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Industrial DESIGN

Social interaction in cities with urban furniture

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JÖNKÖPING UNIVERSITY
School of Engineering

Social interaction in cities with urban furniture möbler

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Abstract

This report is made to create a process for urban furniture that is going to be placed in Jönköping and other cities in Sweden. The process is created in collaboration with the company Re-invent your future, which works with architecture and product design both in Sweden and other European countries. The process will deliver a conceptual prototype with visualization effects, it will include solutions for social interaction, interest and space for the citizens that live in urban spaces and big cities.

Keywords

Urban furniture, Urban cities, Citizens, Sweden, Children playground, Events, Social interaction, Interest, Communication.

Sammanfattning

Denna rapport är skapad för att skapa en process för urbana möbler som ska placeras i Jönköping och andra städer i Sverige. Processen är skapad i samarbete med företaget Re-invent your future som jobbar inom arkitekt och produktdesign både i Sverige och andra europeiska länder. Processen kommer att leverera en konceptuell prototyp med visualiseringseffekter, den innehåller lösningar för social interaktion, intresse och utrymme för de medborgare som bor i stadsrum och storstäder.

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I Introduction

Urban cities encounter multiple problems in their urban environments, such as crowding, housing, pollution, social interaction, interest, landscape, space per citizen and many more urbanized problems that encounter citizens in urban spaces. I as a designer and with the assistance of the facility Re-invent your future had an objective of developing urban furniture that delivers solutions to these types of problems. This furniture will be proposed to Jönköpings municipality for further development and implementation in Jönköpings urban environment.

I.1 Background

The aim of this project is to propose a solution to a municipality in Sweden, which will help the urban environment to invest and conduct an urban product that will fulfil these empty spaces. Due to overcrowding, pollution, social interaction, lack of space and sustainability factors, the Swedish urban environment seeks demand on urban environments to eliminate these problem. Today's urban environments have major problems in creating space where people who live in these urban environments can use these places to interact and create a social interaction. Research of this subject can be described in multiple phases, where some phases can be seen as an investigation to find a solution for the problem in such a way where it can conduct a further investigation of a previous knowledge or a studies [1].

The main leading factors that are considered and used in professional practice are applied in the field of research where problem solving can give the investigator a new type of information that comes from a systematic investigation for problem solving such as research questions, literature search and review [1]. The findings in these literatures that are linked to previous studies, tests, methods and techniques that will be analysed and synthesized to findings for the problem solving and the research questions [1].

Based on an analysis in this report, an urban furniture that were designed for a municipality infrastructure has the goal to create a furniture that will include the factors of an innovative city with good infrastructure that will promote and enhance city branding, space for interaction, sustainability factor, consciousness, communication, interest and happiness, these elements will be the key concepts of this new Artifact (urban furniture).

I.2 Purpose and research question

Urban furniture is an important element in the urban city environment, though there is a lack of urban furniture in urban cities that are designed around social interaction with enough space to gather people around. The aim of this project is to create space for the people to have interest and social interaction with other citizens in the city with the ability of combining space and nature by conducting green areas that have gardens, plants and vegetation. The space must be designed with accessibility to all types of consumers and must provide enough space to conduct place for standard street furniture such as benches, tables, trash bins and other elements found in the city that are designed for public use.

This project will have its aim around answering the research questions documented below.

How can urban furniture create social interaction possibilities for the community?

How can urban furniture be appealing for the urban city environment and its citizens?

How can urban furniture be universal for use by all types of people?

How to combine urban furniture and gardens together?

1.3 Delimitations

This project will have its focus on creating an universal space that can be used by all types of consumers, though only conceptual product design will be introduced in the timeframe of this project. The project will mainly have its aim on designing the space for the consumers, this space will be introduced as a finalized concept that can be communicated with other designers and the municipality of Jönköping city.

This thesis will not focus on ergonomic studies, though it will include basic ergonomic literature to assist the conducted solutions into the conceptual designed product. The research will be limited for urban cities of Scandinavian environments.

The project will not include any mechanical and electrical aspects, though, materials and manufacturing processes will be researched by literature and later be implanted into the final concept of the project as proposals. The process will not include any form of simulations for the structural strength and manufacturing process of the 3D computer aided designed product.

The conceptual design will be introduced as a CAD file that is 3D surface modelled for visualization communication purposes only, no 1:1 scale prototype will be constructed, though a small-scale prototype will be produced by simple construction methods to communicate the shape of the product.

1.4 Disposition

This project will be divided into the following subjects:

Introduction: The project will be introduced, by introducing the topic proposal, goals, limitations and problems.

Theoretical framework: Studies and literature will be included in this section by collecting data that is aimed around the subject of the project.

Method: All methods that will be used to conduct the thesis will be included in this section.

Approach and implementation: This section will discuss how the introduced methods are applied into the process of creation.

Result: The result of the final findings of the project will be included in this subject.

Conclusions and discussion: Here the conclusions and findings will be discussed around the project, timeline and studies, further work conclusions will also be considered in this phase.

2 Theoretical Background

2.1 Industrial design

Industrial design creates innovative solutions for creating products, a good design is the key factor for getting a good reaction by the consumers and clients where it will create a greater performing factor in the industrial world [2]. However industrial design itself had a revolution from the aesthetic and philosophical form continually, where it applied the ability of creating new methods of thinking. On the other hand, design has been a key factor in the fields of art, science, the technological and mechanical aspects for a very long time where these aspects have been independent by industrial design and the new methods of thinking and creating products from a manufacturer and a designer point of view [3]. In other aspects industrial design is seen as a professional method to create a physical object where an industrial designer aims to create this object where it must be functional in an industrial world or a specific environment where this physical object tends to live in [4].

2.2 Design Thinking

The designers use their imagination to see through scenarios where they develop their thoughts and knowledge into a physical product. How the designers think is related to how the designers use their consciousness, how they imagine scenarios and how they think through multiple solutions to a problem even if these solutions do not work in reality [2]. When these solutions are communicated in a network of other people in different disciplines, they will result in a physical final product [5].

A creative process is applied to support the designer's thinking process, since the problem is wicked, this process does not give a fully defined solution to the problem. The process starts with the first insights where the problem is formulated and well defined. When the problem is well understood, a preparation phase takes place where the designers use their conscience to find solutions that can solve the problem, this method gives the designer new born ideas where each solution is defined to the problem. After the preparation phase, this narrows the process down to the incubation phase where the design process is created for the new born ideas. Afterwards when the preparation phase is complete the designers will have the capability to illustrate and produce these new ideas. Following the final step where the conscious development takes place to verify all the given solutions [5]. See figure (1).

This design thinking process can be followed and formulated in different visions, therefore a second formulation by *J.Johansson* will be applied into this study to fulfil the understanding of design thinking and the design process.

The first step in this design process involves the understanding and formation of a certain problem where it is called the **sensitive discovery**, where the problem will be identified and studied to understand the effects it is applying on the identified environment such as humans for example.

The second step in the process will involve **identifying the problem**, where the designer or the researcher will be identifying the problem in such a way where they will have their focus on how this problem can be approached and how they can understand it deeply where a definition will accrue where solutions are found around it.

Idea creation where the researchers/the designers are generating and developing new ideas for new ways to approach the problem with a new solution.

Creation of a prototype to verify if the formulated problem can be solved, the prototype will be tested in the environment it was created for, therefore an evaluation of the prototype will come in hand to evaluate if the problem has been solved.

Finally **assessment and verification** of the output solution where the prototype and the solution will be tested to verify if it has the capability to solve the problem itself [6].

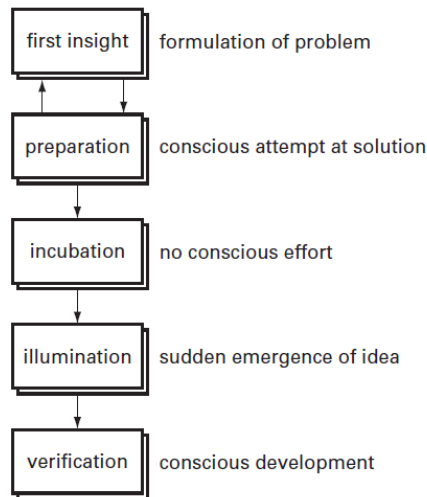


figure (1) creative process phase.

2.3 Wicked problem

Problems encounter all designers in their daily work, by solving these problems new ones might occur with a high resistance to be solvable. A wicked is a complex problem that does not have a fully defined solution or any at all. By solving a wicked problem, new problems might occur. These problems must be discussed between the designer and the user in collaborative design principles where the research and data are an important asset in this case. The solutions of a wicked problem are investigated and qualified for certain conditions, by which the researcher must have an overview and data on how to differentiate all aspects of the problem and how they are related [7].

2.4 Human centred design

When designing a new product, the designer must consider multiple factors that create good design by having needs that are dependent on capabilities and behaviour of a human.

Human centred design aims at a human centred perspective where all new design formulations and challenges can be solved by having an understanding of psychology and technology for example. Don Norman describes human psychology and biology as a slow developing process in society compared to technology development, for example, this will result in the design of everyday things that are still related to the same problems today.

He also described in his book about principles that repeat themselves for a better grasp over products and to have a better perspective over the user experience, these principles consist of affordance, constraint, mapping and feedback [4].

2.5 Visual brand language

Identifying products is generally discussed in the design management process that almost all branded companies apply into their products.

In industrial design there is an important brand design language where all products can be identified and connected to a certain company that creates them. All products have unique identities that separate them from other products, even when they look similar in the same market category. Having a strong identification will strengthen the company brand recognition, creating value, meaning and a good user experience, making the products that the company produces (unique) with special design elements such as the curves and the geometrical shape of the produced products [8].

Product spectrum in the manufacturing process, product market categories and the success of a company and its history are all important aspects to create and manage product identification in a market where all products of the same company have a common identity and brand language [8].

2.6 Bootcamp bootleg

Created at Stanford design institute, bootcamp bootleg is a theory that designers use to develop their design thinking in a process of five stages. These steps assist the designer to create a design process which will take place from the first steps of creating a new product until the product is produced at its best and final state. These steps can also be iterated if the designer might find new conclusions in other phases of the process [9].

Empathize: Human centered design process to observe, engage and immerse with the user to have a better understanding of the design field. While observing, the designer will have an overview of the users behaviours and needs. Engaging and interacting with the user will put standards to values and thoughts, this happens when both the designer and the user interact with each other by interviews and meeting for example. Coming to the final phase of empathizing, experiencing and understanding the main problems of a product is an important factor to acknowledge what the product is and what the problems are [9].

Define: By having an overview of the user and the design process, the designers will have a better expression of the problem based on their experience in the design field. By applying focus and guidance with the user, this step will be an important asset to get insights and a clear definition of the main problems of the product and its development [9].

Ideate: After having an empathize and a defined guidance and understanding of the problem and the user, the designer can begin ideating different types of concepts that will deliver and suggest solutions to the problem. By exploring different suggested solutions and ideas in a vast scale, the designer will have a form of flexibility where each idea will represent a new discovery that can be innovative [9].

Prototype: After getting all ideas from the ideation phase, a physical form will be introduced to each idea for further testing and development. The scope of prototyping must be subsequent to the progress of the designer, also the first early prototypes can be rough made to give the designer more possibilities to explore and investigate new innovative outcomes by testing [9].

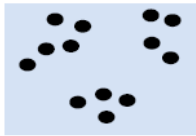
Test: Testing the different concepts that were created by the ideas in the design process to deliver new results. In this matter the designer will introduce new conclusions and feedback for further processing and development. The results from the testing will ensure refinements of the current concepts, figure out what solves the problem and get a better understanding of the user [9].

2.7 Semantics and semiotics, Gestalt

Creating a product that has high aesthetics and a good user expression is important in the design field. The first impression of a product only takes a short amount of time for an individual to determine if the product is charming and comprehend its ability to fulfil the needs it was made for. Therefore, Gestalt is applied into the design field to fulfil the design arrangement and determine if all of the (colours, shape, functionality of the product and all parts) are right. The meaning of Gestalt is related to the German language where it means forms and appearance [10].

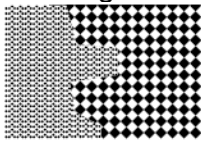
Gestalt consists of different form factors, by which the product will have an easier understanding by the inspectors. Gestalt involves multiple factors:

- a. Proximity: Is when forms and signs are arranged in small groups for an improved stimulus element. Giving the ability to separate different elements and group them to smaller groups, it will give the product a simple understanding of functions and parts [10].



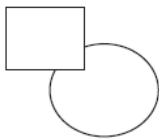
(a) Proximity

- b. Similarity: Similarity will benefit from the separation of elements that are the same and other elements that look different. Similarity will control all types of the same functions and forms together and control the opposite types of functions and forms together as shown in the figure below [10].



(b) Similarity

- c. Closer: Will help the inspector to see forms and objects as (whole/complete) even if this type of area is enclosing in some types of borders that consists of forms and objects for example, see figure below [10].



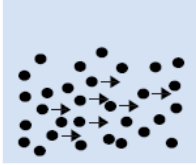
(c) Closure

- d. Good continuation: This phase will help the inspector to see and understand line and curve segments, where all types of lines and curves can be arranged into where they belong to even if there is an overlapping object or curve in its boundaries see figure below [10].



(d) Good continuation

- e. Common movement: Moving objects and forms at the same speed and direction are seen as a whole part by the inspector. In this case the human eyes can detect camouflaged objects and separate them from their background, see figure below [10].



(e) Common movement

- f. Good form: This phase consists of all types of simplicity, symmetricity, regulatory and all predictable items. What will be seen by the inspector is dependent on the type of simplicity or symmetry or the opposite in objects [10].



(f) Good form

2.8 Design for manufacturing

Design for manufacturing DFM is about designing the product with the ability to ease the manufacturing phase, where in the early stages of the design process designers must consider the manufacturing process by introducing manufacturing methods of the product that is being designed [6].

2.9 Design for assembly

Product designers must consider an assembly phase in the manufacturing process or even outside the manufacturing process where consumers may need to assemble the product they have bought. Design for assembly DFA is about simplifying the product structure to have the advantage of reducing the number of parts of the product, with the consideration of designing each part with a simplified structure with ergonomics factors in mind [6].

2.10 Design for accessibility

Developed urban environments and cities design products with a high range of accessibility for different types of people depending on if the people have disabilities or are in need of specific design elements and barrier removal to make their social and professional lives easier. It is crucial for the civilisation to create a way of thinking to assist the product development so it can deliver solutions where they take account for disabled people.

Monograph is the meaning of ergonomics designed for accessibility, designed for people with disabilities with taking the consideration of all factors that have effects on the life of the disabled people and people who are above 50 years old [11].

2.11 Ergonomics

Ergonomics is a vast field focusing on many aspects of how people interact in a workspace or even how human behaviours and functionality act in different environments. Therefore, when designing solutions, they must consider human expectations. Designing furniture, buildings and products with ergonomics in mind is done by designing solutions with high technological criteria where these criteria can help to shape the space used in environments, the comfort of using furniture and products, providing safety matters and avoiding obstacles. While designing solutions and considering ergonomic aspects, the solutions must be designed universally to the environment surrounding the humans, meaning that solution must consider all types of people such as disabled, old, patients and young. This is even applied into architectural matters, where designers and architects must design and shape structures with ergonomics in mind, leading to all types of users to have the ability to use the shaped environment, these design aspects must be considered in the earliest stages of the design process [11].

2.12 Urban City

Urban city was first consensually achieved and documented in between the years 1996 and 2001 before these years and era humans started to leave the villages and move into cities, the transformation varies in different countries depending on what they define as an urban city. To live in bigger groups of people in a small area is what is referred to as an urban city, with the assistance of both vertically and horizontally buildings and complexes where people tend to live in and use. Urban cities often can provide people with many types of services, such as schools, hospitals, transportation etc, it also delivers negative aspects such as crowded space, pollution and noise. The urban cities are dependent on economics and socialization between the citizens; therefore, these two factors encourage people to join the urban society.

