenhouse.



COVERED YARD FIRST FLOOR PLAN







ENTRANCE AREA, TERRACE AND WATER RELATED AREA

Looking now back at the entrance area, it is now defined by the pre-existing volumes occupied by shops on the left and the just mentioned footbridge reaching the riding hall first floor spanning over in front of the actual door of the building. On the right side is then placed the reception, toilet and technical spaces. Over these spaces additional floor area is so created. Here a water storing tank is placed in connection to the technical and wet areas below. From her in fact the major buildings systems regulate ventilation and water distribution to the rest of the space. Rainwater collection from the roofs surfaces and gutters is in fact easily manageable from this position. Water filtering and storage, air heat exchange and electrical systems are carefully handled and showcased using transparent surfaces when possible. Ducts, pipes and cables expand from here to the rest of the building and are kept clearly visible matching the rough industrial character of the existing.

The transparent water tank is a relevant part of the building system, providing water for taking care of the vegetation and toilets flushing as well. The presence of water in this part of the building is also highlighted creating a sort of aquarium/pond area on the first floor level, spacing over the entrance airlock and right along the glazed part of the facade on Magasinsgatan. Hydroponic cul-

tivation and water plants are introduced here and an aquaponic system, requiring the presence of fishes, could also be discussed for possible implementation. The slab supporting this aquarium over the entrance is made transparent to let light pass through and visitors to perceive its presence. On the other side, the volume occupied by the shops is kept and provides surfaces to place other plants growing down the wall.

While being indoor and protected from the weather, the space has never functioned as a properly heated zone but just as ventilated one. In its transformation it can be discussed if heating such a big space reaching the 19-20 C°, usually required for proper indoors, is worth the energy investment. Semi-heated area, obviously with controlled air properties, deriving heat from neighbouring spaces and limited heating requirements may be a better fit. Indirect heating sources, heating storing solutions and renewable heat sources can help this space to act as a winter garden space. The reduced temperatures, especially relevant in the winter season, imply different characteristics for the exhibition space. The nature of showed art work will vary during the year as season dependant space conditions allow specific art materials to be exhibited in order to be properly preserved from decay.

#### BUILDING-NATURE BENEFITS

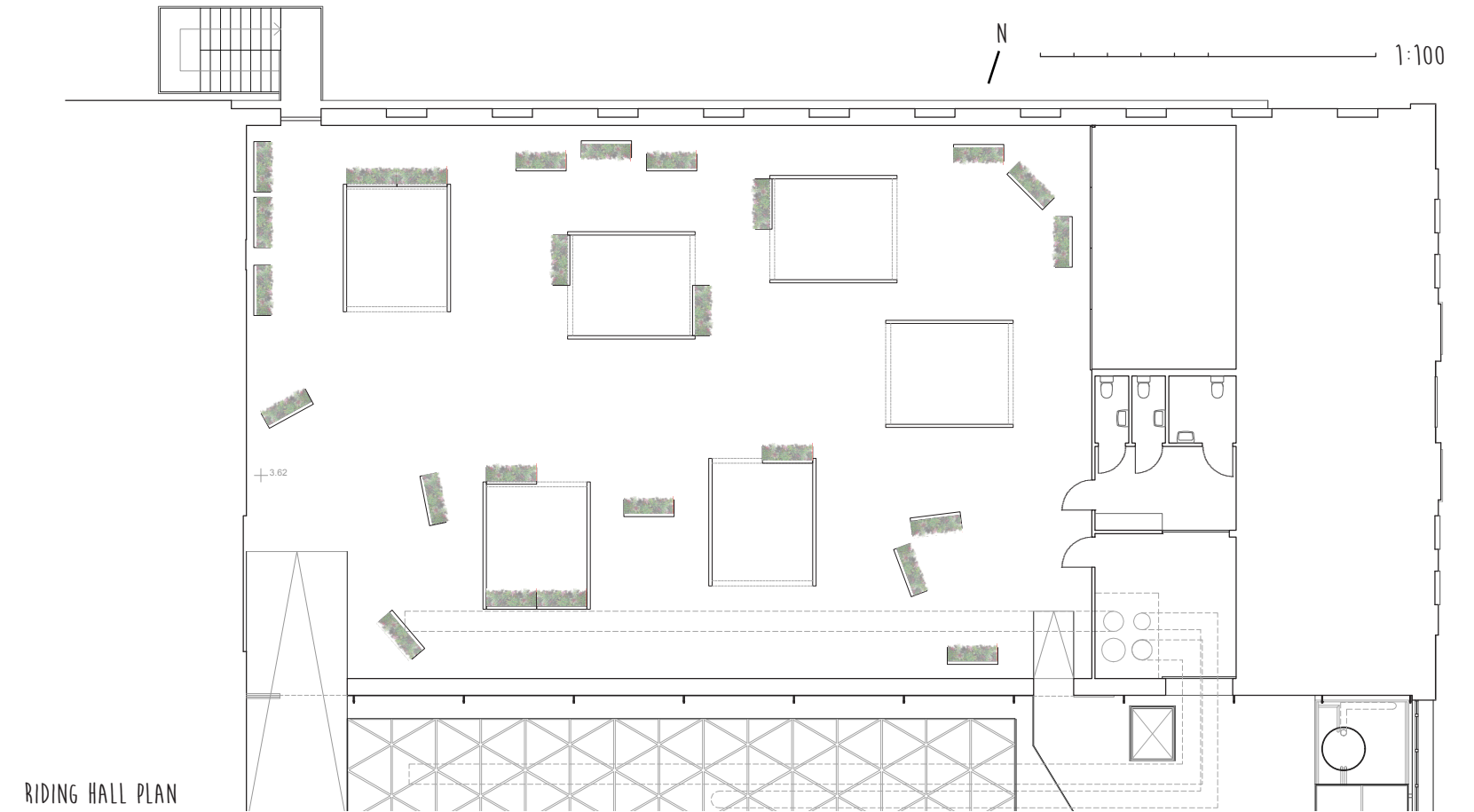
While the staircase can refer more to the already mentioned ground floor atrium area for the benefits taken from nature, the integration of natural elements in the upper floor provides people more of a visual connection as plants in pots and in the water pond cannot be really experienced by touch being more difficult to reach even though they provide variety of species.

The water presence does provide another resource giving the possibility of creating a different indoor habitat. The controlled climatic conditions plus the water availability due to the rain collection system make possible for such species to grow and live inside the building. Hydroponic culture or water plants can be hosted so in the building while giving people another way to interact with natural elements. In fact, like the presence of living nature, elements like water generally affect people minds in a positive way.





RIDING HALL EXHIBITION SPACE



RIDING HALL PLAN

Coming to the riding hall now, we already mentioned the two accesses, the main one from the top of the top of the stair/tribune, and the secondary one right over the reception and toilet zone of the covered yard where the suspended pathway ends. The space of this room is treated differently from the other. If the covered yard acts more like an entry hall, this volume works functionally better for exhibiting art. Here the now completely

empty rectangular room becomes an exhibition space that tries to maintain at most its flexibility and adaptability. Taking as reference the functions hosted in the past in this space, namely riding hall, stable, warehouse and then garage, a system of free moving elements articulates the space. On the east side of this hall, next to the secondary access close to the entrance of the building, are placed some accessory spaces. Storage room for

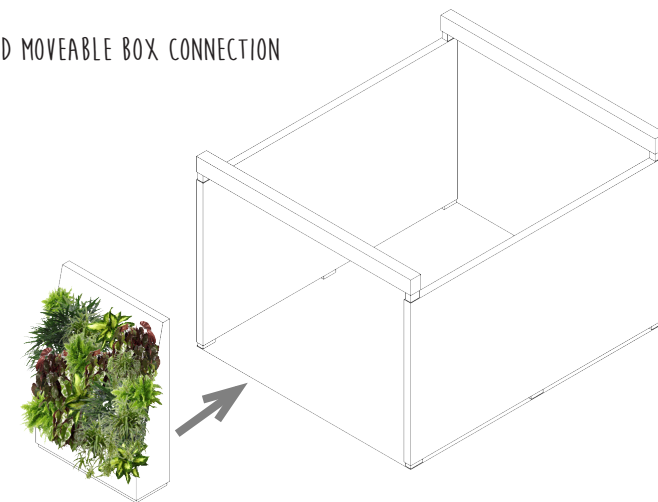
exhibiting support parts and temporary artwork, toilets and technical spaces. A bigger restroom is located here nearing the technical room. The technical room here could be the place for the heating system having in/out ducts in the roof and the connection to the solar energy systems. All the technical systems are visible here as well with ducts and cables going around the rooms along the walls and hanging between the metal trusses.

The stable horse boxes are taken as inspiration as 'art boxes' are designed to define spaces and support artworks. The openness and free space of a riding hall or a garage to allow movement are preserved making these 'art boxes' movable. It is so possible to re-arrange at will rooms and partitioning depending on the exhibition hosted. These boxes though are flexible themselves. They're composed by two fixed wall parts while the other two can be attached depending on the need. These partitions that can be connected at will consist the major natural feature in this indoor space. They consist in movable green walls having plants on one side and a clean surface on the other giving freedom to define spaces with vegetation or without while just turning it around. The limitation of fixed natural elements in this space is pursued to not affect the needs of the exhibition purpose. The green colour of plants in fact may act as disturbance in the display of paintings and photographs. Therefore the moveable green partitions are thought to not limit the space with their presence allowing to arrange which direction green surfaces face.