Urban cities usually appear to be the same around the world, sharing many similar factors from the economical and socialization perspective, they even share the same type of problems like unemployment, housing, transportation and cowardness, etc.

Cities acquire people with different visions and cultures, having different goals and needs, where it puts them in a position of having different jobs and lifestyles even though they live in the same area. One of the major problems in an urban city environment is globalization and growth of the population, leading to less space per citizen. Today it is important to think about the future, because of the growth happening in cities, therefore maintenance and sustainability are huge factors that must be implemented to have a less fragile city environment [12].

2.13 Urban furniture

Urban furniture is designed in urban spaces, more likely in semi-public spaces where people meet to rest and communicate. Urban furniture is also known as street furniture, they are mainly designed and integrated into semi-public space, where the furniture creates identity and sense for place. A semi-public space is a space owned by the municipality in the cities.

Urban furniture comes in different shapes, with a vast variety of products such as benches, trash cans, bus stops and many more products that are made for the citizens and creates a greater city experience for the citizens leading to great social interaction and behaviour in the urban city environment.

The street furniture should be designed around an analysis of the chosen city location, especially when designing high quality furniture, analysing the needs in the city, behaviour of the people, citizens and the environment of the chosen city. These criteria are crucial due to furniture proper functionality.

The analysis contains five stages of criteria that assist the designers to find the correct spot and the right furniture for this environment:

- **Function:** How will the furniture serve its function and purpose? What are the functions that the street furniture is going to deliver?
- **Layout:** Where is the street furniture going to be placed and why? What is the proper layout that the street furniture will be planned for.
- **Form and appearance:** Create shape with continuity and linkage, sharing a design language that could be understood by the consumers.
- **Durability:** Design the furniture with durability in mind, using durable materials that can withstand the usage of the furniture over a long period of time.
- **Cost:** How much will it cost to design and conduct an urban furniture in the chosen environment?

The street furniture should have a universal design, designed with the ability to be used by all types of consumers, disabled people, children and elderly people. The furniture should also have the ability to create social encounters, that is done by creating shapes that are linked with each other where the linkage will encourage people to interact with strangers. Vast spaces between furniture have the effect of drawing people apart, it's important for the designer to create the right space and linkage in between all furniture for providing better opportunities for social interaction. The shape and materials of the urban furniture must be chosen to be safe for the consumers to avoid injuries, making sure to design shapes with no sharp edges. The safety of the furniture is required and considered, such as preventing thieves from stealing the furniture. Vandalism must also be avoided, to prevent the furniture from getting destroyed, prevent people from sleeping on the furniture or to use them improperly.

Material chosen for constructing urban furniture is important, weather plays an extreme role in the material selection, plastic materials when exposed to sunlight will behave differently, characteristics of the material will lead to expansion, deformation. Cold weather such as freezing temperatures in winter, will create moisture to the furniture, if the furniture is made of materials that have a risk of getting moisture. Good furniture design usually has native materials, with light colours and natural earth tone finish.

For the best materials chose, some materials with good characteristics are studied to be durable in street furniture manufacturing and implementation:

Stainless steel: Stainless steel is a good strength material that can hold up big weights, it is a material that can be shaped in dynamic and static designs. Stainless steel is corrosion resistant, can resist impact, where it prevents the steel from needing maintenance over short periods of time. Stainless steel can be recycled and reused after its lifetime ends as an urban furniture.

Wood: Wood is a very popular material used for urban furniture, due to it being a natural material found in trees, people tend to like it a quite bit more than other materials, it is resistant to cold and hot weather, can dry fast when exposed to water and is a cheap material to work with and construct.

Concrete: Concrete is a heavy material with high strength characteristics where it is a durable material in harsh weather, it is a material that is hard to vandalize except vandalizing with spray cans. Concrete is a commonly used material that is used around already existing concrete structures, though it's a material that is hard to shape.

Stone: Stone can be used in different shapes, the most common manufacturing process for stone is carving, where manufacturers carve the stone to form it and shape it into suggested design styles. Stone is a durable and a heavy material, it is very difficult to vandalize except sparing the stone with spray cans.

Plastic: Plastic is a recyclable material, leading to almost all urban furniture made of plastic will get the chance to be recycled at the end of their life. Tough plastic material can get expanded and contracted when exposed to UV light and heat from the sun and they are easy to scratch when exposed to sharp objects leaving them not durable for longer periods of time which at the end will lead to deformation of the original design [13].

2.14 Social interaction

Human interaction and communication are something that people use to interact and communicate with other humans, these interactions happen multiple times a day between humans with different languages and methods. To understand the interaction and communication, humans must have the ability to understand each other, speak the same language for example, if there is a cultural difference where the people doesn't know the language in the environment they are in, there people would be a lacking the understanding and communication method and lead to a less understandable and poor experience, leading them to be unfamiliar with understanding the environment, road signs, customs, etc.

Social interaction is the key to communication, cooperation with other humans, creating new relations with people. These factors assist mankind to live through the day and educate themselves for the better [18].

2.15 Construction methods

2.15.1 Precast concrete manufacturing

Precast concrete is delivered as a product that has been manufactured in an industry, where after the manufacturing process it can be shipped and transported after it dries and cures. Precast concrete is suitable for any part and structure, the process starts by shaping a mould to a specific geometrical shape, the mould can be created by different materials, steel, plywood, plastic materials, clay etc. For better strength characteristics, the concrete must have a reinforcement material to support the structure of the cast, reinforcement can be used in different shapes and materials, such as iron beams, textile materials usually made by synthetic materials, alkali-resistant glass which tend to be high performance technical fibres [14].

Constructing complex shaped products and architects with concrete is a challenging method for designers, constructors and engineers. Instead of using traditional techniques to cast concrete such as using plywood to get flat and hard surfaces with 90-degree joints, new simple construction techniques can change the understanding and shaping of concrete structures into soft and sensual curves and surfaces that tend to be light reflecting and appealing. To create curvature concrete casts, timber lattices are used to support the concrete cast that will shape itself into curvature, the timber lattices are positioned horizontally and controlled by vertical stands to have accurate measurements. While designing curved concrete shaped elements, the reinforcement will be bend along the mould.

Beams to support the curvature can also be used instead of timber lattice, this method uses calculated mathematical equations to create vertical beam support for the mould.[15]

2.15.2 Fabric moulding

Fabric moulding is done by exchanging the plywood casting techniques with flexible moulds, concrete is a material that does not have an opinion about how it's shaped, as long as it can be held by a mould for 2-5 hours to cure and harden.

Using flexible moulds creates an evolution in construction concrete objects, making the constructed objects alive with curvature and have way more complex shapes, this aliveness creates new results of determination of form and shape by designers, engineers and constructors. The observer of technology and culture scientist *Ursula Franklin* describes technology as “a way of doing something” instead of collecting different tools and gadgets, which also reminds the designers to think of new solutions to approach problems.

To cast in a flexible mould, fabric and concrete are forced together to comply with the shape under specific restraint conditions. After casting into the rigid mould that has been 3D modelled in earlier stages by hand, the rigid mould must cure from water, where it becomes hard and ready to use. This method can have impact on the prediction of the dimensions and accuracy, leading to less clear results due to the stress and expansion of concrete that accrue while it dries which can lead to inaccurate tolerances, though that can be solved with CNC machining, and carving techniques to have a smoother surface or to have accurate measurements of the casted objects.

The mould of a rigid flexible can be repeated and duplicated, though it won't be with the same tolerances and might need to be processed by CNC techniques [16].

2.15.3 3D printing

3-dimensional printing (3D printing) is a vastly spreading technology, it has been researched for multiple years leading the technology to enter the concrete architecture manufacturing with special 3D printers using concrete filament. The concrete 3D printing technology delivers many geometric shapes giving designers much potential in designing more complex shapes with sensual curvatures that plays with light reflections leading to reduced material consumption and a smaller construction chain link between constructors. There are different methods of 3D printing, the first method is to 3D print a hollow structure, using less material.

The second method of 3D printing is referred to as “print in print”, this technology is the opposite of hollow print, where mathematically shaped geometrics designed by computer aided design and artificial intelligence are printed in between the outer surfaces to strengthen the characteristics of the constructed object.

Some 3D printers in our modern era can print structures up to 4 meters in height, with the ability to add more height and length extension by adding linear rails both vertically and horizontally, resulting in printing objects larger than the printer itself. Abilities of creating moulds using 3D printed plastics and clay, printed as thin shells that can hold up concrete while it is casted both on construction site and precast in industries. 3D printed plastic shells can dry fast and put to use rapidly after they were printed, though it is wasteful and hard to remove from the concrete cast, though clay can be used for the same purpose, where it can have much more advantage because it can be removed much quicker and recycled much easier than plastic materials [17].

Though this construction process is still in research and development due to material and technological limitations, these technical issues apply mostly to overhanging structures because of the

required material mixture and the characteristics of the environment but does not apply into the print-to-print method of printing and cast prints. This type of 3D printing technology is best used to construct simple structures, with less curvature and overhanging geometries.

The concrete 3D printing technology requires data that must be gathered and analysed which can deliver different results at different print speeds. These errors can be avoided by having enhanced layer control and correct material mixture with the right environmental circumstances. These factors will give the designers and constructors the ability to construct large geometrical bodies.

A robotic work cell, a silo container and a mixing pump is needed at site, assisted by a toolpath coordinator and computer software. All these tools must cooperate with each other to construct a concrete 3D printed object [17].

3 Method

3.1 Gantt-chart

Gantt chart is one of the most popular and classical tools to set up a planning for project management, where the Gantt-chart becomes the main communication language between the project participant. This method is used to create a time planning management, where it can illustrate and plan a project schedule time management in an emphatic solution to time and timing [19]. Gantt-chart is also used to plan tasks into timelapses, where it assigns each task to its own specific time management system, where timing and deadlines are an insistence to the project. Thus, there are many arguments around the Gantt-chart system, where scientists discuss how it functions as a time and planning management system. There is a high percentage where Gantt-chart can fail to achieve the deadlines due to the project's complexity, where errors accrue in the project, and due to already planned deadlines it can result in time management errors where these deadlines cannot be achieved due to an incomplete phase [19].

3.2 Design thinking strategy

Design thinking strategy is a methodology used by designers and Re-invent your future, a product developing Scandinavian design company located at since park in Jönköping city. The company uses the design thinking strategy to assist designers to have a greater experience during the design process. This process allows designers to create a complete product solution, starting at the observation phase where designers start to define the problems, the causes and the effects, with the continuation of the process to the end, by ending it with the project presentation where all aspects are finished with a complete presentation, prototype, blueprints such as 2D-drawing and visual identity [5][20].

3.2.1 Observation

Observation involves all the causes, problems and effects, where the designer must create a research in the market to identify and define all the issues that involve the subject that the given and the task has it aims for. Generating research questions around the area of development, by observing and researching the area and the situation that involves all the people and environments in a period of time [20].

3.2.2 Research and development, Human centred pyramid

Research and development involve all aspects in the design process form research of considering the human centred pyramid 5 what(s) and how (5W+H) or as described from Re-invent your future the design compass, this method includes:

What: Is usually asked by what activities, issues, tasks and functions there are in the researched area.

Why: What is the meaning of this research, and why are researchers looking for reasons to study what they have research questions around.

Where: Where are the areas that are going to be researched? Where are these environments and people that the research questions are going to play a role around.

Who: By exploring human factors, questions accrue around who are the people the study is going to be made for? Which communities are involved and what is their behaviour?

When: In an interactivity point of view for what time period is this research going to conduct?

How: How is this study going to be conducted? What methods and tools are going to be used for a successful approach? [21].

3.2.3 Information analysis

This analysis helps designers to study and gather information around the main subject, this method gathers information from literature previews, books, interviews, internet search, scientific papers etc. The designers later will have all the necessary information that is needed to conduct a study [1][5].

3.3 Brainstorming

Brainstorming is a method used in the design process by designers both as an individual participant or in groups of multiple participants to rapidly generate new ideas in the field of study and generate solutions to problems with great efficiency. These solutions generate new possibilities by exploring the main area that a research question, a problem or a topic is generated around [22].

3.4 Market research

To research the market, identification of trends, competitors and needs can help the designer to understand and find gaps in the market. What consumers need, what problems there are in the community world and if there are any competitors in the industry that fulfil these needs.

Market research is done by observing product advertisements, trends and brands in the market. This research methodology will uncover the design language and the competitor brand around a specific product to unveil the visual impression in the market [20].

3.5 Function analysis

To meet all the given requirements in an environment where a product is being developed for, the product creators have the responsibility to study and understand the environment that the product is going to be created for [6]. To develop a product, a function analysis can be a reliable factor in the developing phase, where each function of the product is categorized in between **main functions**, **necessary functions** and **desired functions**.

Main functions: are the most necessary functions that are required into the objective of the product, what the product is supposed to do or what the product is expected to do in an environment.

Necessary functions: are functions that are added to and facilitate the objective of the main functions, where each of them can enhance a greater value to the product's functionality and behaviour.

Desired functions: are functions that are desired by the users, these functions can add more desirability to the product itself but are not important compared to the other functions the products will provide.

3.6 Go/No-go Matrix

The elimination matrix, which is also called Go/No-Go, is specified in removing/eliminating all unsuccessful solutions, as this process begins after the concept generation phase where all solutions that do not meet the requirements or are unreasonable must be sorted aside.

These solutions are mapped as if they can really provide a solution to the problem, meet the requirements in the requirements specifications for the product, can be operational in reality and can be created in the industry. Also, they must consider a negotiation in the financial conditions that includes price range. finally, if they meet all laws from an environmental and safety perspective. This process creates a context out of the concepts that can really continue to be developed, all other concepts that are eliminated then do not pass the evaluation and therefore will not be further developed in this process [6][20].

3.7 Pugh's Matrix

The decision matrix (Pugh's matrix) presents all choices that depend on the solution alternatives and creates a comparison between them. These selections made are later used to formulate criteria in the specifications created for the product. This matrix is based on important points that must be considered as follows:

- All selections that are created must be based on wishes and requirements that must be fulfilled.
- The decision matrix must cover all aspects that are relevant to the problem solution and focus must be placed on the critical problems that the product must solve [6][20].

3.8 TAIDA

The human way of thinking and planning scenarios starts with the understanding of the imagination that the brain develops. Therefore, humans try to seek the innovation of the future by understanding these imaginations, what goals need to be reached, decide what should be done and finally ensure the necessary actions that should be taken according to the plan [24].

Tracking, analysing, imagining and deciding are all parts of the human thinking interphase of understanding the future according to Mats Lindgren [25].

Tracking: happens while tracing new trends, the future of the industrial world and the future of innovation to seek opportunities and threats that can be both beneficial and harming.

Analysing: happens while analysing the researched opportunities and threats to originate and seek new scenarios and consequences.

Imagining: the new vision of the future by identifying all new opportunities leads to the vision of what creates the desirability of the scenarios.

Deciding: by deciding and planning about what happens next, after imagining the process of the future and by processing all the information. Deciding on new strategies to meet up with the vision and the goals so later a systematic approach will be developed to shape the vision of the future for both opportunities and threats.

Acting: is to take actions of what was decided in the planning phase, where goals are going to have a setup and be handled by actions [24].

3.9 Persona

A persona is an acting methodology that is created to represent a person from a community to help the development of a specific product. The persona describes a fictional personality, that most of the time has its demands on the same environment that a product is being developed for, therefore it is used to understand the community role in to the development of the product to find problems that are described as main issues and needs that are relevant to the product design [25].