MOVEABLE GREEN WALL



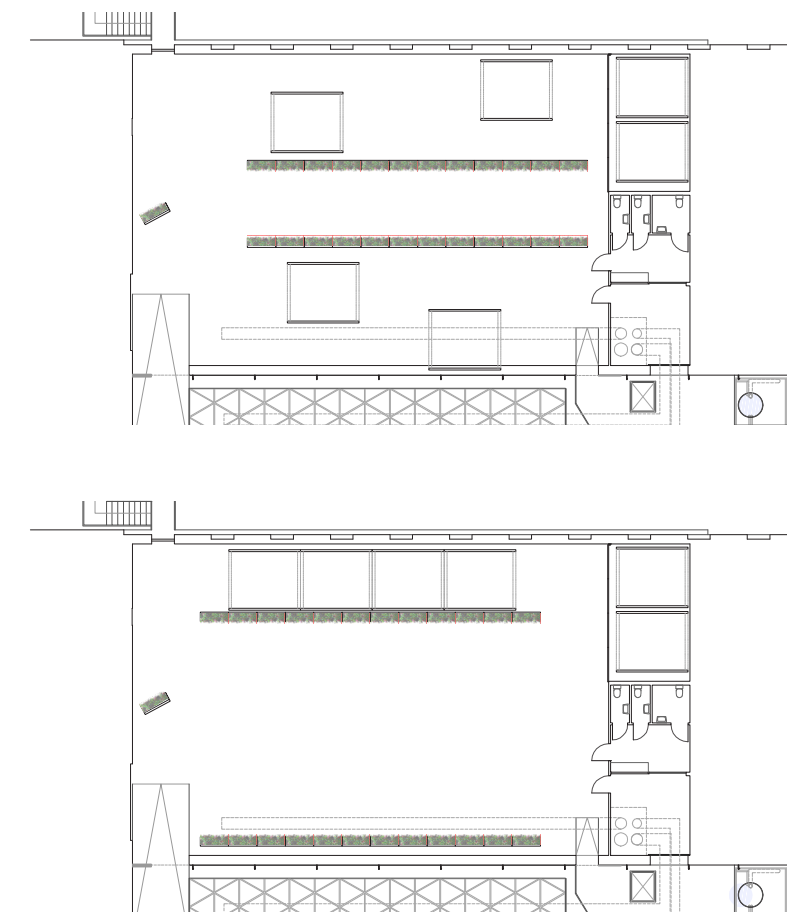
GREEN PARTITION AND MOVEABLE BOX CONNECTION



PARTITIONS + BOX COMBINATION EXAMPLES



BOXES AND PARTITIONS LAYOUT EXAMPLES



1:200



## ROOFS

A big concern for the inclusion of nature but also for a quality indoor environment is the amount of light in the spaces. Due to the preservation of the historical values, the original metal trusses and the overall shape of the building will not be changed in modifying the roofs.

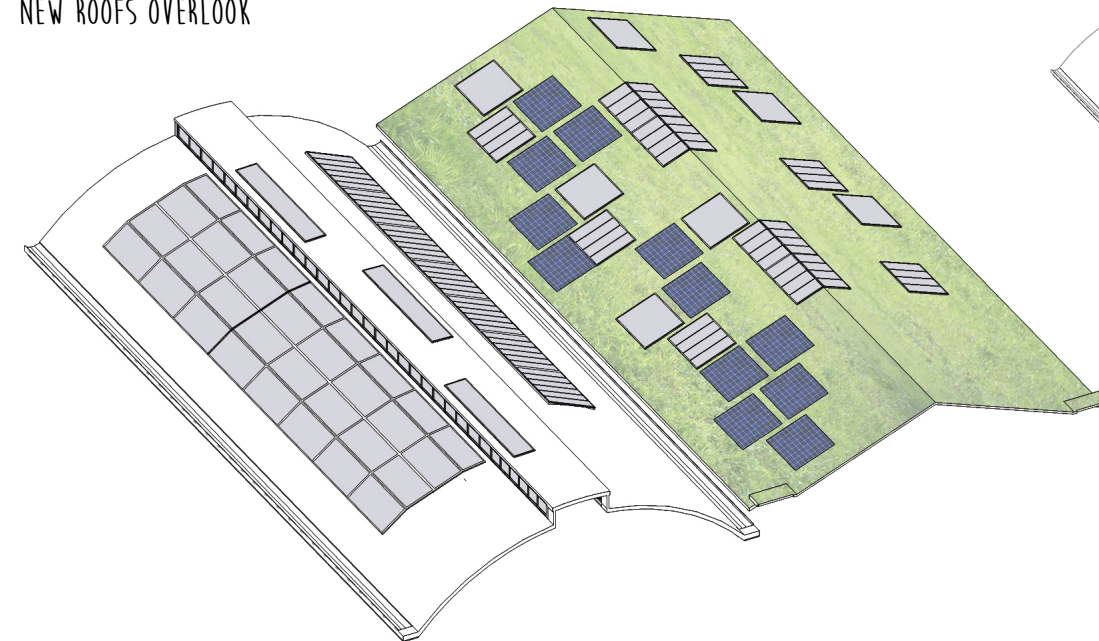
While daylight in the covered yard may not be a big problem, as the existing glazed parts of the facade and the roof allow quite good illumination conditions, direct sunlight can represent an obstacle for the vegetation. Studying the sunlight availability and how it reaches the indoor space, placing the vegetation on its right (north) side, were the green house is located, may address the problem or at least part of it. For this reason in the proposal skylights and glazed roof portions are added to improve life quality for plants. In concomitance an interior textile shading system is placed for filtering the light coming through the roof when needed.

For the riding hall the roof modification will be more relevant while still keeping the same shape and the showing trusses. The slab though will use newer material improving the performances, insulating the roof with lightweight solutions. Opening will be added to the already existing glazed surfaces, increasing the skylight numbers and area. This will allow an improvement in daylight level and sunlight income, reducing the need of artificial light. A textile shading system will be added, like the one described for the covered yard. An important possibility given by the roof replacement of the riding hall, adding to the increased thermal and structural performances, is to transform the now metal sheet covered exterior surface. Over this new structure a green roof can be easily introduced. We already went through the benefits vegetation and soil structures bring to buildings roofs but for the specific case benefits are numerous. Depending on the thickness of the growing media, rainwater retention can reach high levels, close to 75-80% drastically reducing

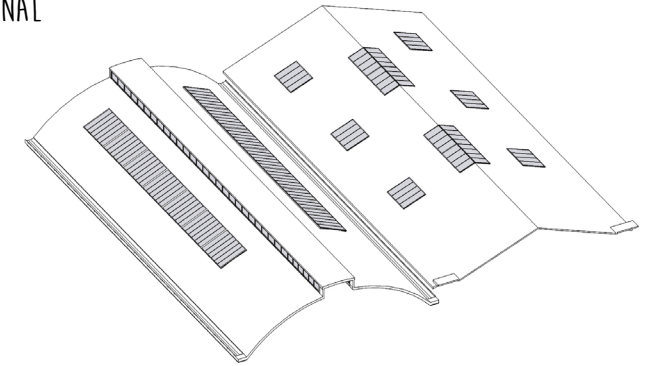
the stress on the waste water management. A large vegetative roof like this can provide also ecological benefits, providing habitats for migrating species and pollinators are just a couple of them. The effect of vegetation will reduce the temperatures reached by the surface, improve the sound insulation against rain and hail, and qualitatively improve the cityscape of the area. This roof in fact is clearly visible from the surrounding buildings but also from street level and the nearby parking lot/square. A green roof over an historical building is a strong intervention but the intention of this design is to investigate the possibilities available of the specific case. Adding to this is also the possibility to include solar technologies. Solar panels for water heating and pv-cells can be placed on the south facing slope of the roof. Energy harvesting solutions can benefit the building reducing the ecological footprint of its functioning.

The real conditions of the structure are though unknown so, if the replacing of the entire slab keeping the metal trusses should not be carried out due to the stability of the building or its actual non suitability, the addition of skylights could still happen, not affecting too much the design of the indoor spaces. An alternative option with less invasive intervention on the building envelope is developed on the side.

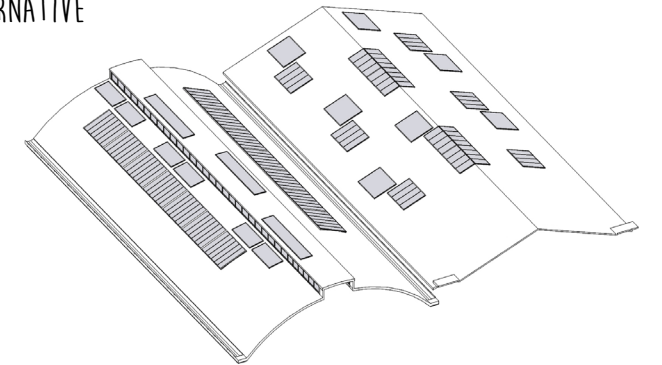
## NEW ROOFS OVERLOOK



## ORIGINAL



## ALTERNATIVE



— N

SPECIES SELECTION

Important in shaping these spaces is the selection of species to include in the building. Precedence in selecting plants has to be given to those that physically enhance the air quality. Oxygen production, fine dust capturing and air pollutants filtering are the principal processes through which enhancing the indoor environment. Other species though concur more to the softer and more undefined sphere of aesthetical qualities or relate to the Swedish landscape. Very relevant in collocating these plants is the light availability each spot the design offer for inclusion of vegetation. Even though a complete study with qualitative technical data on daylight and sunlight availability

is not carried out in this work, the general collocation of plants of the design sees the use of species less dependent on direct sunlight where it is not possible to achieve optimal conditions for others. The not fixed position of most of them allows also to temporarily move planters and pots for better exposition when needed.

The plants distributed in the building will range in a selection of air filtering and purifying species that do not require tropical climate conditions. Natural air filtering allow to reduce pollutants such as benzene, formaldehyde, trichloroethylene, ammonia, xylene and toluene (Wolverton, B.C., Douglas, W.L., Bounds, K..1989). Here is shown a range of building fitting filtering plants.



Aglaonema



Chlorophytum comosum



Dracaena fragrans



Ficus benjamina



Nephrolepis exaltata



Phoenix roebelenii



Anthurium andraeanum



Chrysanthemum morifolium



Dracaena reflexa



Ficus elastica



Nephrolepis oblitterata



Rhapis excelsa



Chamaedorea



Dieffenbachia



Dypsis lutescens



Hedera helix



Philodendron bipinnatifidum



Sansevieria trifasciata



Epipremnum aureum



Liriope spicata



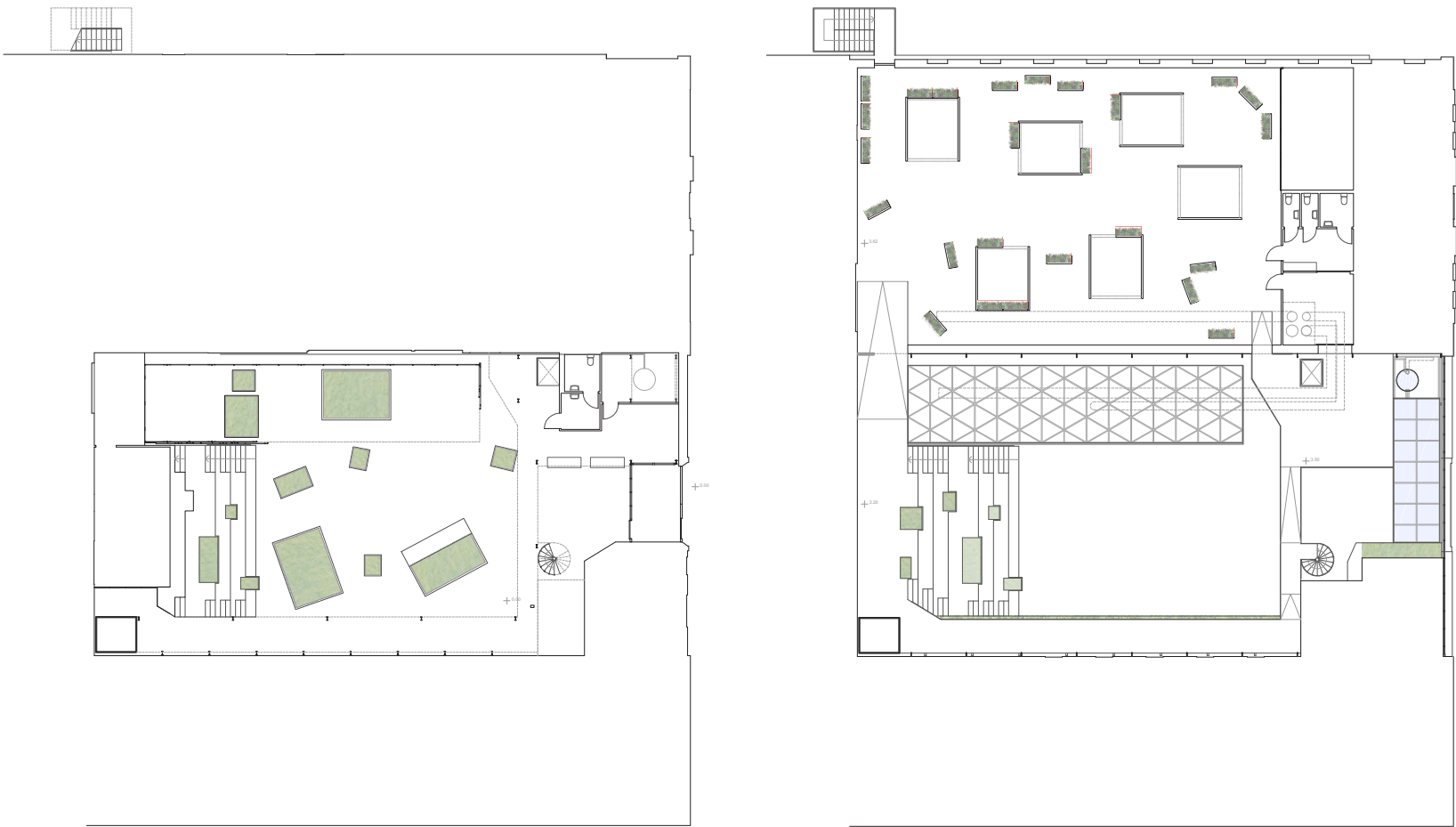
Philodendron domesticum



Spathiphyllum