3.10 Mood board

To increase the bond, the feelings, the fantasy and to form the final vision of a product in the earliest stages, the designer needs to implant a phase in the design process to give an instinct about the form and the feeling of the product. A mood board is a good method to share these instincts and have a good early communication with the client [20]. The mood board is a method used by designers to visualize the shape, the texture and the guidelines of the product in the form of pictures. This method will improve the visualization of the product and will also have an improved aesthetics to human visualization where humans can examine the pictures in the mood board and can have an understanding about the texture, the shape and elements in a confident manner [20].

3.11 Sketching

Sketching is an important tool in the design process, it develops new ideas that are drawn on paper to visualize the designer's vision in the design process. By sketching new ideas designers can seek new design possibilities, have freedom to discuss these possibilities and implant them into the real world where they can identify the important key points in the development of a product.

Sketching can be done with different styles both in a systematic and an uninformed, referred to schematic and thematic sketching style. The thematic style of sketching is an uninformed sketching process to give a propose to what to sketch on a paper, this purpose adds value to the new product's physical form with fluid shapes that are dynamic lines with the freedom of creating physical shapes even if these types of sketches may need an explanation for a better understanding of what they consist to the human eyes and clients.

On the other hand, schematic sketches drive a systematic workflow where valid data is used to confirm the precision to the approach of the design process. This systematic sketching tool helps designers to communicate the design visualization quickly within the design parameters, later the designer gets the chance to present the visualization, sell it or take it further to the prototyping and production phase [20].

3.12 Mock-ups

A mock up is a rapid solution to generate a rough physical 3D-module to help the designers. A mock up can be created with hardened paper, high dense foam and even rough 3D-printing with the help of computer aided design [26].

3.13 Prototyping

Prototyping in design engineering is done to seek and test the output of the development of the physical product in the design process. This phase in the design process brings the final result of a product before the start of the production phase. The prototypes can visualize the shape of the product to communicate it in the field of design and sometimes they can be functional with mechanics that drives the product into testing, analysing and further development of the product [6].

3.14 Computer aided design

Computer aided design is a process to create and visualize 2D-drawings and 3D-modeling in a computer aided software. This method helps the designer to understand and act, to create a design process that has a better success rate in optimizing the design workflow, improving quality of the products and creating an enhanced communication database base between designers, manufacturers and clients. The computer aided design stores its database in an electrical and electronic software where the database is stored in a form of files in a computer hard drive [27].

3.14.1 Alias

Alias is a 3D surface modelling software, designers use it to generate fast 3D-modules with high quality surfaces, these surfaces are generated in the same form of pipeline where the 3D module can be communicated between designers and have the same workflow in between them with these simple design tools. Alias can be used to create a complete 3D-CAD module, where this module can be created from a curve into a complete module with high quality surfaces that later can be produced in the industrial manufacturing industries [28].

3.14.2 Solid works

Solid works is an engineering construction CAD software where users can draw 2D-drawings and create 3D-modules and turn them into solids. Solid works is mostly used in the mechanical industry, it has huge benefits on the development time and cost of creating products in a simplified design solution process.

Solid works is famous for its diagnostics analysis, users can diagnose the constructed solid modules and make analysis about the functionality and simulate the solids strength and weakness for an example [29].

3.14.3 Visualization and renders

To visualize a physical form and test it in an environment can be challenging without creating a full scale functional and physical prototype. Therefore, computer aided programs such as Key shot are used to simplify this step, this happens by rendering the CAD version of the product into a software to visualize the product into an environment where it can be tested digitally with all the materials and environments that are available [31].

3.15 3D-printing

3D-printing is an adaptive manufacturing (AM) process that is used to rapidly prototype 3D modules with complex geometries. 3D printing today can be done with a high amount of different materials such as polymers, metals and even ceramics such as concrete. A 3D-printer can print a complex 3D geometry with multiple materials in one single print. For a rapid prototyping method, 3D printing is considered as an excellent tool to visualize, test and experience an early prototype of a developed product in an economically cheap price and time. This prototyping phase helps creators such as designers to prototype with their products and have an instinct for further development in the design process.

3D printing is also used in architecture constructions, where constructors use a larger 3D printer with architecture materials to construct buildings with complex geometry shapes, this method gives benefits to time construction and long-life structures [30].

4 Approach and Implementation

4.1 Observation

By observing the market and the problems of the urban environment, research was conducted to find all effects and causes that are referred to the problems of the urban environment and urban furniture.

Social interaction is one of the major problems in urban city environments, where people do not socially interact with strangers at a high rate, affecting to less relations created within the people, leading to less interest. This problem is caused by lack of space, where people do not find the right circumstances or space to create relations and interact with other people. The lack of space in urban cities that is planned for the people lacks semi-public spaces such as landscape, parks and urban furniture. The urban environment has unsustainable factors in the environment that is developed for the people. These factors are found in urban environments and mentioned as crowdedness, pollution, awareness, economic growth, management, social interaction, etc. All these factors are affected by lack of space and how humans behave when they do not have enough space [11][12].

4.2 Market research

Urban furniture is usually created to live and function in populated cities in semi-public spaces, where the semi-public space is a space owned by the municipality in the cities. Furniture mainly serves their function to be used by the people, such as benches, billboards, bus stops, fountains, statues and almost all objects that are designed to serve the humans in urban cities. In this research, only the history, the form structure, and what type of furniture exists in the market will be implanted by data collection methods.

The study starts with the history analysis of urban furniture, *as shown in the appendix I section in the end of the report*. The history of urban furniture dates all the way back to the first documented object in the historical roman period, it was used as a millstone to describe the routes and locations to citizens living in the Roman empire. Later in the time lap of history humans started to construct benches made of wood, these beaches were used by humans to sit on and watch the amphitheatre, these beaches were designed to let people sit on them instead of sitting on the gras. The wooden beaches evolved into stone benches, created in huge structures where they are placed above each other for a better viewing experience for the citizens. The evolution seen in the development of the amphitheatre seating space started from sitting on the ground or the grass into sitting on benches made of different materials with the help of the evolution of development of that era of civilization.

Moving into the modern era starting at the late 1800 century, the first consciously designed urban furniture was designed in Paris, France. The bench was made of metal alloy and wood and was designed to help the people who were walking to sit and rest on these benches due to the lack of transportation at that time. Continuing to research urban furniture of the modern era, we can find similarity in the construction of the urban furniture industry, up to the 2000 century the construction method and the design of urban furniture is similar. The main big changes that are found are materials, since the evolution of materials has been vast, new materials have been introduced into the urban furniture industry, where these materials gave designers new opportunities to develop new kinds of structures that serve the same function, serve the citizens in urban cities. When new materials and technologies were combined together, new shapes and understanding of urban furniture were introduced in the late 2000 century, therefore the urban furniture industry started to construct urban furniture that can have more functions rather than being only used for sitting and resting. The new methodology of urban furniture delivers new shapes, where users can use the type

of furniture in more exceptional ways, where they can park their bikes, plant plants into the furniture, work, relax, find information and interact with other people. Sometimes urban furniture is created as a large architectural complex that provides a vast space where it delivers a key to communication and interest.

A foam board is conducted in the form of a document, where many pictures from different eras and competitors *as shown in the appendix 2 at the end of the report* are introduced to show different types of urban furniture in the market. Each urban furniture is categorized as organic, classic, futuristic and artificial. Here the competition can be analysed in the market where each furniture can provide information about how it is constructed, what it is used for, what materials it contains, what environments they are created for and how it is categorized as urban furniture in the market.

4.3 Function analysis

Based on the market research and other urban furniture constructed in other countries around the world and what Jönköping a Swedish city environment requires for an urban furniture to be, a function analysis is created for urban furniture in urban cities.

Class	Verb	Noun	Specification
M	Rest	Body	Resting the human body
M	Interact	People	Interaction between people
M	Make	Interest	Create interest factors for the people
M	Access	Universal	A universal access for all type of people
N	Store	Equipment	Storing equipment that citizens may need.
N	Play	Ground	Playground for children.
N	Protect	Weather	Protection against cold and warm weather.
N	Organize	Events	Place for events and organization
N	Organize	Place	A platform/computer that can organize the artifact.
N	Protect	Vandalism	Protection against vandalism.
N	Offer	seating	A place where people can sit and rest
N	Adapt	Kitchen	Kitchen for the citizens to use.
D	Plant	Plants & Vegetables	Space for planting and farming plants and vegetables such as flowers
D	Hold	Pets	A place where people can shelter their pets
D	Falling	Water	Water in the artifact, like a water fountain etc...
D	Mount	Bicycles	A parking space for bicycles and E-bikes
D	Access	Electricity	Having electricity access in the artifact

D	Facilitate	Repair	Having the accessibility of repairing the artifacts and its components.
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Table of contents I, Function analysis.

The function analysis also bases itself on what the consumers need and require for an urban furniture in an urban environment where it is crowded. By having a vast variety of people and cultures with different passions and visions, the adaptability factors for different types of people, for example people who have children, disabled people on wheelchairs, adapted for children where they can have activities, having the ability to park the bicycles and E-bikes with the opportunity to charge them.

4.4 Human centred pyramid

The human centred pyramid describes what is needed in the urban environment and the aim of the project:

What: Urban furniture, semi-public space,

Why: Lack of semi-public space, lack of interest, lack of communication, lack of sustainability factors.

Where: Urban city, Jönköpings municipality.

Who: The citizens of the urban space

When: Today 2022/2023 and upcoming years.

How: Human centred design, create a good user experience.

4.5 Persona

The personas were conducted on fictional people who are adapting their life inside urban cities, with different passions and life experiences, some of these people have disabilities, some are tourists from other countries and cities. The fictional people will help the development process and assist the functional analysis as seen in appendix 3.

4.6 Scenario sketches

The scenario sketches are designed to show and roleplay scenarios of different people doing activities inside and around the artifacts as seen in appendix 4.

4.7 Mood board

The mood board describes and visualizes what the project is aiming for. Each picture is communicating the structural shape and functions of the guidelines of other structures and products, sometimes categorizing themselves as modern urban furniture, with inspiration of colours and materials both in concrete and wood in different tones and styles.

Moodboard

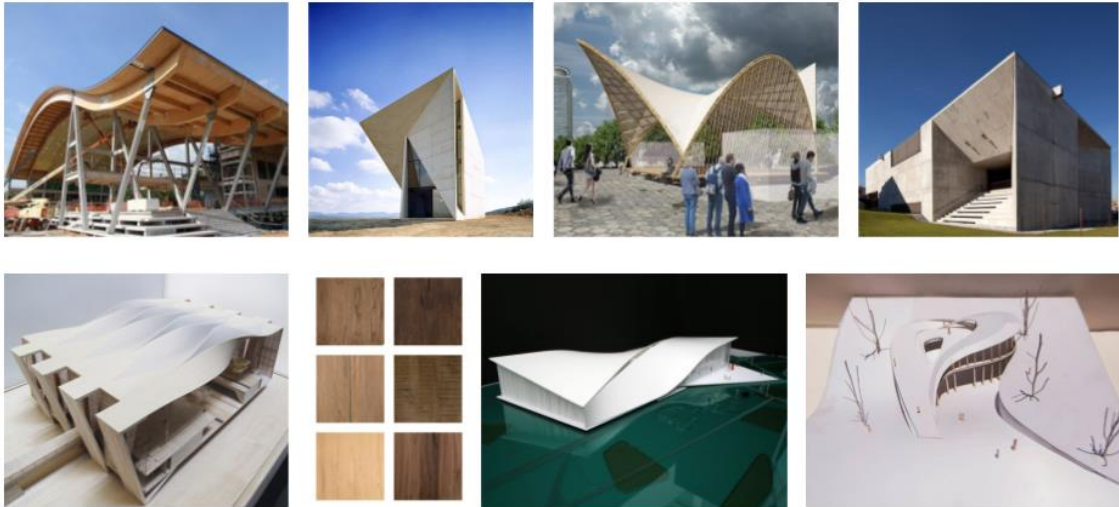


Figure 2, mood board.

4.8 Trend analysis TAIDA

The trend analysis will assist the choice of the concept and apply a trend to it, suggested materials trend and manufacturing techniques by tracking, analysing, imagining, deciding and acting around different trends in the era the project is going to be developed around. Each trend analysis module discusses the different opportunities that the artifact can be designed around as seen in (*appendix TAIDA*).

4.9 Brainstorming

The brainstorming got divided into sessions, where each session had a sketching event in the design studio of re-invent your future company. The sketching session contained 3D sketches, by sketching different types of structures, where each structure is acting like it is an outdoor building exposed to the outdoor environment. Each structure shares the similarity of having big windows, fountains, ramps for people with wheelchairs and for people who have child strollers, an amphitheatre, space for children, pets and the possibility of having an art gallery, kitchen and private rooms for work. Every sketching event ends in a discussion between me as a designer and the other members in the design studio of re-invent your future who also have engineering and design passion. Each discussion gave feedback around what functions should be included and declassified, with the help of a go-no go matrix through the brainstorming process.

QUICK SKETCH EVENT



Figure 3, quick sketch event.

After many discussions and workshop events where interviews were conducted with both engineers and designers from the engineering school of engineering of Jönköping and other professional architects and material experts. The concepts that had the best manufacturing possibilities and could provide all the agreed service and functions for the citizens and roleplay from the workshop event were going to be chosen for further development.

The ideation phase was focusing on universal, adaptable, durable and appealing design.