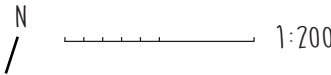


BUILDING'S DRAWINGS

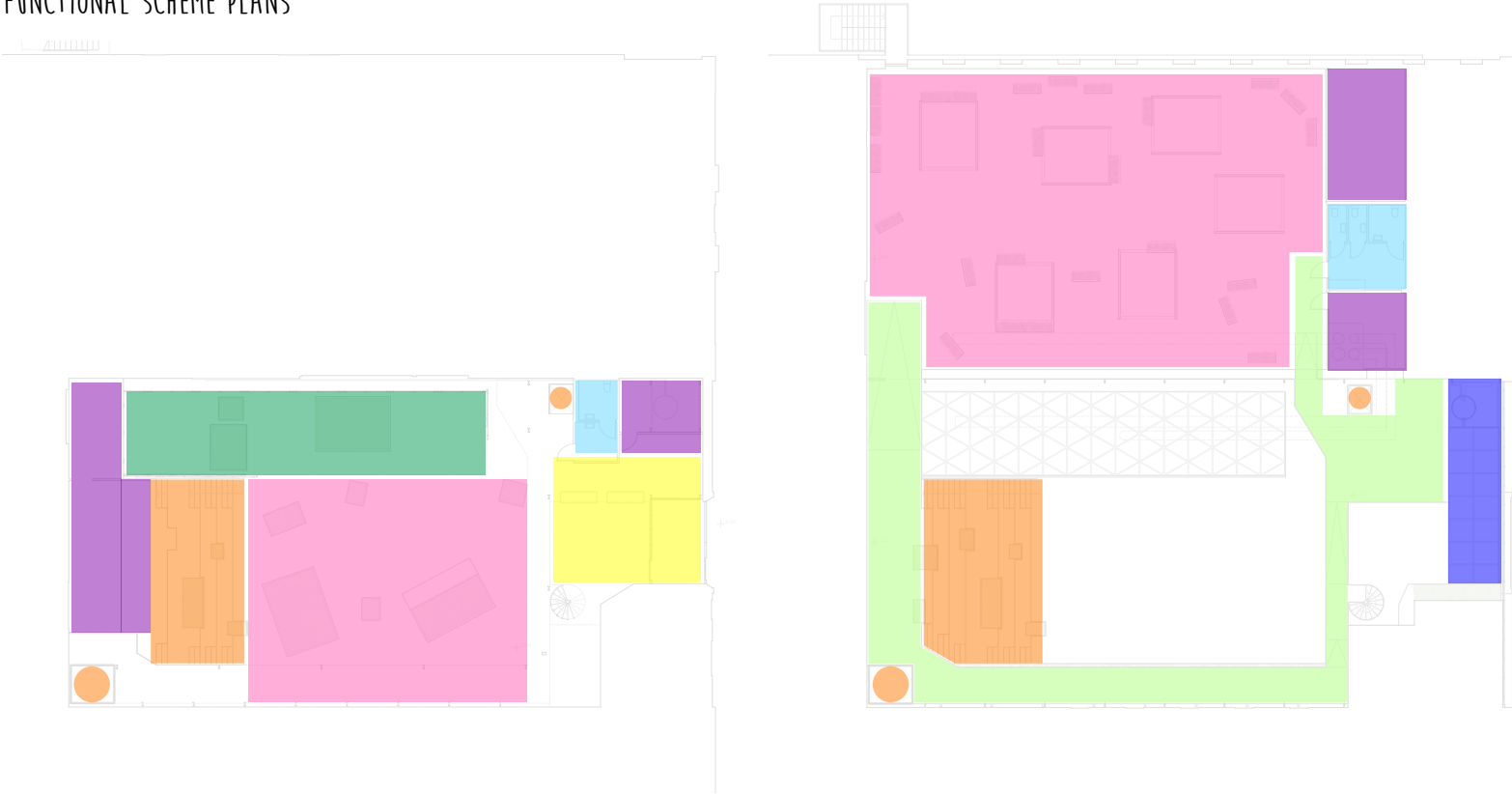


GROUND FLOOR PLAN

FIRST FLOOR PLAN



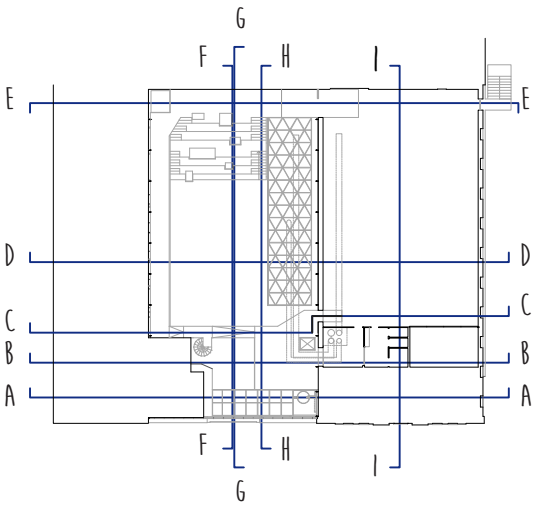
FUNCTIONAL SCHEME PLANS



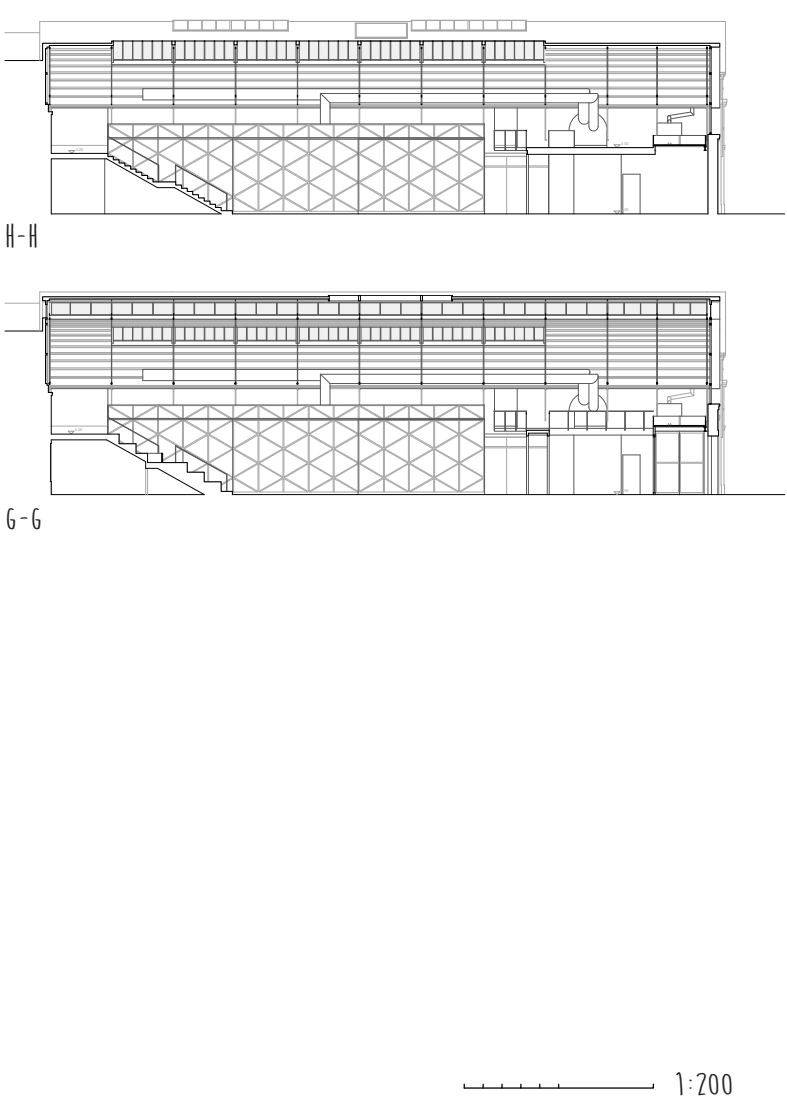
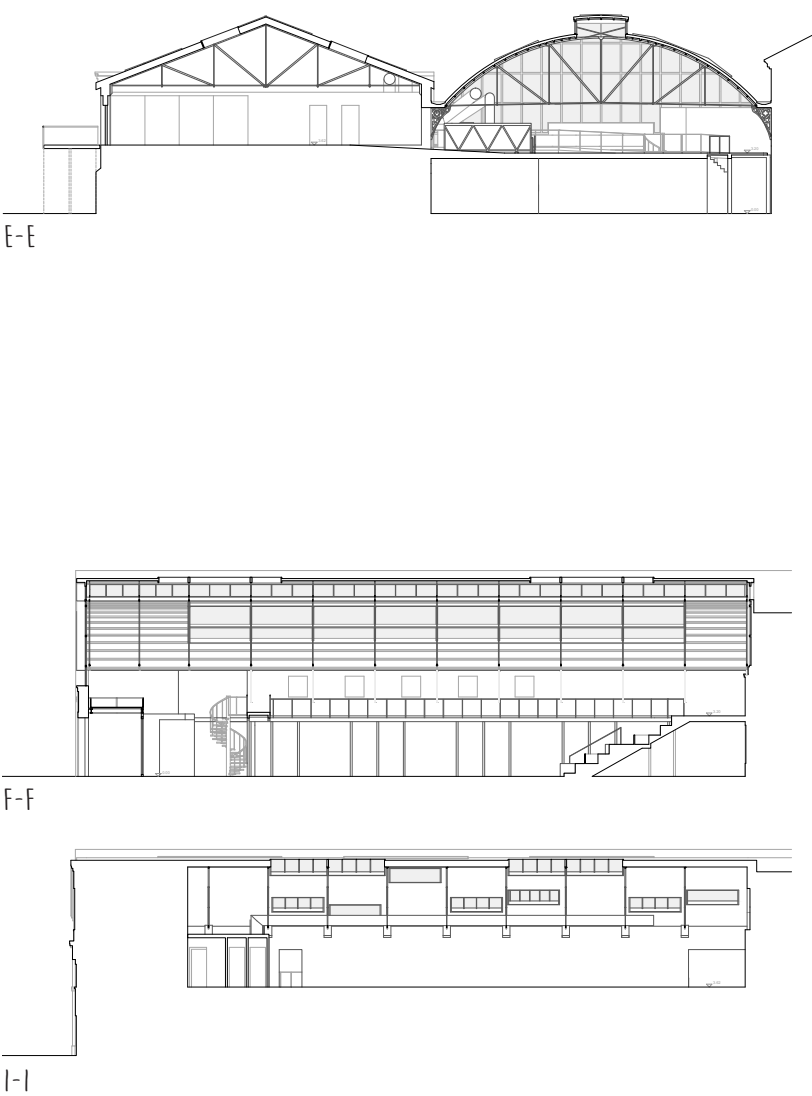
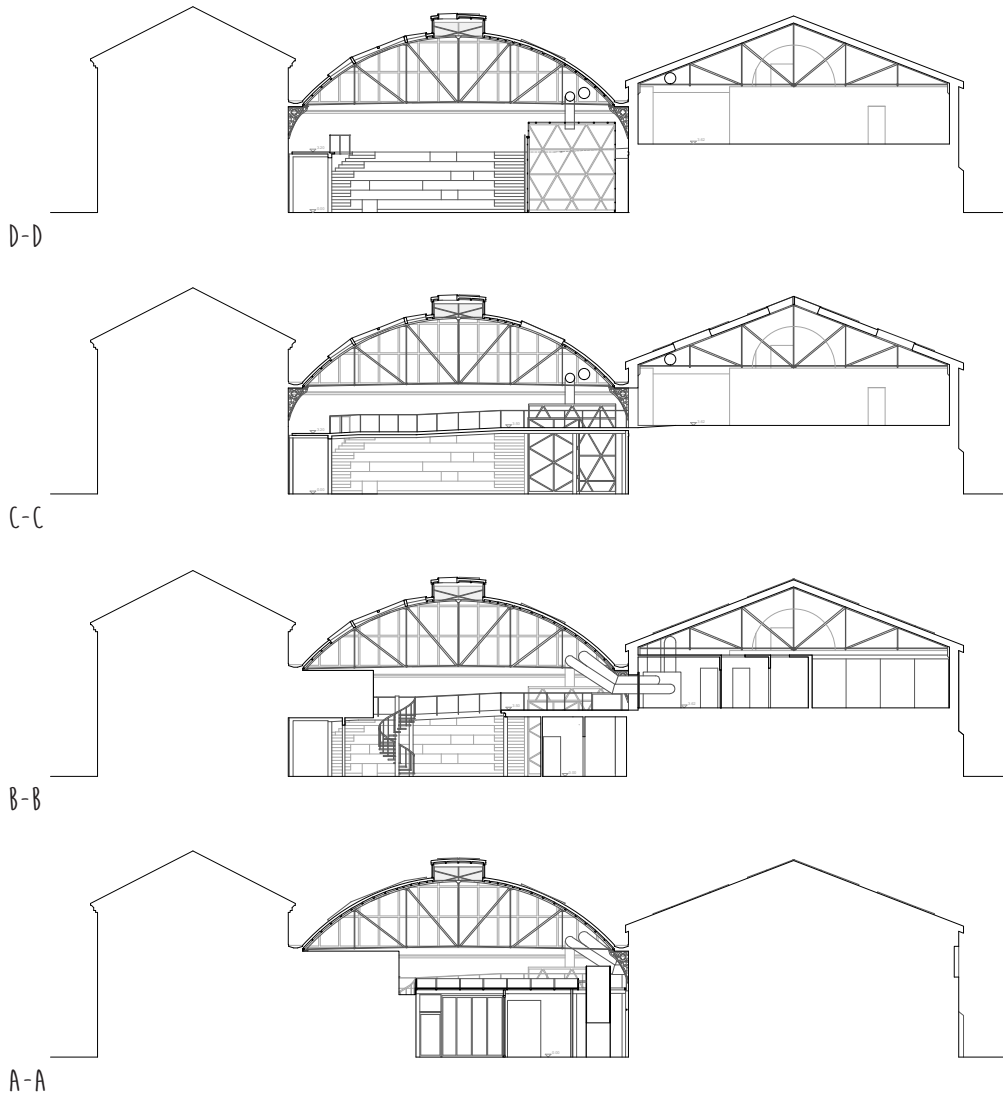
- Entrance and reception
- Exhibiting space
- Vertical connections
- Green house
- Circulation and balconies
- Storage and technical spaces
- Restrooms
- Water related zone