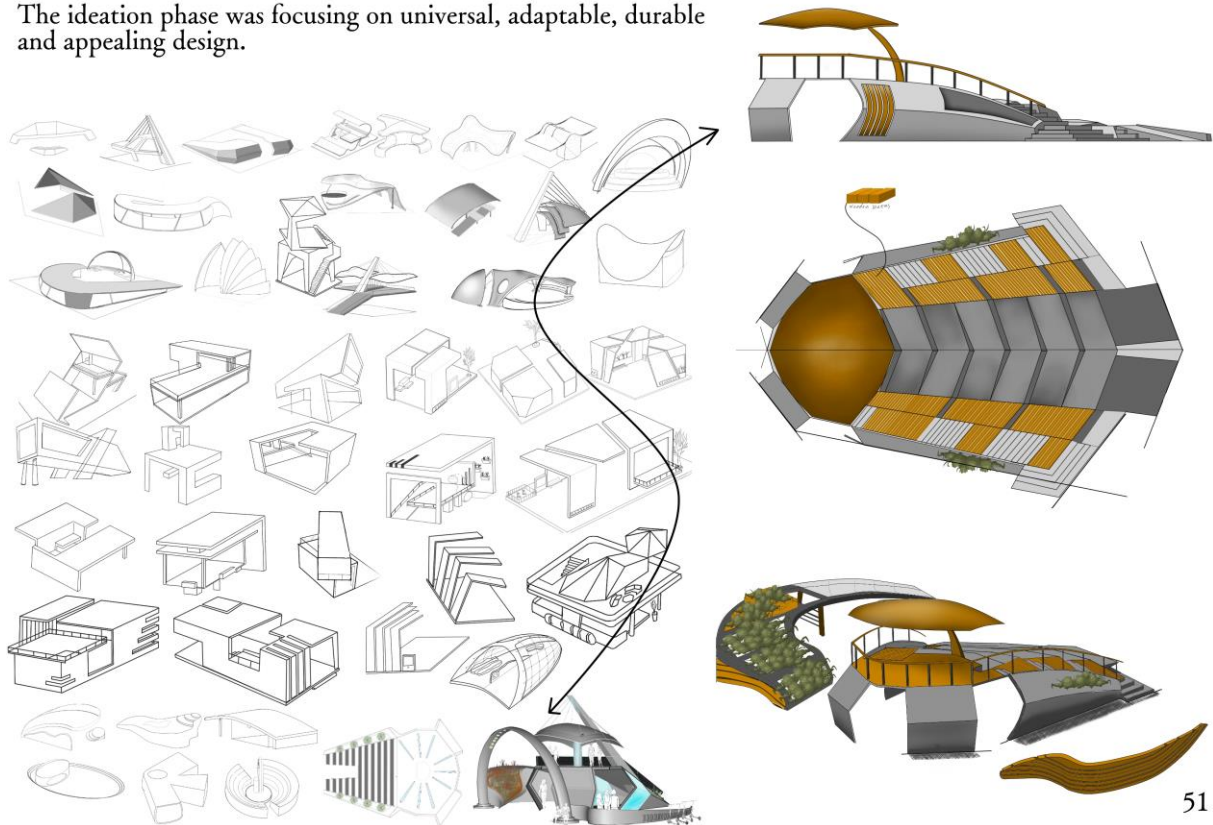


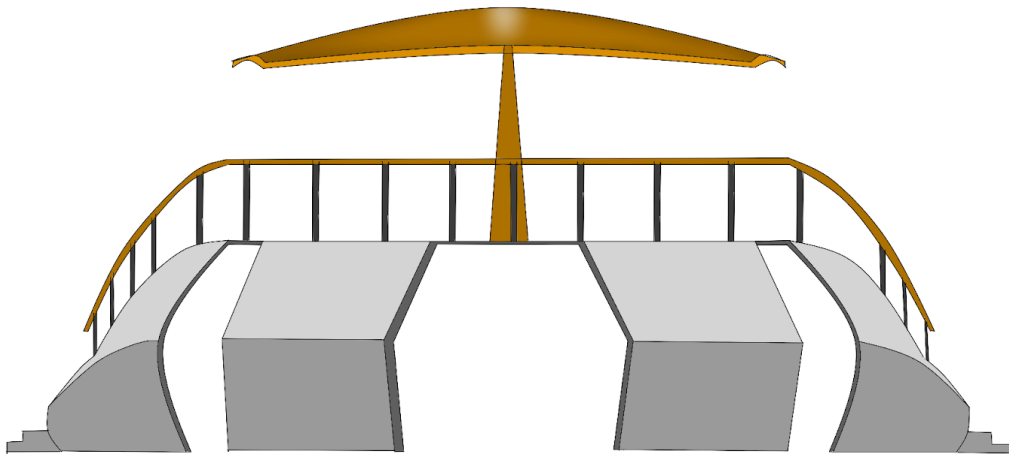
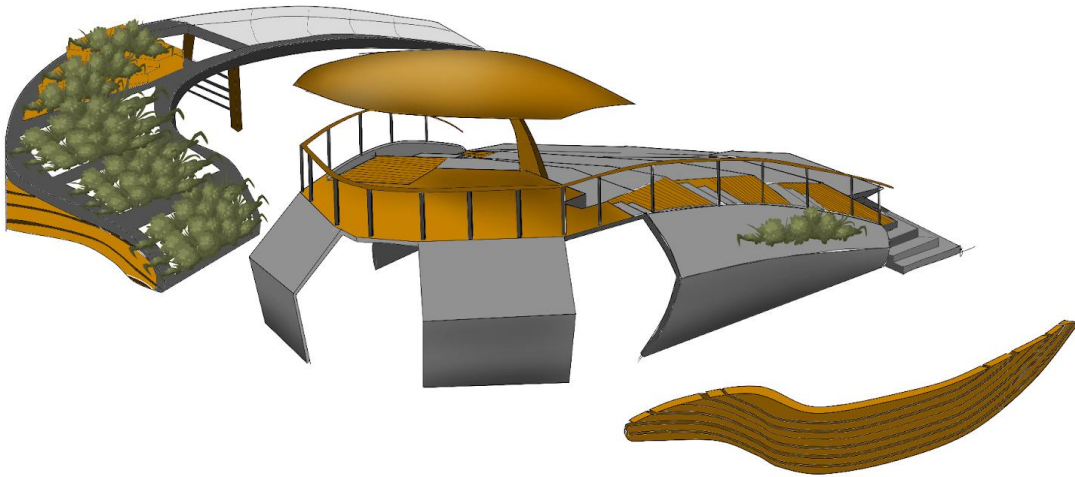
Figure 4, brainstorming event.

Some of the concepts were designed with the mind of having two floors, the second floor can be accessed with stairs and ramps. The other concepts were designed with a single ground floor in mind, with the consideration that all solutions that are ideated must share the same functionality factors from the function analysis.

Figure 5, brainstorming event.

4.10 Final design

The final concept was chosen with a relation of a presentation and a discussion with the Re-invent your future company and a presentation at the design studio of Jönköpings tekniska högskolan. The chosen concept was named (The Artifact) and it was the winning concept because it was the one that had the accessibility to conduct all the space needed to deliver the best user experience and the required functional aspects.



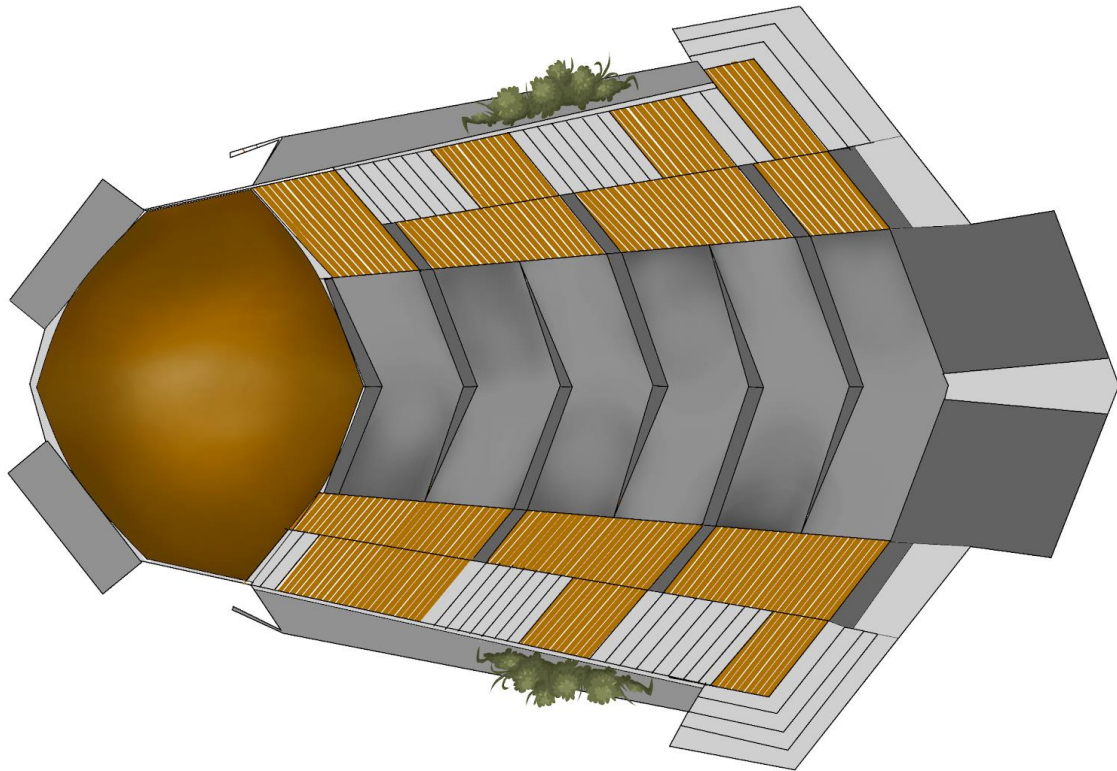


Figure 6, final design sketch.

The final sketches of the final concept will be assisting the CAD design process, since they will be inserted in the CAD software as canvases to assist shape the 3D module.

This shape combines the states of both dynamic and static form, where at the front of the artifact has a static shape, it is achieved by straight lines and a still position with no energy form, combined with the back and the sides of the Artifact that are designed to be as dynamic shapes with curvature where they deliver energy and flow with the rhythm of Artifact.

By exploring different shapes, I as a designer and Re-invent your future decided to combine different structures from the brainstorming process. The combination led to a born idea of combining 3 structures, each of the structure will serve a different purpose to the consumers by having different functions.

This shape was chosen due to its universal design for all consumers, it delivers space to all types of consumers with high attraction of its shape and design making this concept appealing in the city. The universal design creates space for disabled and elderly people, by removing obstacles from the Artifact with the ability to deliver safety for the consumers by providing products that function to assist the consumers and deliver safety factors at the same time. Such products are introduced as multifunctional staircases where it assist people to hold on to while walking up to the second floor and also prevent people from falling while they are on the second floor, the stairs and the ramps, these staircases use different elements such as cables at the bottom and beams to assist both children and people with wheel chairs to hold on to while going up to the second floor and prevent them from falling of the structure.

Space for children was also designed separately from the main middle structure, with a free space in between the main structure and the space for children. The space for children has enough space to

include different types of products for children to interact with and spend their time with other children.

On the right side of the main structure, a seating area and a bicycle park with the ability to conduct an E-Bike charging station vegetations and other products.

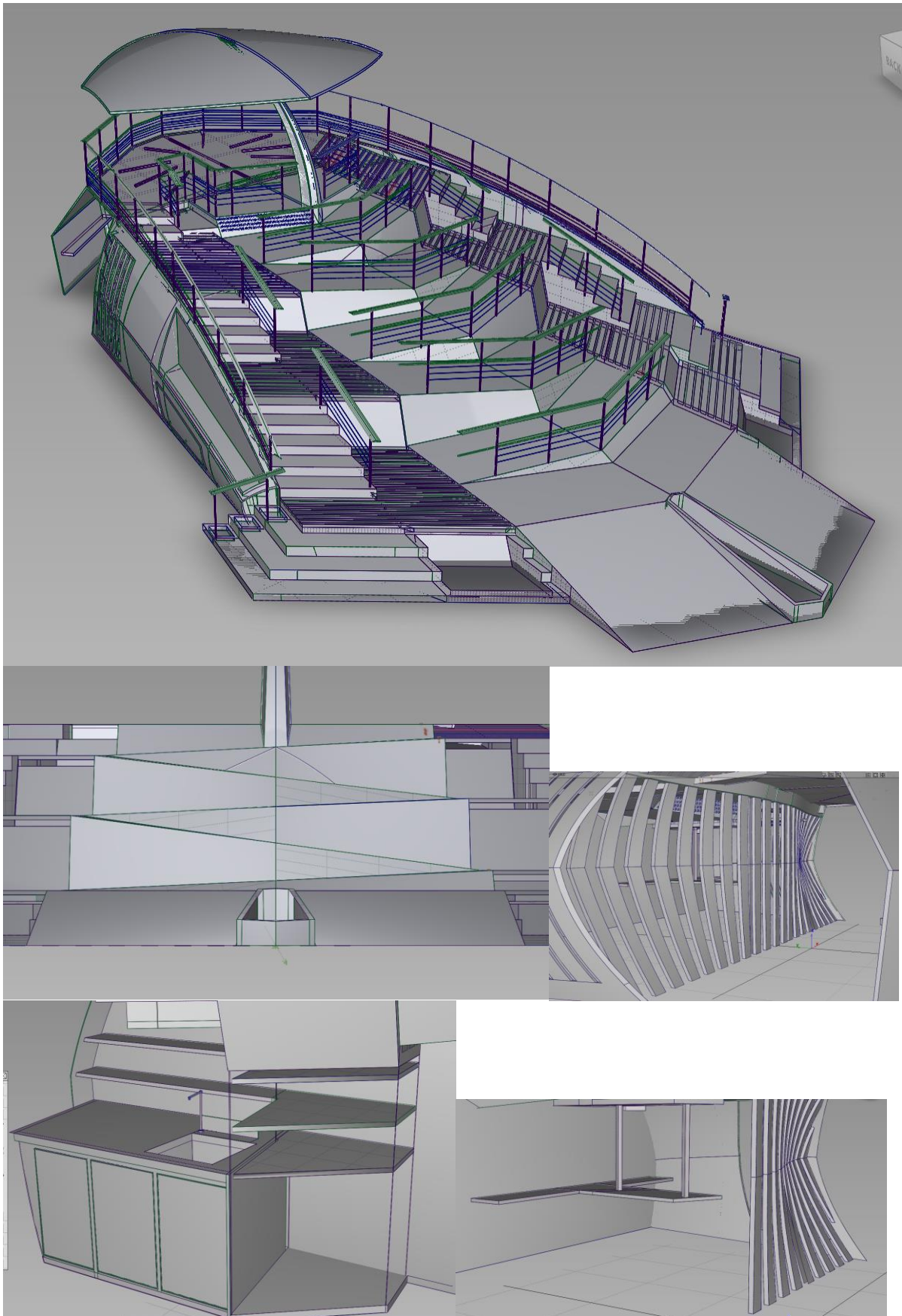
Inside of the artifact there is a vast area that gives me as a designer the ability to conduct an adaptable kitchen and a space for people to work, study and have short meetings, this space is separated by a wooden barrier, dividing the space into an open space and a space that is closed at night time to prevent vandalism.

4.11 CAD

The CAD process started by inserting canvas sketches into the Autodesk Alias CAD software, the sketches were previously designed in 2D-form to assist the 3D modelling construction process. The 2D-sketches were used as a reference to assist the shape, the curvatures, lines and elements of the structure such as ramps, stairs, doors and windows of the structure, though only the outer shape of the structure was used as a reference, excluding the accuracy of measurement to the stairs, ramps and other dimensions of the structure, which only gave an idea reference about how the shape will be visualized in a from the sketches point of view.

Auto desk Alias is a surface modelling software, where it delivers very high-quality surfacing methods for the designers and helped me as a designer to work in the same pipeline method, leading to accurate surface modelling and assembly for all 3 constructed objects and all parts that they include.

All 3 structures include multiple parts, both on the outside and the inside, though they were all designed on the same CAD software resulting in accurate measurements and tolerances in between the parts. The ramps, stairs, staircases and the table were all designed according to standard measurements used for urban furniture and urban environments. The ramps on the other hand got measurement references from companies, literature and ergonomic tolerances for people who have wheelchairs, child strollers and elderly people [32]. All the parts got modified and polished for the final version of the design as seen in *figure 7 below*.



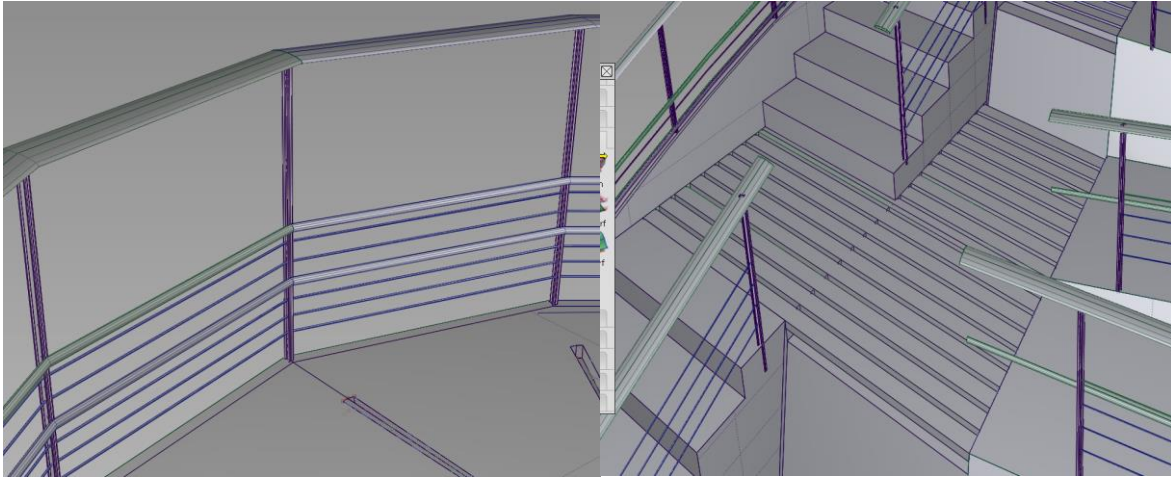


Figure 7, CAD process and assembly of main structure, The Artifact.