SECTIONS

FUNCTIONAL PLANS



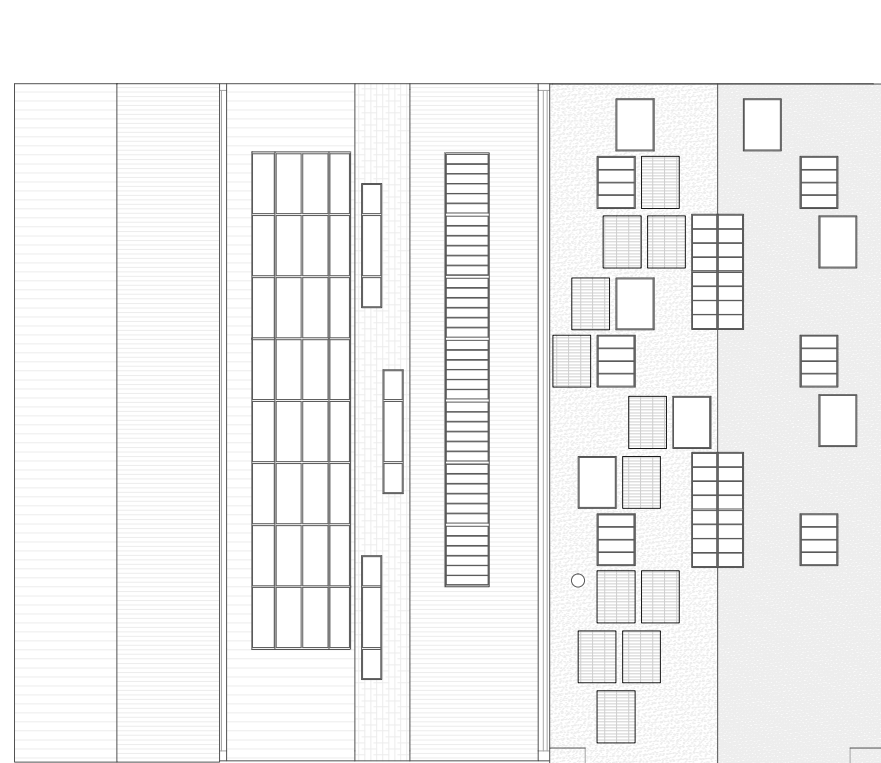
N 1:200



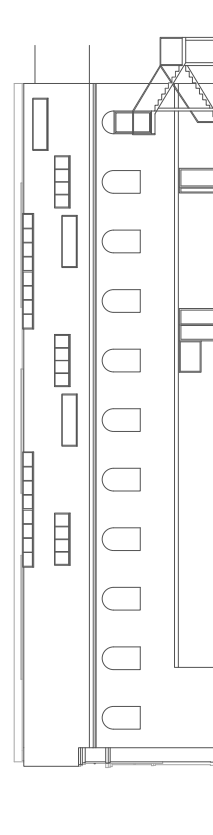
1:200



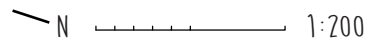
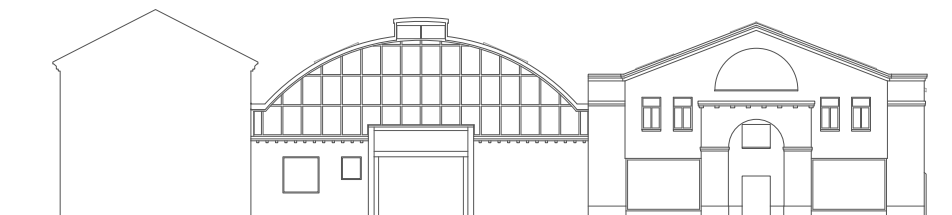
ROOF PLAN



NORTH FACADE



EAST FACADE



## MATERIALS SELECTION

The materials used for the building modification are also important for the experience of the place and the relation between new and old. The use of transparent surfaces helps keeping visual connection between spaces, let natural light in and to perceive the existing materials. Added floor area is thought as wooden planks flooring, supported by wooden beams and pillars when possible, otherwise steel in order to minimize dimensions. Wood with its texture gives another way to connect through senses to nature and biological matter. When possible it is preferred to use it as less chemically treated as possible. All the structure of this added floor space shows underneath its construction and the technical systems grid reaching around the building. Light structures and detached from the existing walls when possible give the proposal a reversible character, not preventing a future transformation or modification. Flexibility in the long term is so considered too in the design process. Simple

design and simple construction techniques mean it is easy to disassemble too. Materials can be reused realizing the intervention as well as after its life in the building.

## ACCESSIBILITY AND FIRE

To complement the design it is important to mention that accessibility is provided throughout the whole building, ramps, elevating platforms, doors and toilets provide complete autonomy for everyone. Fire security is also thought through. Even though technical safety systems are not considered, fire escape routes rules are respected positioning one emergency staircase in the north-west corner of the riding hall where an emergency door is already present. The 30 meters distance range is therefore respected.

## OTHER SPECIFICATIONS

The decision not to define any café area in the building comes from my own interpretation of the case. Mobile furniture can be placed to

host small bar and catering activities as some space is available in the ground floor opposite to the reception area for this. The temporary nature of the exhibitions and the richness of buzzing bars and restaurants in the area and even in the building complex, made me not consider this as a major fixed design function. A coexistence and collaboration with surrounding businesses is then possible, allowing to arrange events or even developing in time a stable in house café.

I also didn't exceed the plot area in my exploration other than positioning the needed emergency staircase. The neighbouring parking lot/square could be considered as a resource for the building transformation but the extended influence this space have in the public urban space made me limit the building to its borders. Plans for the square are being discussed by the property owner and the rich social and economical activity of the area might also be affected by an intrusive architectural intervention.

To sum up the design exploration to bring on for a discussion on the topic, the inclusion of nature in the building is achieved in 5 ways. Pots and stabile planters, moveable planters interacting with climatic spaces, in combination with exhibition supports, roof surfaces and water surfaces related. Even though the latest one as not been fully developed in the design, the other methods used in the interior spaces combine with the functions and affect them in their own way. Matching with the need for flexibility the moving green elements spread the presence of nature throughout the whole building and change with it.

Plants and vegetation ended up being the limited part of nature included. The case availability of only indoor spaces, excluding roof surfaces, and the constraints dictated by the function and the materiality of the building allowed only flora to be included. Thoughts about aquaponics, implying presence of fishes in the water for aquaculture, surfaced but ethical concerns about nature life quality in such limited space made me discard this option.

## ECOSYSTEM SERVICES IN THE BUILDING

Looking back now at the research previously done and the tool box of ecosystem services identified for a possible nature inclusion, it is possible to sum up the actual bundle of these services the design exploration has developed.

### WATER

In case of a green roof the property of the rainwater collected change in comparison of a standard roof. Constructing and layering properly a vegetative soil structure allows a first filtration of dust and small particles. In the design this service is considered but its effect is almost irrelevant to the functioning of the building. If a complete water purification system would be implemented this would be more relevant but as the city grid already provides easily, and more effectively, potable water with high quality standards this becomes irrelevant. The filtration effect of a green roof in this case helps only considering the relevant better condition of the system managing the collected water storage and distribution, reducing the amount of solids to be taken care of.

### REGULATION OF WATER FLOWS

The green roof works at its best in the design reducing the rainwater runoff on site. Depending on the thickness of the soil structure it is possible to achieve an important reduction, in the range of 70-80% for some cases, of the rainwater to be taken care of by the building or the city drainage systems. In a very impermeable soil area like the city centre of Gothenburg this does reduce effectively the footprint of the building but doesn't achieve a big change in the general context. In fact to be effective on an urban scale this strategy should be implemented in way more buildings and sites of this area.

### MICRO CLIMATE REGULATION. SOLAR IRRADIATION CAPTURING AND SHADING

Another benefit taken from the green roof is the reduction of the surface temperatures of the roof area. This not only acts against the heat island effect, reducing the temperatures of the air surrounding the building in the summer, but provides insulating effect for the building envelope. This thermal property is effective only in warm months but it helps in reducing the cooling

demand of the building providing a lower surface temperature and protecting against irradiation the compact part of the roof envelope. Lower cooling needs would mean lower energy consumption and relatively smaller dimensioned air conditioning systems, reducing expenses for the building management.

### INDOOR AIR QUALITY REGULATION, FINE DUST AND CHEMICAL POLLUTANT CAPTURING

As already mentioned in the previous paragraphs, big relevance is given to the ability of plants to affect indoor air quality. Of all the ecosystem services considered, the ability of some species to provide oxygen and remove pollutants from the air represent the most powerful in the design. The effect of air quality on people is a very important trait of a possible shared landscape. While it can be hard to quantify the effect of the total amount of plants in this regard as it connected to the total leaves surface, it is possible to assume that with specifically selected plants distributed all over the building this service can really make a difference in the quality of people experience.

### NOISE REDUCTION

The noise and sound disturbance reduction is a positive effect the total amount of vegetation provides to the spaces. In large open spaces with the original surfaces not thought for a public use of the rooms the acoustics can be problematic. Especially in a design like the one developed where the openness and unity of the large spaces is preserved and considered important for its functioning, the help plants give in managing the absorption and braking down of sound waves is highly regarded. To measure in advance this effect though might not be easy, especially with so many moveable parts and features rearranging the spaces in infinite configurations.

## PSYCHOLOGICAL BENEFITS

In addition to the ecosystem services, the benefits provided to the psychological dimension of people experience can also be discussed. It is impossible to quantify this effects but we are able to foresee how the presence of nature in the design can provide a qualitative improvement compared to an aseptic building. The ability of vegetation to interact with human senses defines a new character of the spaces. From smelling the scents of different plants, touching a tree bark or a grass bed, to seeing the plants climbing down the walls or to closing up on a flower and, by extension, hearing the water flowing and dripping for the irrigation system or the water pond. A full body experience of nature is provided in the building and a connection with the natural elements can be seen as possible. The ability of this kind of space to affect people's perception of nature and the relation they have with it cannot be assured but a step in this direction is taken within the design. A relaxing atmosphere becomes anyway the result of a building where plants and natural elements shape the spaces.



To conclude this thesis work my reflections will be mainly over the design exploration result and my learning experience over the thesis process.