The left structure that is designed for children, delivers a vast space for children activities where many different products can be installed on and inside the structure to create the best interaction experience for children where children can use these products, though only a climbing tower with a slide were designed for this project as seen on figure 8 below.

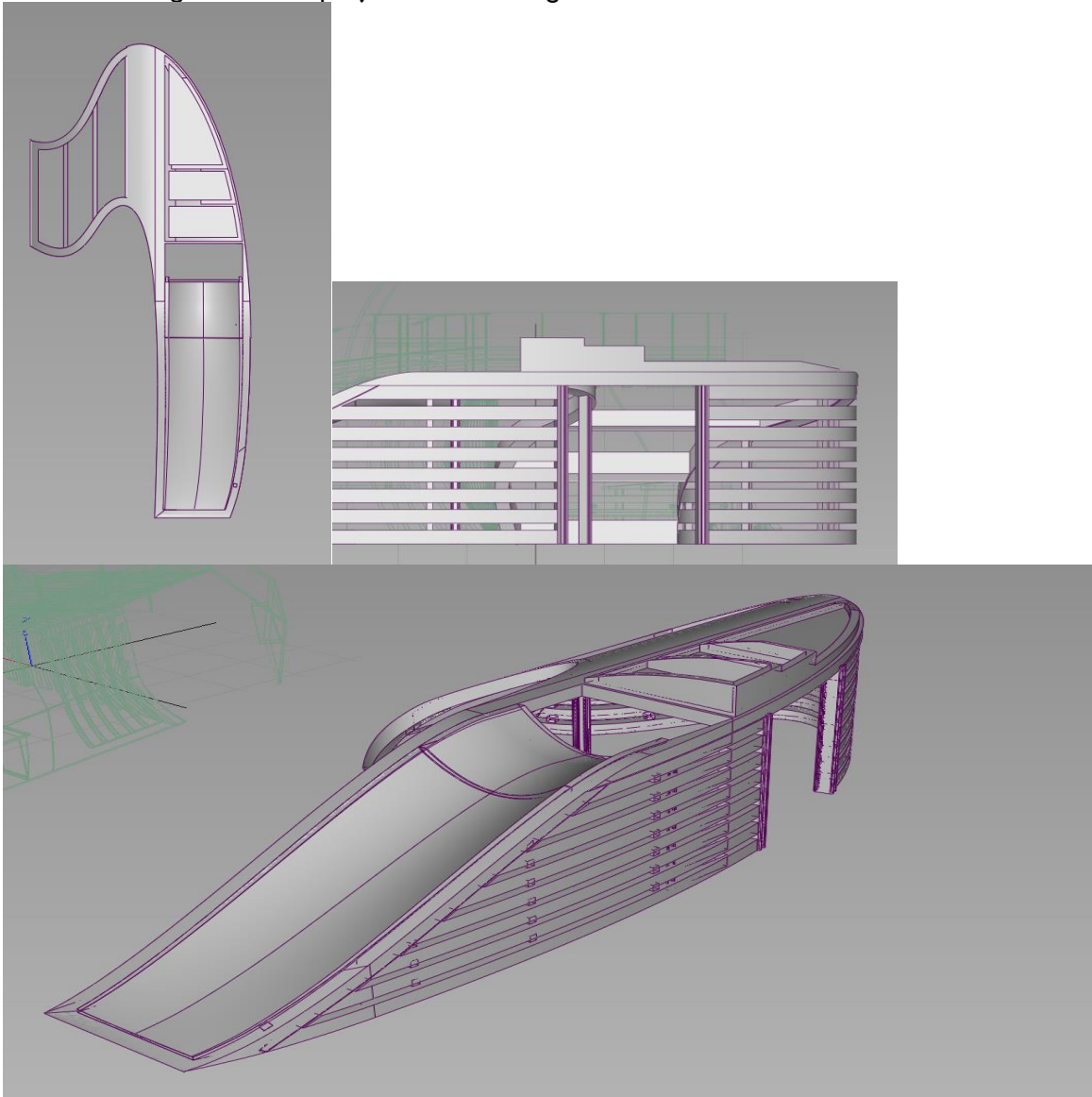


Figure 8, the children area.

On the right side of the main structure, a seating area was designed with a custom designed bench and a bicycle parking space as shown in the figure 9 below.

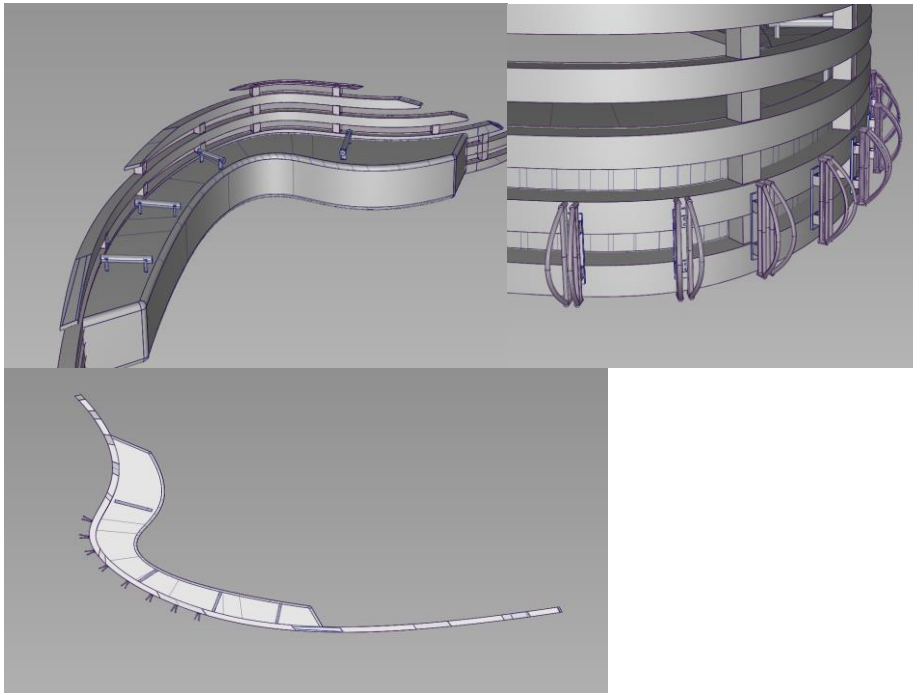


Figure 9, The outside seating area.

4.12 Visualization

The visualizations were made to communicate and visualize the artifact with the material selection. This process was conducted after all 3D models at the CAD process were finalized and assembled, though all the extra products that are seen in the renders are not designed by me the designer, they are all downloaded from [archibase.com](https://www.archibase.com) and [grabcad.com](https://www.grabcad.com) to make the artifact look functional and can implant furniture such as benches and tables and deliver the designed space.

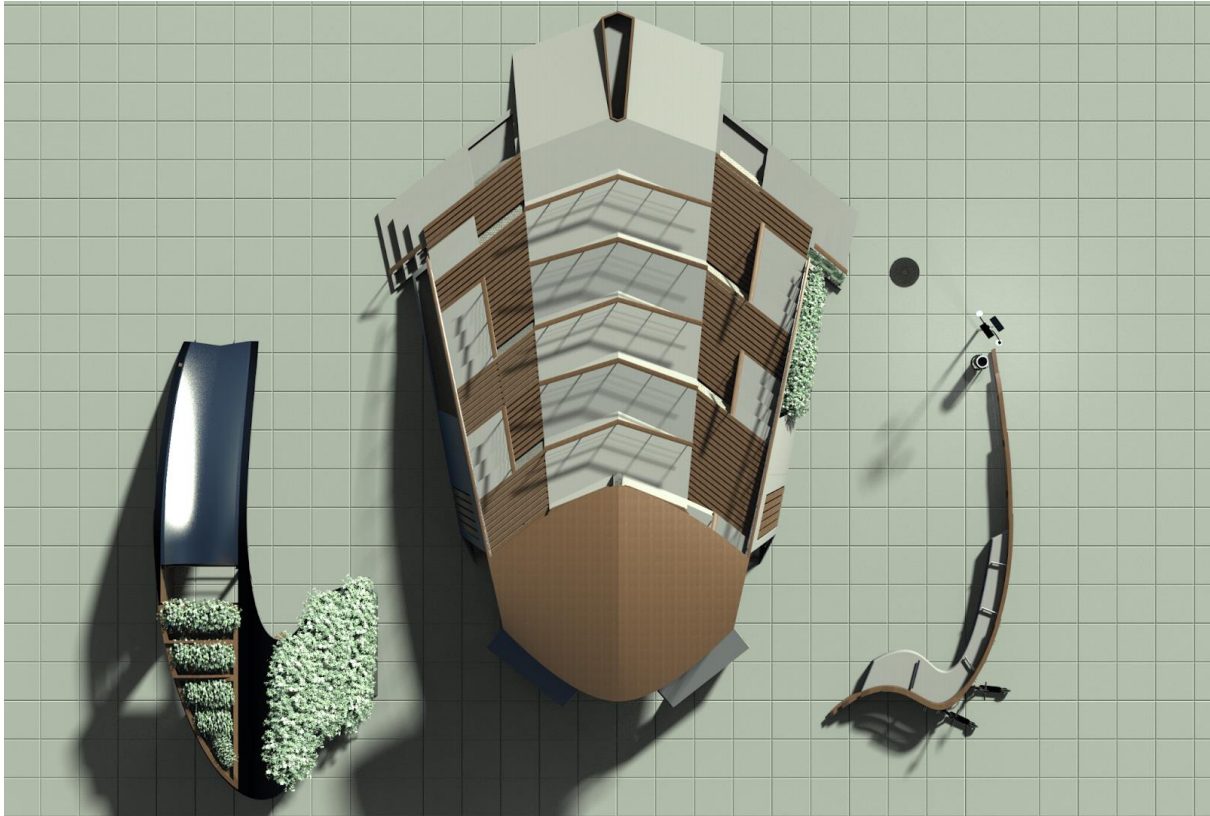


Figure 10, simple visualization of The Artifact.

4.13 Mock-up

Mock ups were designed with rough CAD modelling, since it would be difficult and time consuming to create a mock up from high density foam or hardened paper sheets. This method is chosen due to the curvature and surface design where it would make it difficult to mirror the curvature and get the right curvature tolerance at both sides. Later at the muck ups creation process, a 3D printer was used to 3D print the mock ups as seen in appendix 5.

4.14 Prototype

When the CAD 3D modules were finalized, a prototype at a 1:55 scale was created to visualize and communicate the structure, though only the exterior of the structure was visualized for the prototype. The creation of the prototype started inside the workshop of Jönköpings Tekniska Högskolan, where the CAD files got converted into the 3D printing software for preparation of the 3D printing process. All 3 structures were 3D printed and got cleaned of the extra plastic filament, which later got lightly brushed and polished with sandpaper for a smoother finish before painting. The prototype was painted white for the best visualization experience as seen in appendix 6.

4.15 Go-No Go matrix

The elimination matrix helped me as a designer to only consider the concepts that could fit the required functions and space into the structure where they can deliver what the consumers, designers, constructors require to the agreed services from the main, desired and necessary

functions of the function analysis. Solutions that could provide the space needed to conduct all the necessary functions were chosen to continue in the development process. Other reasons for eliminating solutions are the manufacturing techniques of the structure and not having the possibility and the technological aspects of creating a concept that are complex and does not meet the requirements of design for assembly and manufacturers.

4.16 Pugh's matrix

Based on wishes and requirements created with the help of the re-invent your future design studio, all aspects must be considered and weighted to have a valid comparison:

- Visual identity: How/poorly the concept represents the city.
- Visual identity: How/poorly the concept appeals to the citizens of Jönköping.
- Visual identity: How/poorly is the concept perceived to be for decibels people.
- Visual identity: How/poorly well the concept links the structure.
- Weather resistance: How durable the concept is in a wet and cold environment.
- Event management: How/poorly the concept acquires events.
- Vertical gardens: How/poorly the concept implants landscape and vertical gardens.

The matrix was analysed and weighted around the final concept.

5 Result

The result of this project was aimed to deliver a conceptual designed prototype that is designed around a purpose and research questions that are formulated around a problem in urban environments, literature and methods were collected and used to study and assist the solutions generated around the problem.

5.1 Final design

The Artifact was complete, as a conceptual prototype delivering an universal and vast space for all types of consumers where multiple activities such as resting, social interacting, working, studying, finding information, presenting, etc is implanted into the space. Space for the people, children, vertical gardens, water fountains, a kitchen, silent room and bicycle parking were all included inside, on top and around the Artifact.



Figure 11, full scale render of The Artifact.

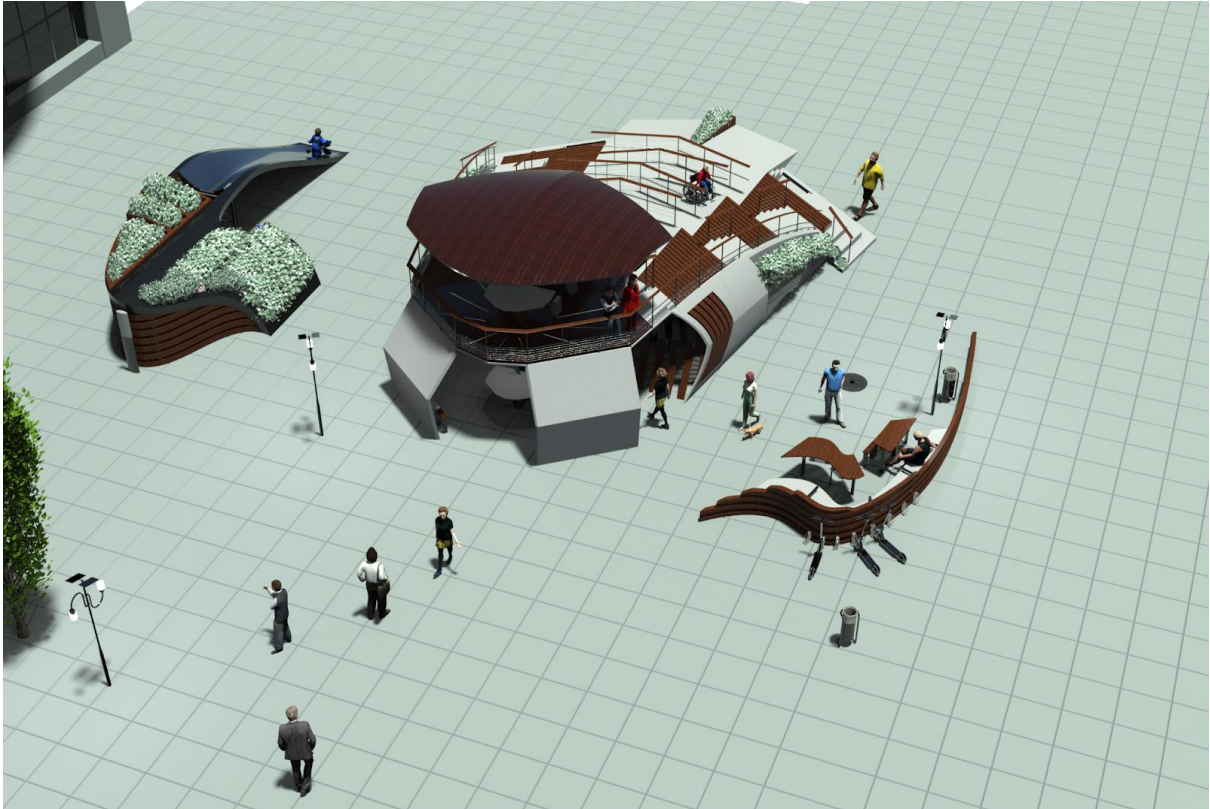


Figure 12, full scale render of The Artifact, top view.