## 7. DISCUSSION AND CONCLUSION

### EVALUATION OF THE DESIGN RESULT

#### HOW IS NATURE INTEGRATED IN THE BUILDING?

The inclusion of nature in the explorative design is consequential of the different facets the case provides. Physical structures and conditions for example provide the opportunity to place vegetation over the roof surfaces or providing favorable temperature and light conditions. Functional requirements on the other hand provide even more intimate connection between nature and people. Artwork exhibiting supports became green walls, and the major central atrium characterization defining the atmosphere of the exhibition hall is given by the moveable planters articulating and changing the space over time. The function so gives more potential for inclusion.

As functions could be seen as the life of buildings, a variation in use provides different possibilities. Having defined the art exhibition space had, as a consequence, larger freedom of strategies to incorporate vegetation in the building. Can we say that the function is what control the possibility of sharing the historical built environment with the rest of nature? To a degree yes, but the function is partially consequential from the building itself. Historical buildings especially, require for best fitting use in their transformation in order to conserve their relevancy and values. The success of nature inclusion in historical buildings is so dictated in great part also by the building itself, its constructions, its conditions and its nature.

## PERSONAL EVALUATION OF THE RESULTED DESIGN

The design exploration might not have been the part of this thesis work on which I spent most of the time but it embodies all the aspects of the thinking process carried through the research and analysis part while also representing an evolution of my own position on the matter of nature inclusion in historical buildings. The knowledge acquired in the process perhaps made me take some decisions I wouldn't have considered before the start of this thesis. If I had to re-design again the building I would also probably make some different ones. The whole design process has been a fluctuation between more prudent and conservative positions, and some stronger and daring ones. The result finds itself in the middle, failing to take one or the other direction but maybe trying to make the most out of the two opposite positions. This is reflected in the overall look of the design. I consider its biggest weakness the gene-

ral tentativeness of trying to show a governing principle to define the whole building. It may appear as a combination of strategies for nature inclusion rather than a whole design process. Different ways to integrate plants in different spaces and as practical as possible. I'm also questioning myself if this reflects more my difficulty of finding a concept for the transformation of existing buildings or if the way I deal with them is instead finding for each case a specific dimension and attention to its characteristics and peculiarities. A position that always inspired me in dealing with historical heritage is letting the building express itself and not to try to force my own identity through the design disrupting its existing identity. I don't know if this is what I've really done in this work but it something that will shape my thinking going forward trying to review this work and having it in my experience baggage.

## REFLECTIONS ON THE DESIGN EXPLORATION RESULTS

In exploring a possible design to investigate the 'symbiosis' between human and natural landscape this work was characterized by a cautious approach. Having to deal with delicate objects such as historical buildings require all the decisions and modifications to be fitting and caring of a wide range of aspects. Material conservation plays a big role in limiting the design possibilities. Not only the presence of nature, in this case plants, can physically damage surfaces and structures, but the modification of the physical properties of the indoor air quality provides a big threat to original materials. Air humidity and moisture level on and inside surfaces and structures can be seen as the most contrasting aspect for the coexistence of natural elements and historical buildings. The need and reliance of plants on water imply that the more plants are present in a certain space, the higher the humidity will get.

Having had some time to reflect on the design outcome, I can see now how these cautious approach led me to a final proposal aiming to be possible and more realistic than what was probably needed for supporting the starting idea. A bolder design placing more emphasis on the con-

ceptual relevance of combining nature and historical buildings would have probably accompanied better a wider context reflection. The design solution developed is also characterized by a variety of different elements concurring to include nature in the building through different strategies but the overall development and design of the nature presence could be seen rather disconnected and missing some unity. Developing a more daring concept, directed to strengthen the overall nature presence could have solved this partial disunity of green elements in the building.

Given this general reflection on a possible different development this work could have taken I also have to state that the exploration developed offers still some elements useful for reflecting on the difficult combination of this two often opposed world. A more prudent use and collocation of plants in an historical building represent for me a not too extreme example of integrating nature in the built heritage, somehow mediating between opposite positions. In the eyes of more conservative and tradition oriented architects an extreme example of the 'symbiosis' can receive a completely different perception than the one of the more visionary and experimental ones.

As resulted from the final seminar and the public presentation of this work, ideal would have been

to develop three different designs, each with a different approach to be able to compare and reflect on how and if this new human-nature relation can find place in the historical heritage context and become part of it. The different scenarios provided would have for sure enriched the material to reflect upon. A different structure of the workflow in developing this thesis would have been needed, defining from the start what the outcome should have been.

I think the broadness of the topic and subjects involved didn't let me foresee a bigger picture of what the optimal design exploration should have proved and maybe having developed the design process throughout the whole semester would have helped me. The importance of the process itself though for my own learning experience made me take this direction. Learning how to undertake a broad research process, to elaborate the knowledge acquired through it and to understand of the importance of a structure in the work process are the background aspects I consider important for my personal growth during this work. I can see now looking at the big picture of this semester the importance of seeing things in a structure, understanding the overall process, helps to identify at which stage to take important decisions to achieve the best results.





VIEW FROM THE SQUARE/PARKING LOT

Another way to develop further the design is to consider the neighboring square/parking lot part of the transformation. The possibility this space provide to take the nature presence inside the building and expand it towards the outside, could be seen as an extension of the symbiosis principle to a wider context. It could translate the sharing of the indoor spaces to the outdoors. While developing the square cannot be considered itself dealing with the Artilleristallet building, the importance of an urban transformation of the connected square could pretty much the building's façade facing it. The transformation of this public space bring another input to the redevelopment of the building, expanding its uses and modification possibilities.

There are two reasons that prevented me from intervening on this site in the design process.

First is the owner's unknown plans for the site. Wallenstam AB was considering using the building right pending on the square plot. The modifi-

cations a building will create in the configuration, use and activity of this valuable urban space could dictate a completely different scenario than having the parking lot remaining this vibrant informal square. Having based the design exploration on a real interest of transformation and concrete conditions for its possible implementation, the uncertainty regarding the near future plans made me consider to not go through an in depth design. It would have probably been more possible, feeling more fitting, having developed a more conceptual and bold design diverging and having more freedom from the grounded contest considered instead.

The second reason is my understanding of the character of the square. As my interest in this part of the city made me think over the last one and an half year about how can this place can be transformed, I came to a point where I think no formal architectural design should be undertaken in its overall modification. The transformation history of this whole area is defined by single

separate interventions slowly developing the site in its present form. The Artilleristallet building as well shows this character. For the square small modifications shaped the space, and they are still happening. Defining a complete design for its transformation seems to me risky, as it could denaturize the sense of place. I believe so that it's incredibly hard to produce a suitable design in the common sense of the term. Defining more a scenario of small strategies might be the way to take care of the future of this place, adapting and interacting with the changing needs of the stakeholders involved. The presence of nature can so be considered, and must be, in the future plans. The urban symbiosis idea could so expand from the building adapting to the local context. Seeing this process of landscape sharing as a wide concept, able to transform the whole urban context and not strictly defined by and for a specific site, can find place in this part of the city creating a unique combination of historical, architectural and social values.



## RESEARCH ANSWERS

Going back to the research questions now, did I answer them?

What can the coexistence of nature in human habitat bring to the evolution of the historical built environment?

What are the viable methods of habitat sharing regarding the scale of an historical building transformation case?

How to include nature in buildings' life in the West Coast Sweden context, and more particularly, to the case of Gothenburg's Artilleristallet transformation?

Starting from the last one as it is the easiest to answer as the design exploration has to focus on being the actual answer, I would say yes. But my initial tone on the regional context in phrasing it reveals an intention to investigate more the possibility of a generalization of intervening on historical buildings in the Swedish west coast region. After going through the literature and exploring the possibilities for the building, the regional

context seems more like part of building cases and backgrounds. The contingent specifics of each case though is what became more important to my eyes. The significance of the specificity of every case when dealing with historical buildings, already discussed in contemporary conservation, is reaffirmed for the particular case. The nature inclusion approach strengthens this specificity as the possibilities and strategies for the use of natural elements are affected by the context of application and its unique features. The resulting architectural example is then crafted with its own identity derived by the identity of the place itself and its characteristics.

For the second question, identifying instead an approach on how to deal with achieving a symbiosis in historical buildings between human and natural sphere, is driven by the knowledge acquisition of all the elements taken in consideration. Acquiring knowledge so helps to identify contingent strategies and design solutions to pursue a symbiosis in the urban landscape. Different cases produce different results, just like ecosystems vary depending on the very local conditions.

Keeping open boundaries in framing the idea of architectural design provides freedom to interpret and adapt theories and concepts for every peculiar context of application in order to reach the best suiting result.

The first question is a very wide one. During this work I developed my own thoughts trying to track down what nature can potentially bring to historical buildings. Dealing with heritage and its defining traits, means dealing with our own identity. Having plants and animals as part of our buildings' life can be seen as a manifestation of the present identity of our society. Every contribution to a cultural field, like historical built environment in this case, is a manifestation of the entity that creates and sustains that field. By integrating nature in historical building, aiming to live symbiotically in the landscape, we manifest the idea of being in relation with and founding part of nature. It is not nature bringing elements to the evolution of the historical landscape, we develop it by manifesting our belonging in the natural world.

## LEARNING PROCESS

The learning process has been challenging. Feeling disoriented and overwhelmed by the topic I chose to develop at times and the work load I put in this final job as a student left me nearly completely exhausted. I think it was an important learning experience and made me understand a lot about how to handle and lead a task in the proper way.

Having gone through all the research process, reading and appropriating a variety of literature and material to support the nature inclusion in historical buildings, in my mind it became obvious the reasons why to work for an inclusive landscape and I think the whole thesis work modified my perception of things. Some aspect may need further development but I feel my effort in expressing the work done was always there.