The materials that were used as a proposal to visualize the Artifact were concrete, wood, stainless steel and aluminium. These materials can survive cold weather and resist wind stress, they are materials with high strength characteristics where it makes the structure durable for a long period of time and difficult to vandalize. Vandalism elements such as metal rods are placed on the designed benches to minimize the probability of the people to sleep on them, along with vertical gardens placed on the walls of the artifact which will also help to minimize vandalization with spray paint.



Figure 13, full scale render back view.

An art gallery used by citizens, artists and companies that want to display art, products, and projects is designed inside the concrete structure. Along with a smart pop-up kitchen that can be used by consumers who tend to reserve the structure to showcase their productivity and create activities for the citizens.

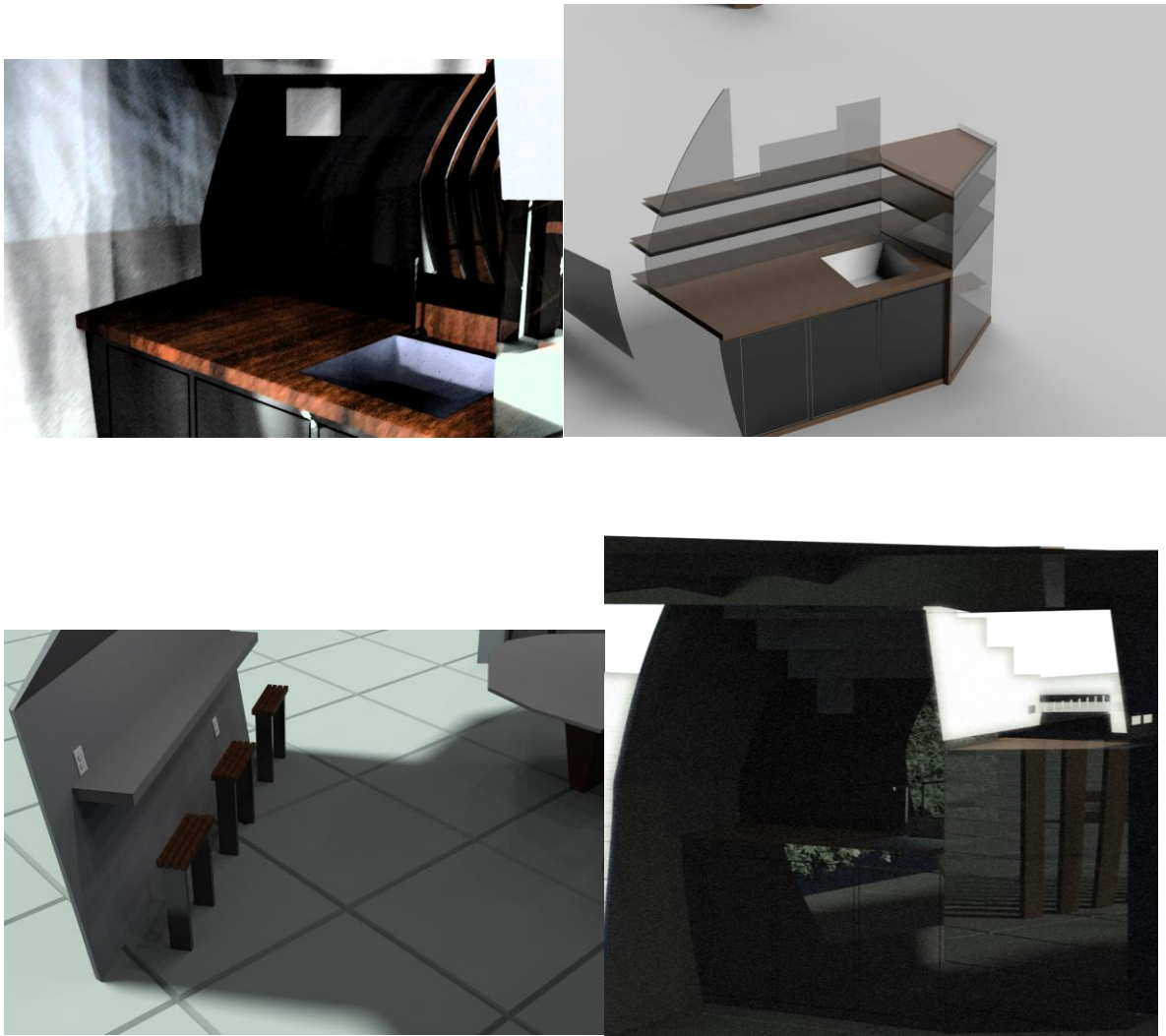


Figure 14, full scale render of the interior of the main structure of the Artifact, showing the art gallery, seating area and the adaptable kitchen.

Silent room is designed inside the concrete structure with the purpose of being used by the people to work, study and meet.

A dynamic wooden barrier inside the concrete structure is constructed with the ability of closing a part of the structure at night time, preventing people from entering inside the Artifact and into the art gallery, pop-up kitchen and the silent room area, this wooden barrier is implanted to prevent vandalism and protect these elements.

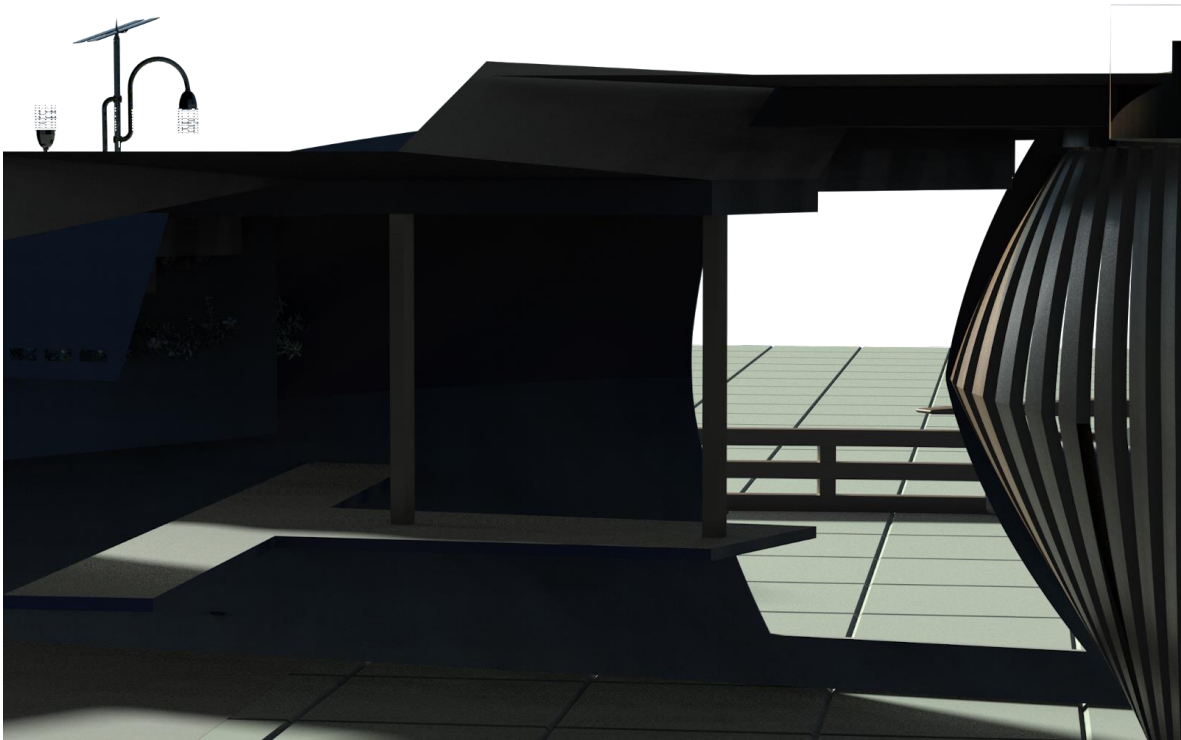


Figure 15, full scale render of the silent room inside the main structure of The Artifact.

The waterfall inspired fountain is designed on top of the concrete structure, following the path of the ramps and the stairs by letting the water fall with the assist of gravity to the bottom of the structure where water is gathered in a small pool and pumped to the top again for the same use.

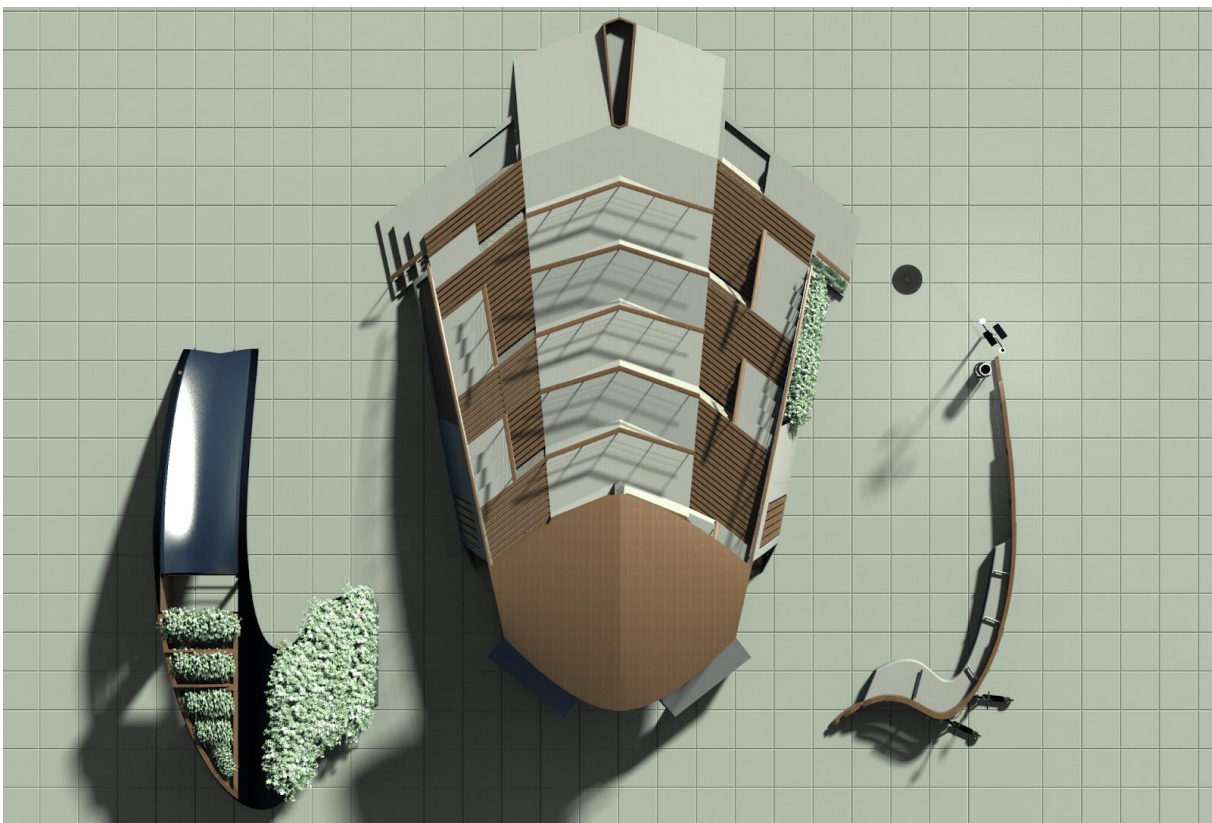


Figure 16, Wooden floor and waterfall beneath the wood, the pool at the bottom of the structure.

5.2 Ergonomics

The Artifact is designed for accessibility, meaning a universal space design for all types of consumers is important, elderly people, people with disability, children, people with child strollers and carriage must all have the same type of accessibility to the Artifact. Removing obstacles is an important element in urban furniture design, obstacles such as stairs cannot be accessed by people with disability such as people with wheelchair, sometimes even by elderly people who doesn't have enough energy to use stairs, to solve this type of problem and deliver the best comfortable solution for all these type of people, ramps were designed to give an option for the people to use them safely and get to the second floor of the Artifact.

Ramps were designed parallelly on top of each other to provide accessibility of going up or riding the wheelchair to reach the second floor of the concrete Artifact. The ramps are elements designed with the purpose of removing obstacles for people who can't use stairs, they are designed with a standard height of maximum 25cm for each ramp with a flat area for resting in between each ramp. The ramps are designed with a 1:12 ratio, meaning with each 1 meter of height there is 12 meters of length, with an angle that does not exceed 8% tilt from the horizontal plane. After each ramp there is a flat surface plane for people to rest after using the ramp, the surface plane has an area of 2 square meters. This area assists the people to rotate their wheelchairs, carriages and child strollers.

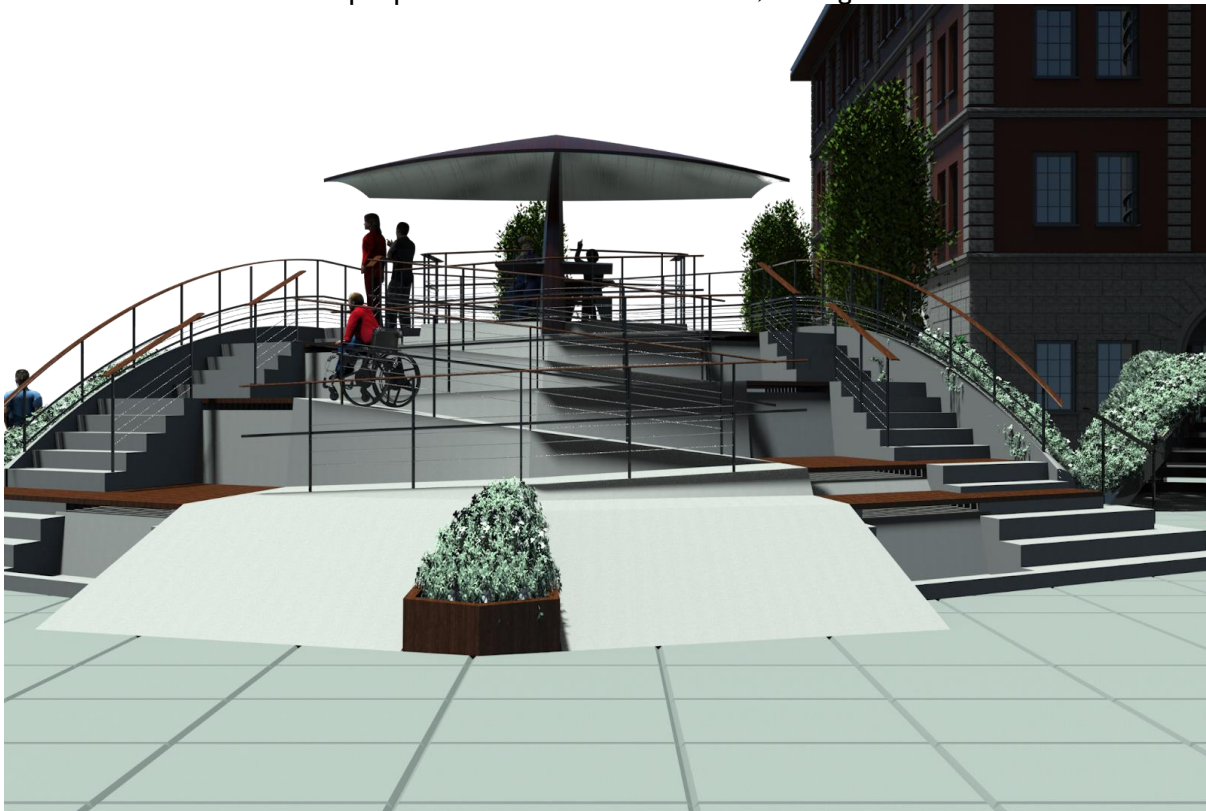


Figure 17, showing people using The Artifact.

Staircases are designed with elements that assist the users and deliver safety at the same time, they are designed with a half spherical top to provide comfort while holding them for assistance. A cylindrical rod is designed beneath the wooden staircase top to assist children and people with wheelchairs. Stainless steel cables are implanted to prevent children from falling from the Artifact. Around the ramps similar elements are found to assist the people with disabilities and elderly people for going up and down and prevent them from falling.

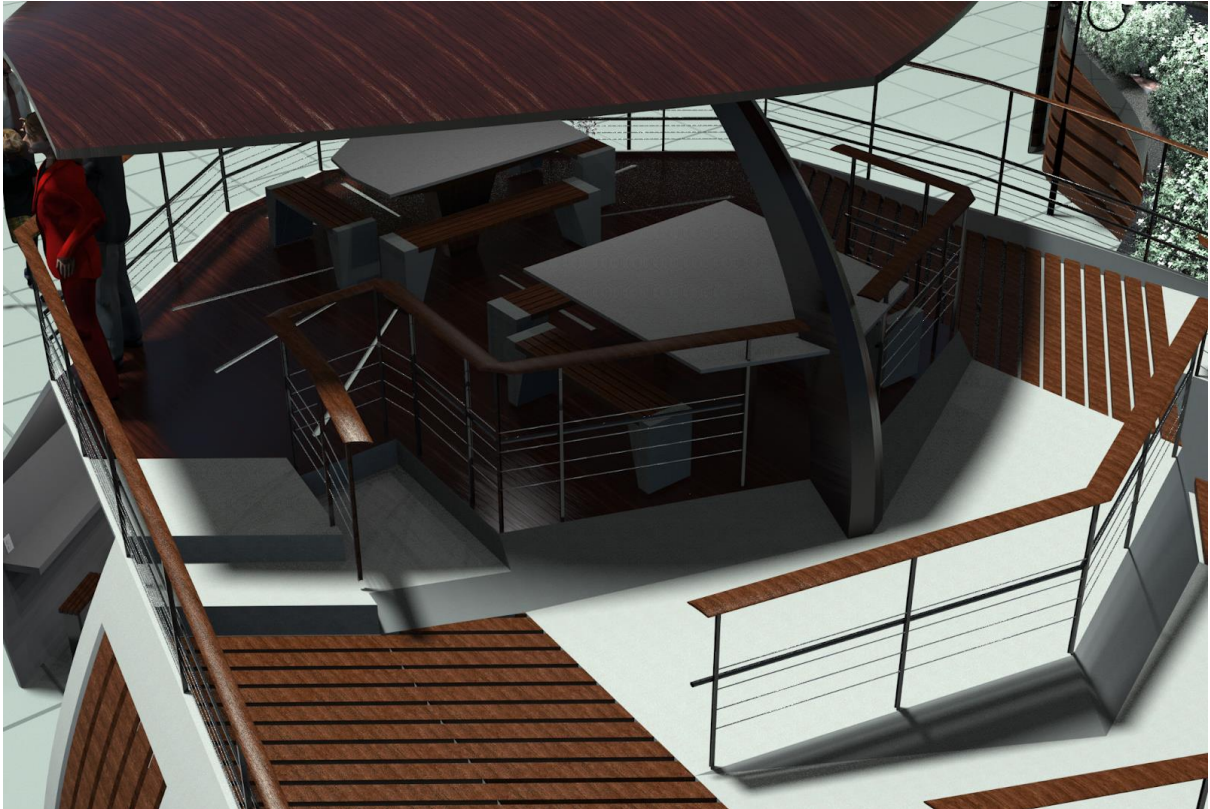


Figure 18, full scale render of the wooden floor and the star case.

The stairs steps are designed with a standard height of 16cm, making each step match the height of street steps and stairs in urban environments making it safer for the users to use the stairs for going up and down by sharing similar shape and surface area in the urban environment.

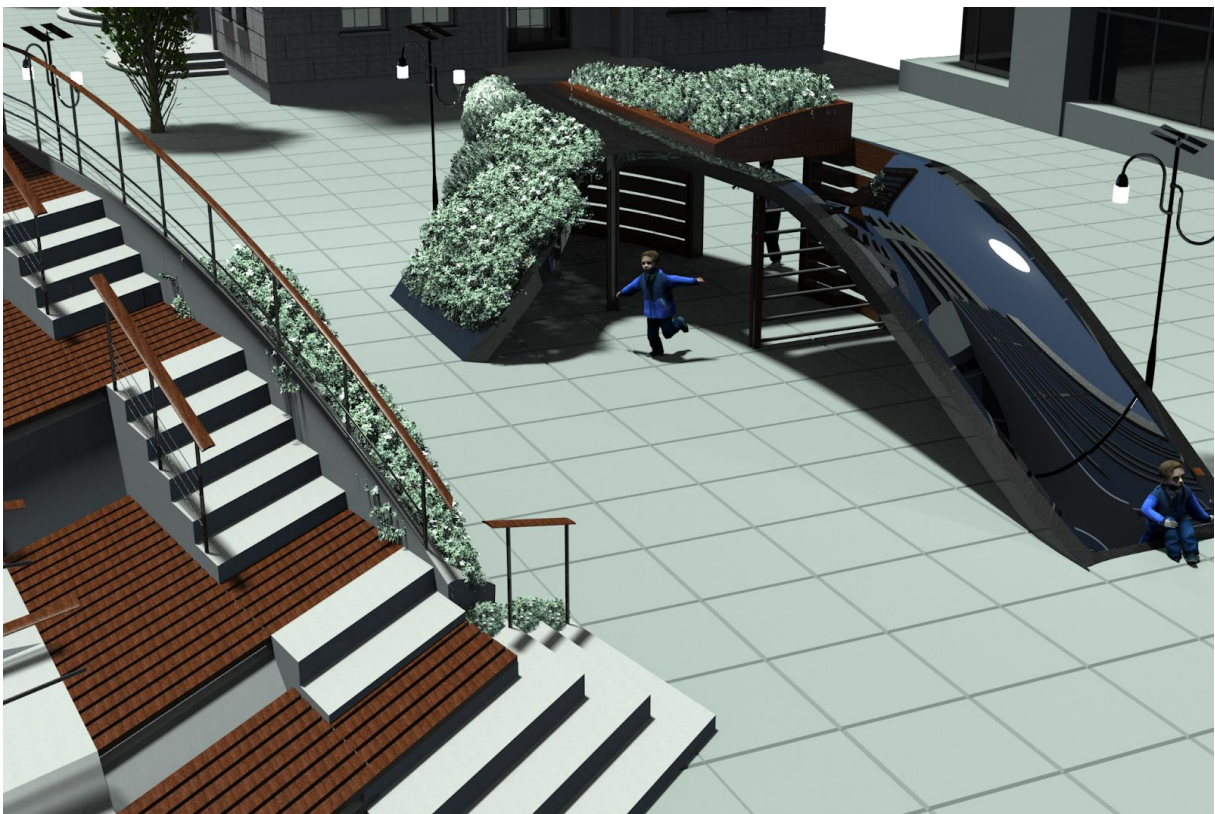


Figure 19, full scale render of the staircase, stairs and the wooden plank floor.

The children area is designed with no sharp edges, making the entire area safe for children to use, climbing stairs that are designed for children to climb up to the slide tower are designed with a cylindrical tube with a 25 cm distance in between each rod. A high dense rubber floor is proposed to prevent children from getting hurt where it makes a smooth floor for children to stand and play on and will have better protection for them in case, they fall from the slide tower.



Children area

Figure 20, full scale render of the children area with children interacting with the furniture.

The seating area that is combined with the bicycle, E-bike and scooter parking is designed with a concrete bench that has implanted metal roofs that prevents people from sleeping or using the bench incorrectly. The backside has an implanted parking mount and can also implant a universal charger for all types of E bikes and vegetation mounts.

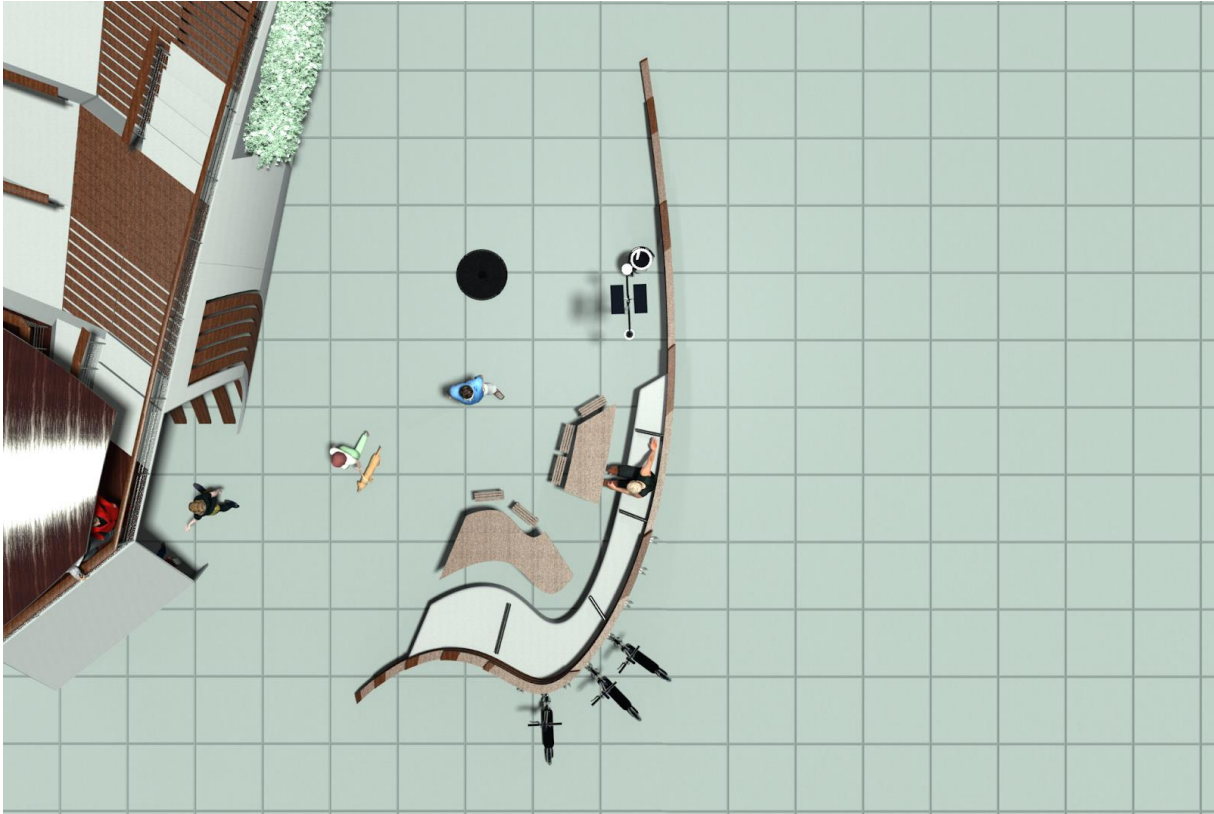


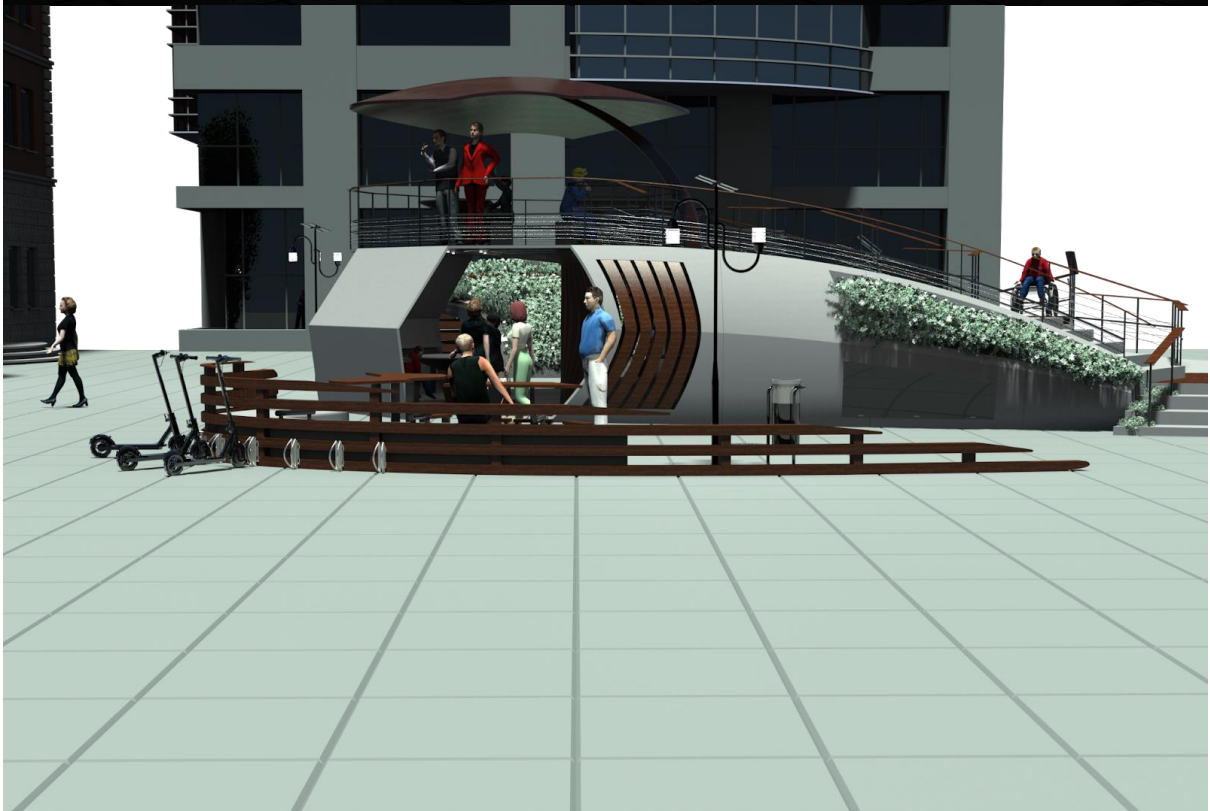
Figure 21, full scale render of the outside seating area with the implanted bike mount, concrete bench and custom-made tables and wooden benches.

To prevent people from getting inside the Artifact at night time, a mechanical wooden door was built with a sliding system that allows the door to open and close easily. This mechanism will prevent vandalism at night time, preventing people from stealing the art in the art gallery, using the private room, or destroying the popup kitchen.



Figure 22, full scale render of the dynamic wooden barrier inside the main structure.