As mentioned in the introduction, the research process is carried out trying to grasp many concepts from various fields. As my main focus was trying

to connect and relate interesting facts and notions, their selection is based on my personal view and I hope to have been able to communicate them in an effective and proper manner. Relevant contributions treated in this work might be underdeveloped, missing or criticized as the concern was mainly to find elements that could come together from an interdisciplinary research.

Even though the design exploration is developed with a careful approach to resources use, economical concerns and limitations are not considered as starting point that might affect the actual implementation of the design. Own made assumptions, as thought through and evaluated within the goals of a scholastic work, may have missed some reality based concerns but the non ultimate status of the design exploration, and its flexible and adaptable nature, might be further developed and adapted. Functional program defined on my own may lack specificity of a real task as well due mainly to the difficulties in trying to get in contact with the stakeholders.

While I do take a lot of knowledge out of the research, analysis and design parts, the overall experience is what gave me the most to reflect on how to develop myself as a professional and individual. There are certain aspects I'm happy about and I know the things and skills I have to learn and try to improve for the future. Understanding more the scope of a task would be the first together with a better conceptualization of a design task. Finding better ways to relate broad conceptual topics and small scale issues in order to strengthen the soundness of the result of an architectural work.

Knowing what has been put behind all this work and my effort, I feel also rewarded by having accomplished this result even if not perfect and without mistakes still. I hope I will be able in the future to come back on this work and use it as a tool to reflect on my personal development looking at what I was able to produce at this stage of my life, as I think it's one of the most interesting aspects a thesis work can provide for the future.



# REFERENCES

## BOOKS

Almusaed, A. (2011). *Biophilic and bioclimatic architecture*. Springer.

Chapin, F.S. III, Matson, P.A., Mooney, H.A. (2002). *Principles of Terrestrial Ecosystem Ecology*. Springer.

Chiodo, S. (2011). *Estetica dell’Architettura*. Carocci.

Herklint, M., Sedenmalm, S., Lind, O. (1992) *Göteborg: Kulturmiljöer av riksintresse*. Länsstyrelsen i Göteborgs och Bohus län.

Jokilehto, J. (2002). *A History of Architectural Conservation*. Butterworth-Heinemann.

Jung, C.G. (1971). Psychological Types. *Collected Works, Volume 6*. Princeton University Press.

Kellert, S. R. (1997). *Kinship to mastery: Biophilia in human evolution and development*. Island Press.

Kellert, S. R., Heerwagen, J., Mador, M. (2008). *Biophilic Design*. Wiley.

Ljungberg, V. (1924). *Göteborgs befästningar och garnison*. Litogr. A.-B.

Maas W., Thackara J. (2010). *Green Dream: How Future Cities Can Outsmart Nature*, NAI Publishers.

Mostafavi, M., Doherty, G., Harvard University Graduate School of Design (2010). *Ecological Urbanism*. Lars Müller Publishers.

Munoz-Vinas, S. (2012). *Contemporary Theory of Conservation*. Routledge.

Odum, E.P. (1971). *Fundamentals of ecology*. Saunders.

Peterson, G., Allen, C.R., Holling, C.S. (1998). Ecological Resilience, Biodiversity, and Scale. *Ecosystems, 1*. Springer.

Roszak, T. (1992). *The voice of the earth*. Grand Rapids.

Ruskin, J. (1849). *The Seven Lamps of Architecture*.

Schultz, P. W. (2002). Inclusion with nature: The psychology of human-nature relations. *Psychology of sustainable development*. Kluwer Academic.

Walker, B., Holling, C. S., Carpenter, S. R., Kinzig, A. (2004). “Resilience, adaptability and transformability in social–ecological systems”. *Ecology and Society, 9*. The resilience alliance.

Wilson, E. O. (1984). *Biophilia*. Harvard University Press.

Wright, J.P., Jones, C.G., Flecker, A.S. (2002). An ecosystem engineer, the beaver, increases species richness at the landscape scale, *Ecosystems Ecology, 132*. Springer-Verlag.

Zecchi, S. (1991). Spengler. *Estetica*. Il Mulino.

## ARTICLES

Boyd, J., Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics, 63*. Elsevier.

Conn, S. A. (1998). Living in the earth: Ecopsychology, health and psychotherapy. *The Humanistic Psychologist, 26*. Routledge.

Daily, G.C., Alexander, S., Ehrlich, P.R., Goulder, L., Lubchenco, J., Matson, P.A., Mooney, H.A., Postel, S., Schneider, S.H., Tilman, D., Woodwell, G.M. (1997). Ecosystem Services: Benefits supplied to Human Societies by Natural Ecosystems. *Issue in ecology, 2*. Ecological Society of America.

Evans, G. W., McCoy, J. M. (1998). When buildings don’t work: The role of architecture in human health. *Journal of Environmental Psychology, 18*. Elsevier.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., Holling, C.S. (2004). Regime Shifts, Resilience, and Biodiversity in Ecosystem Management. *Annual Review of Ecology, Evolution, and Systematics, 35*. Annual Reviews.

Luck, G.W., Daily, G. C., Ehrlich, P. R. (2003).

Population diversity and ecosystem services. *Trends in Ecology and Evolution, 18*. Elsevier.

Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., Dolliver, K. (2009). Why is nature beneficial?: The role of connectedness to nature. *Environment and Behavior, 41*. SAGE.

Wolverton, B.C., Douglas, W.L., Bounds, K. (1989). *A study of interior landscape plants for indoor air pollution abatement*. NASA.

## WEB PAGES

Löfvenberg, A. (10-06-2013). *Därför säljer Harling ut sina klassiska kvarter*. GT Expressen. <http://www.expressen.se/gt/kultur/darfor-saljer-harling-ut-sina-klassiska-kvarter/> (retrieved March 2015)

TEEB glossary. <http://www.teebweb.org/resources/glossary-of-terms/> (retrieved April 2015)

UN-Habitat (2012). *Manifesto for cities*. <http://mirror.unhabitat.org/categories.asp?catid=708> (retrieved September 2014)

Weatherbase website. <http://www.weatherbase.com/weather/weather-summary.php3?s=21520&cityname=Gothenburg%2C+Sweden&units=> (retrieved March 2015)

Windfinder website. [http://www.windfinder.com/windstatistics/goteborg\\_save](http://www.windfinder.com/windstatistics/goteborg_save) (retrieved March 2015)

## OTHER SOURCES

Australia ICOMOS (1999). *The Burra Charter*. <http://australia.icomos.org/publications/charters/> (retrieved April 2015)

ICOMOS (1964). *The Venice Charter*. [http://www.icomos.org/charters/venice\\_e.pdf](http://www.icomos.org/charters/venice_e.pdf) (retrieved April 2015)

ICOMOS (1994). *The Nara Document of Authenticity*. <http://whc.unesco.org/archive/1994/whc-94-conf003-inf8e.pdf> (retrieved April 2015)

Boverket (2012), *Boverket’s Building Regulations*. <http://www.boverket.se/en/start-in-english/publications/2012/building-regulations-bbr/> (retrieved March 2015)

Browning, W.D., Ryan, C.O., Clancy, J.O. (2014). *14 Patterns of Biophilic Design*. Terrapin Bright Green. <http://www.terrapinbrightgreen.com/report/14-patterns/> (retrieved April 2015)

English Heritage (2008). *Conservation Principles Policies and Guidance*. <https://www.historicengland.org.uk/images-books/publications/conserva->

tion-principles-sustainable-management-historic-environment/ (retrieved April 2015)

Haemig, P.D. (2012). *Ecosystem Engineers: wildlife that create, modify and maintain habitats*. ECOLOGY.INFO #12. (online review) <http://www.ecology.info/ecosystem-engineers.htm> (retrieved April 2015)

MEA (2005). *Ecosystems and human well-being*. <http://www.millenniumassessment.org/documents/document.356.aspx.pdf> (retrieved April 2015)

Miljö- och energidepartemente (1998). *Miljöbalk*. <http://www.notisum.se/rnp/sls/lag/19980808.HTM> (retrieved April 2015)

Socialdepartementet (2010). *Plan- och bygglag*. [http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Plan-och-bygglag-2010900\\_sfs-2010-900/?bet=2010:900#K8](http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Plan-och-bygglag-2010900_sfs-2010-900/?bet=2010:900#K8) (retrieved April 2015)

TEEB (2010). *The Ecological and Economic Foundation*. <http://www.teebweb.org/our-publications/teeb-study-reports/ecological-and-economic-foundations/> (retrieved February 2015)

Lindholm, M., Lange, J. (2013). *Artilleristallet: Kulturhistorisk beskrivning och inventering*. Lindholm Restaurering AB.

## FIGURES LIST

figure 1. Mika Kohan. *Street Art by BLU in Belgarde, Serbia*. [© and courtesy of Mika Kohan]. Via Street Art Utopia, <http://www.streetartutopia.com/?p=8105> (retrieved May 2015)

figure 2. User: Astrodyum. *Curitiba From Barigui Park* (Curitiba, Brazil). [public domain]. Via Wikimedia Commons, [http://commons.wikimedia.org/wiki/File:Curitiba\\_From\\_Barigui\\_Park.jpg](http://commons.wikimedia.org/wiki/File:Curitiba_From_Barigui_Park.jpg) (retrieved May 2015)

figure 3. Studio Invisible. *Beirut Wonder Forest*. [© and courtesy of Studio Invisible]. Via Designrulz, <http://cdn.designrulz.com/wp-content/uploads/2012/05/Beirut-Wonder-Forest.jpg> (retrieved May 2015)

figure 4. Metro Vancouver. *Ecosystem services*. [© and courtesy of Metro Vancouver 2015]. <http://www.metrovancouver.org/services/regional-planning/PublishingImages/EcosystemServices.jpg> (retrieved May 2015)

figure 5. SCAPE / Landscape Architecture PLLC. *Oyster-tecture, Gowanus Canal*. [© and courtesy of SCAPE / Landscape Architecture PLLC]. Via Archdaily, <http://ad009cdnb.archdaily.net/wp-content/uploads/2012/01/1328067286-scape-image-1.jpg> (retrieved May 2015)

figure 6. Atelier Jean Nouvel. *Musée du quai Branly, Paris, France*. [[© and courtesy of Atelier Jean Nouvel]. <http://www.jeannouvel.com/en/desktop/home/#/en/desktop/zoom/paris-france-quai-branly-museum1> (retrieved May 2015)

figure 7. Paul Langrock, Zenit/laif/Redux. *Vancouver's thousand-acre playground, Stanley Park includes lakes and beaches* (Vancouver, BC, Canada). [© and courtesy of Paul Langrock, Zenit/laif/Redux]. Via National Geographic, <http://images.nationalgeographic.com/wpf/media-content/photos/000/823/82350-cb1406933633.jpg> (retrieved May 2015)

figure 8. Graham Ballantyne. *Tanner Springs Park* (Portland, OR, USA). [https://creativecommons.org/licenses/by-nc-nd/2.0/]. Via Flickr, <https://www.flickr.com/photos/grahamb/6048230417/in/photolist-adsLbM-6Mxt2S-8yVp-pW-2Asit5-4iBZvG-6MjCLu-4u6MQZ-advAfu> (retrieved May 2015)

figure 9. User: Gallardo. *View of the northern façade of the Royal Palace of Caserta, seen from the monumental fountain passeggi* (Italy). [Public domain]. Via Wikimedia Commons, <http://upload.wikimedia.org/wikipedia/commons/7/7d/CasertaReale.jpg> (retrieved May 2015)

figure 10. Michal Osmenda. *Generalife gardens in Alhambra, Granada* (Spain). [http://creativecommons.org/licenses/by/2.0]. Via Wikimedia Commons, [http://upload.wikimedia.org/wikipedia/commons/4/48/Generalife\\_gardens\\_in\\_Alhambra%2C\\_Granada\\_%287068992009%29.jpg](http://upload.wikimedia.org/wikipedia/commons/4/48/Generalife_gardens_in_Alhambra%2C_Granada_%287068992009%29.jpg) (retrieved May 2015)

figure 11. Photochrom Print Collection. *Winter garden (interior), Nice, Riviera* (France). via Library of Congress, <http://loc.gov/pictures/resource/ppmsc.05966/> (retrieved May 2015)

figure 12. User: Roede. *Farm buildings in Heidal, Gudbrandadal, Norway*. [http://www.gnu.org/copyleft/fdl.html]. Via Wikimedia Commons, <http://commons.wikimedia.org/wiki/File:Heidal.jpg> (retrieved May 2015)

figure 13. Daniele Domenicali. *Mario Cucinella Architects, ex-Ducati south view* (Rimini, Italy). [© and courtesy of Mario Cucinella Architects]. Via Archdaily, <http://www.archdaily.com/16863/ex-ducati-mario-cucinella-architects/> (retrieved May 2015)

figure 14. M. Rehemtulla. *A green wall or living wall on display at the children's museum in Kitchener, Ontario, Canada (The Museum)*. [http://creativecommons.org/licenses/by/2.0/deed.en]. Via Wikimedia Commons, <http://commons.wikimedia.org/wiki/File:Livingwall.jpg> (retrieved May 2015)

figure 15. User: Vincent. *Wageningen University - Building Lumen* (Wageningen, Netherlands). [public domain]. Via Wikimedia Commons, [http://commons.wikimedia.org/wiki/File:Wageningen\\_University\\_-\\_Building\\_Lumen.JPG](http://commons.wikimedia.org/wiki/File:Wageningen_University_-_Building_Lumen.JPG) (retrieved May 2015)

figure 16. ecoLogic Studio. *The Urban Algae Canopy, Milano, Italy*. [© and courtesy ecoLogic Studio]. <http://www.ecologicstudio.com/v2/project.php?idcat=7&idsubcat=59&idproj=129> (retrieved May 2015)

figure 17. User: Andrewglaser. *A Heliotrope showroom and visitors center designed by Rolf Disch Solar Architecture for Hansgrohe in Offenburg, Germany*. [http://creativecommons.org/licenses/by-sa/3.0/]. Via Wikimedia Commons, [http://en.wikipedia.org/wiki/File:Heliotrop\\_Nacht.jpg](http://en.wikipedia.org/wiki/File:Heliotrop_Nacht.jpg) (retrieved May 2015)

figure 18. User: TheDailyNathan. *The enclosed rainforest at the California Academy of Sciences* (San Francisco, CA, USA). [http://creativecommons.org/licenses/by-sa/3.0/deed.en] Via Wikimedia Commons, [http://commons.wikimedia.org/wiki/File:California\\_Academy\\_of\\_Sciences\\_Indoor\\_Rainforest.jpg](http://commons.wikimedia.org/wiki/File:California_Academy_of_Sciences_Indoor_Rainforest.jpg) (retrieved May 2015)

figure 19. User: NordNordWest. *BIQ mit Bioreaktorfassade (Am Inselpark 17) auf der IBA Hamburg in Hamburg-Wilhelmsburg* (Germany). [http://creativecommons.org/licenses/by-sa/3.0/de/legalcode]. Via Wikimedia Commons, [http://commons.wikimedia.org/wiki/File:IBA\\_Hamburg\\_BIQ\\_%281%29.nnw.jpg](http://commons.wikimedia.org/wiki/File:IBA_Hamburg_BIQ_%281%29.nnw.jpg) (retrieved May 2015)

figure 20. User: Loz Pycokk. *Serpentine Gallery Pavilion 2011 Designed by Peter Zumthor* (London, UK). [https://creativecommons.org/licenses/by-sa/2.0/]. Via Flickr, <https://www.flickr.com/photos/blahflowers/5897880880/> (retrieved May 2015)

figure 21. Barry Plane. *Reichstag Dome at night* (Berlin, Germany). [http://creativecommons.org/licenses/by-sa/3.0/deed.en]. Via Wikimedia Commons, [http://commons.wikimedia.org/wiki/File:Reichstag\\_Dome\\_at\\_night.jpg](http://commons.wikimedia.org/wiki/File:Reichstag_Dome_at_night.jpg) (retrieved May 2015)

figure 22. User: Daderot. *Invernadero de Atocha, Madrid, Spain*. [Public domain]. Via Wikimedia Commons, [http://commons.wikimedia.org/wiki/File:Invernadero\\_de\\_Atocha,\\_Madrid\\_-\\_view\\_2.JPG](http://commons.wikimedia.org/wiki/File:Invernadero_de_Atocha,_Madrid_-_view_2.JPG) (retrieved May 2015)



figure 23, 24, 25. Weather and climate website.

*Average Weather in Goteborg, Sweden*. [© and courtesy of [www.weather-and-climate.com](http://www.weather-and-climate.com) 2015]. <http://www.weather-and-climate.com/average-monthly-Rainfall-Temperature-Sunshine,goteborg,Sweden> (retrieved May 2015)

figures 23, 24, 25, 30, 44, 45, 47, 48. Emilio Lorenzato. *Artilleristallet self produced photographic documentation* (multiple pictures, Gothenburg, Sweden).

figures 26, 27, 28, 49, 50, 51, 53, 54, 56, 57. Johanna Lange. *Artilleristallet self produced photographic documentation* (multiple pictures, Gothenburg, Sweden). [© and courtesy of Johanna Lange & Lindholm Restaurering AB]

figure 29. Hitta.se. *Satellite photo*. <http://hitta.se/karta> (retrieved May 2015)

figure 31, 32. *Gothenburg 1855 and 1862 historical maps*. [http://goteborg.se/wps/portal/invanare/bygga-o-bo/bygga-riva-och-forandra/arkiv-och-ritningar/historiskt-material/kartor!/ut/p/z1/04\\_Sj9CPykssy0xPLMnMz0vMA-fIjo8ziAwy9Ai2cDB0NLAx9DQ08jU3MXb1N-zIxCLMz1wwkpiAJKG-AAjgb6BbmhigApA-7tR/dz/d5/L2dBISEvZ0FBIS9nQSEh/](http://goteborg.se/wps/portal/invanare/bygga-o-bo/bygga-riva-och-forandra/arkiv-och-ritningar/historiskt-material/kartor!/ut/p/z1/04_Sj9CPykssy0xPLMnMz0vMA-fIjo8ziAwy9Ai2cDB0NLAx9DQ08jU3MXb1N-zIxCLMz1wwkpiAJKG-AAjgb6BbmhigApA-7tR/dz/d5/L2dBISEvZ0FBIS9nQSEh/) (retrieved February 2015)

figure 33, 36. *First Gota Artillery stable settlement* (Fotou.nr:0:1757), *1901 Covered yard* (GhmPK:312). Gothenburg's Stadsmuseet.

figure 34, 35, 37, 38, 39, 40, 41, 42, 52. Bygglövsritningar arkiv (building permit archive). Västerås Arkivfotocentral AB. via Johanna Lange.

figure 43. Göteborgs Stadsbyggnadskontor. *Kontor, Butiker och verksamheter vid Kaserntorget, kv 32 Artilleristallet, inom stadsdelen Inom Vallgraven i Goteborg* (Detaljplan extract 1989). via Johanna Lange

figure 46, 55. Julio Amorim. *Artilleristallet photographic exhibition november 2013*. [© and courtesy of Julio Amorim]. <http://anavedobomgosto.blogspot.se/2013/11/the-photo-gallery.html>, <http://anavedobomgosto.blogspot.se/2013/11/artilleristallarna.html>

All drawings, schemes and figures not listed here are my own production and property. Emilio Lorenzato 2015