The Artifact was finally complete and visualized in different environments, during day and night time:



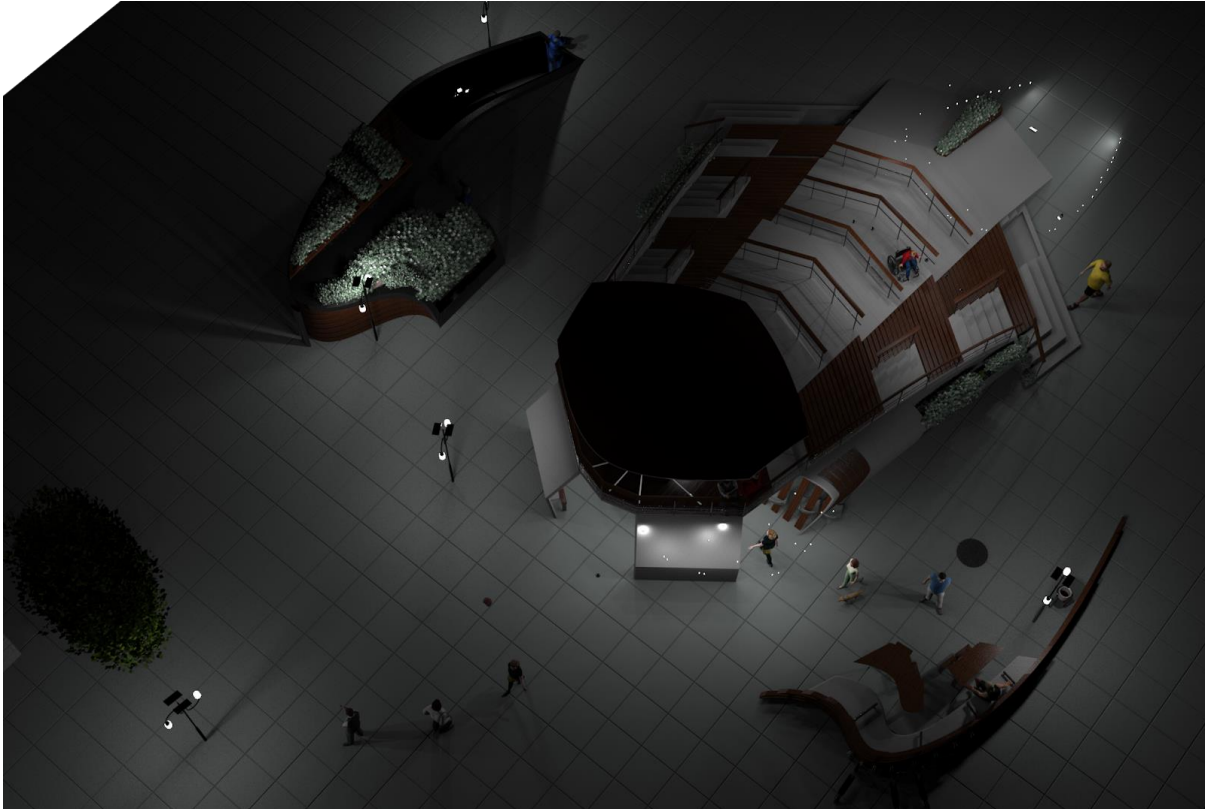


Figure 23, full scale render of the Artifact in different environments during night and daytime.

5.3 Construction method

Manufacturing techniques that are suggested as a proposal to manufacture and construct the Artifact were precast concrete methods, adaptive concrete 3D printing technology, laser cutting technology and saw tools to cut the wood. The first proposal for the concrete structure is precast concrete parts that are manufactured in the manufacturing industry and shipped to the construction site for assembly.

The precast concrete method is used by constructing moulds to hold the concrete cast, since concrete does not desire a specific shape, it can be created in any geometrical shape as long as there is a mould that can hold up the concrete until it hardens. The moulds can be created from different materials such as plastics, plywood and metal. Since the concrete must have reinforcement, both flexible and static reinforcement can be used to construct the cast, flexible reinforcement materials can be used as textile such as synthetic, alkali-resistance fibres and the static materials are used as iron beams that can be bent and formed to the shape mould.

The moulds are designed to the proposed shape, with the help of support of timber lattices, placed horizontally along the curvature of the mould, each timber must be positioned vertically with a specific height that follows the curvature line.

Fabric moulding can be used to create natural looking surfaces, this type of method is not assisted by CAD software, therefore it must be manufactured by hand. Fabric moulding can be used to cast the waterfall walls, for a textured concrete mesh on the main structure.

Adaptive manufacturing techniques with concrete, 3D printing, the entire concrete structure can be 3D printed on site. This method can create the concrete main structure by printing concrete layers upon each other delivering a high potential of creating very complex shapes. Print in print method will deliver a strong structure that can withstand load and stress.

Different types of wood can be used to construct the Artifact, leading to the opportunity to choose from different tones of wood materials that have different characteristics. Laser cutting technology will give the advantage for manufacturers to rapidly cut the wood and shape it to the dynamic 3D shape with curvature. Glass was proposed to create an art gallery inside the main structure.

The metals on the main structure and on the secondary structures can be manufactured by welding the stainless steel and aluminium.

6 Conclusion and discussion

6.1 Methodology implementation

The method chosen for the design process, bootleg bootcamp, was not fully strictly used during the process, which happened due to errors in the design flow, where reconsiderations for some of the parts in the process had to be taken.

These reconsiderations were formulated around the material selection, ergonomics, and the manufacturing techniques, where each of these factors had to be considered for the design of the Artifact. Since we chose to design a complex shaped geometry structure, the design process had to repeat itself to get an accurate Artifact that could combine all these 3 structures. The bootleg bootcamp methodology does not strictly forbid the designer to fully implant it and follow it, and this factor helped me as a designer to redesign the artifact and implant methods and tools that could make the project a success.

The timelapse and planning of the project was not strictly followed due to the reconsiderations that were mentioned earlier, deadlines had to be reorganized in the systematic Gantt-chart methodology.

6.2 Research questions discussion

6.2.1 How can urban furniture create social interaction possibilities for the community?

Urban furniture is an important factor that has effective solutions to improve social interaction and the quality of the urban city environments. Social interaction refers to the fact that people will have opportunities to create relationships with each other.

Communication between people can be created when there are the right circumstances in the environment. Urban furniture is a huge factor that can create good reasons for communication between people if it is planned in the right way where it can create opportunities for people to interact with each other. Strangers or people who are familiar with each other, have the same conditions to communicate and create new relations, for example if the urban furniture or a structure are place close to each other with linkage and good placement with linkage of the urban furniture, promotion to interaction and communication will result great conditions for people to sit close to other humans and communicate with them, where they can get to know new people and create relationships with them.

These conditions have been created inside and outside the Artifact where furniture and elements were planned and placed close to each with linkage to utilize space and create conditions and opportunities for social interaction.

Interest is another huge factor that can drive social interaction, the more interest there is, the more chance there is to create new relationships between humans, for example, creating events such as presentations, music bands or to create art galleries for people where they can join to watch, listen and communicate with other people. The events can be arranged from the same people who come and use the Artifact, however these events can only be created for the people and not for the creators own use.

6.2.2 How can urban furniture be appealing for the urban city environment and its citizens?

The design of the urban furniture has a big role in this section, the functionality and who the furniture can create interest for the people. The geometrical shape of the furniture also plays a big role in how pleasing and appealing the furniture is for the urban environment, as the geometrical form can drive people to the structure, creating interest for the people where they will become curious to explore the structure and its components. The structure can resemble the city's reputation, from the technological, architectural, educational and sustainable aspect, as the people from the city and other cities such as tourists can use the structure and its components to get information and a look of the city structure. Plants and vegetation create a natural environment in populated urban areas where there is a lack of nature. Functions plays a big role in how appealing the structure can be for the urban environment, how people in the city can interact with these functions and how much need they have for them, for example if a citizen have an E-bike and want to use the urban furniture for resting, waiting and communicating, they will have the access to electricity and charge the E-bike meanwhile using the structure at the same time. Another function that can create interest in the structure is to have access and ability to create presentations, music bands and create festivals and events for the people.

6.2.3 How can urban furniture be universal for use by all types of people?

A universal product that is made to be used by all types of people must consider all types of people such as children, elderly and disabled people. The brainstorming phase and the function analysis gave conclusions and questions around the adaptability of the structure to the urban environment and how the consumers will interact and adapt to the structure.

The Artifact was designed with many adaptability solutions to assist consumers to adapt to the functionality of the structure:

- Designed for accessibility where ramps and stairs were designed with suitable dimensions to remove obstacles from the structure and let consumers access areas that are placed higher than the ground level.
- Area for children was designed with no sharp edges and rubber floor in a huge structure where implantation of different products can be achieved to create a greater experience for children. Parents can leave their children at the children's area and can watch them while they rest at the main structure.
- Benches and tables were designed with suitable dimensions for urban environments.
- Silent room was designed for the people who want to read, work and have a quiet space.
- A kitchen is designed in case people want to create events and have a recourse of water, and kitchenware.

6.2.4 How to combine urban furniture and gardens together?

The combination of urban furniture and landscape were achieved by designing the urban furniture with implanted space for gardens on the urban furniture. The space was proposed in the brainstorming process since the beginning of the design process. The proposal was to implant the gardens vertically, to save up unused space such as rooftops, walls and spaces where the consumers would not use. This implementation will have benefits to the consumers, science the consumers and citizens will see and smell the plantation and the combination of architecture and nature, where it

will relieve them from the urban crowded environment that is polluted by transportation hazardous gas and industries.

6.3 Further work and development

The development process of the Artifact was a success, every element that was designed and implanted into the artifact delivers functions that can drive the Artifact to solve the problems of the urban city environment. Thus, some elements on the Artifact can be further developed, such as the roof of the main structure, where it can be re-designed to be retractable and adjustable for sun rays at the summertime and cold weather in the winter. The current state of the roof is static, it is not adjustable or retractable.

Benches and tables that are going to be implanted into the artifact are proposed to be custom made with the same design language of the Artifact, this implementation will create more interest in the Artifact where people can see furniture that are rare and designed with quality materials that suit the Artifact.

The children area can implant a wide range of products that suit children use, such as climbing products where the children can climb the structure and use the slide to slide down. As mentioned earlier in the report a soft rubber floor can also be implanted to reduce the impact of falling in case children do fall down from the slide tower.

The seating area with the bicycle parking space can implant a universal charging station for E-bikes and scooters, the universal charger should be designed with good ergonomics that suit all types of people that visit the Artifact.

The Artifact can be electricity powered by green energy, solar panels can be designed and implanted into the Artifact. Green energy will create a sustainable energy for the Artifact inside the urban environment.

Lightning systems can be designed inside and outside the Artifact to create a suitable lightning environment at night time.

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8 Appendices

Appendix I market research in the history study.

History

"Urban furniture is the equipment that have been built in different cultures throughout the history in order to maintain the order of society in urban life." Journal of History Culture and Art Research (ISSN: 2147-0626)

- The first urban furniture was found in the Roman Period



Date: Historical Roman Period

The lower plate of the Milliarium Aureum milestone

Task: Show directions of the road to the citizens of the roman period



Date: Historical Greek cities

Seating bench made of wood

Task: Theater benches used to watch theater instead of sitting on the grass.



Date: Historical Greek period

Seating benches made out of stone

Task: Theater benches that were developed from wood to stone used to watch theater.

Historical ages



Date: Late 18th century paris

1800-1900

The first consciously designed urban seating

Task: Urban seating bench used by people in public and semi public spaces.



Date: 1935 London park

Seating benches made out steel and wood

Task: Urban seating bench used by people in public and semi public spaces.



Date: 1950 Kungsträdgården Sweden
Nolas design

1900-2000

Seating bench made of wood and iron in sweden

Task: Urban seating bench used by people in public and semi public spaces.



Date: 1960 Switzerland Park by Willy Ghul

Seating benches made out fiberglas and tubular metal

Task: Urban seating bench used by people in public and semi public spaces.



Date: 1980 Park bench

Seating bench made of wood and iron

Task: Urban seating bench used by people in public and semi public spaces.



Date: 1940 - today 2022

Seating bench made of wood and iron

Task: Urban seating bench used by people in public and semi public spaces.



Date: Today's modern bench

Seating bench made of wood and polymers and sustainable materials

Task: Urban bench used in public and semi public spaces with **multipurpose**.



Date: Today's modern bench

Seating bench made of wood and Sustainable materials

Task: Urban seating bench used by people in public and semi public spaces.



Date: Today's modern bench

2000-2022

Seating bench made of wood and polymers and sustainable materials

Task: Urban bench used in public and semi public spaces with **multipurpose**.



Date: Today's modern bench

Seating bench made of Sustainable materials.

Task: Urban seating bench used by people in public and semi public spaces.



Date: Today's modern bench

2000-2022

Seating bench made of wood and polymers and sustainable materials

Task: Urban bench used in public and semi public spaces.



Date: Today's modern bench

Seating bench made of wood and Sustainable materials

Task: Urban seating bench used by people in public and semi public spaces.



Date: Today's modern bench

2000-2022

Seating bench made of wood and polymers and sustainable materials

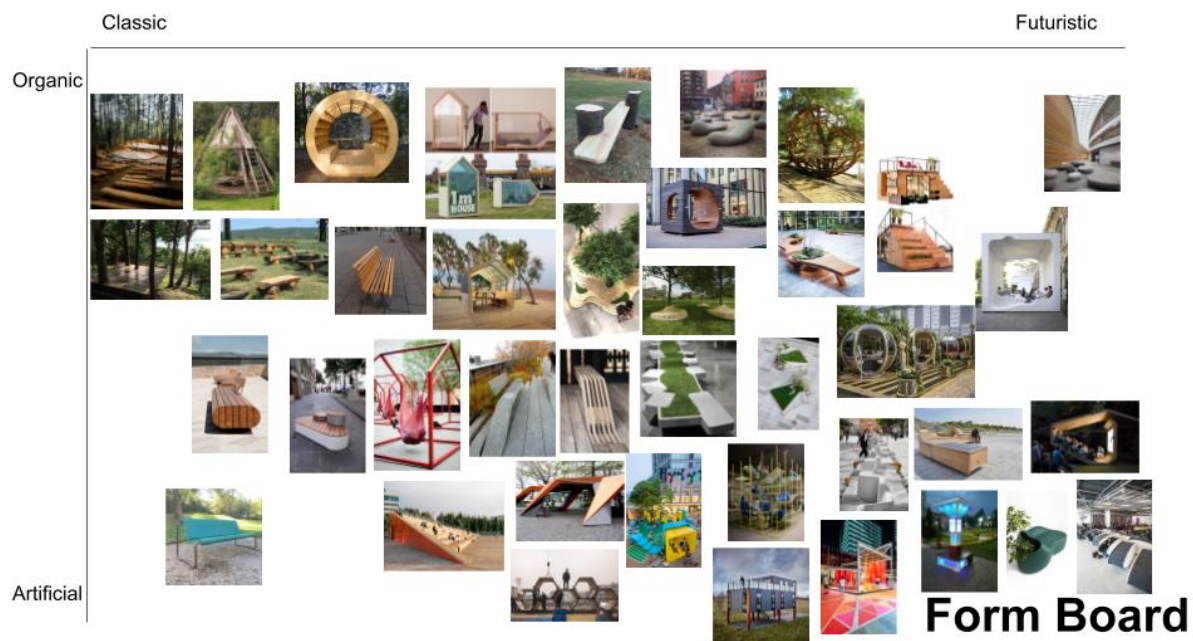
Task: Urban bench used in public and semi public spaces.



Date: Today's modern bench

Seating bench made of wood and Sustainable materials

Task: Urban seating bench used by people in public and semi public spaces.



Appendix 3, persona.



Family with kids

The family Andreson, live in Jönköping Sweden, both parents work and have free time in the weekend, they like to go on adventures with their children and they also like shopping a lot in the center of Jönköping every weekend.

The family of 2 kids and partners are walks around the city center of Jönköping city in Sweden. The parents find out there is a lack of free space for them and their children, they always tend to leave the city center to find a location to rest and let their children play in playgrounds made for their children.



Alexander Taylor

Tourist and adventurer

31 years old born in England

Likes to seek adventures and learn about new societies with much excitement for exploration.

Alexander arrives to Jönköping as a tourist and want to explore the city, but before he explores he always wants to gather information about the city, find out about events and maybe see a map of the city with the most famous locations so he can ride around Jönköping with his E-scooter.

Alexander likes to communicate with people, create new relationship with new people.

He also likes quite outdoors spaces where he can conduct his findings in the social media sites, he mostly use a laptop to conduct his work and findings, and sometimes he needs electricity for his laptop and E-Scooter.



Anders Gustavsson

Future design manager of Jönköpings municipality for urbanspace.

53 years old, born in Jönköping.

Has vision of CO free Jönköping.

Has an objective to make Jönköping more suitable for the citizens.

Anders is a man who cares about his citizens of Jönköping, where he has an objective to create an urban space for the people to create a suitable environment for them where they can interact, communicate, rest and have a good experience in the city environment.

Anders is always looking for new solutions and ideas that could make the city environment more suitable for the people who tend to live in Jönköping and new tourists.



Tyson Winsten

Student in Jönköping University.

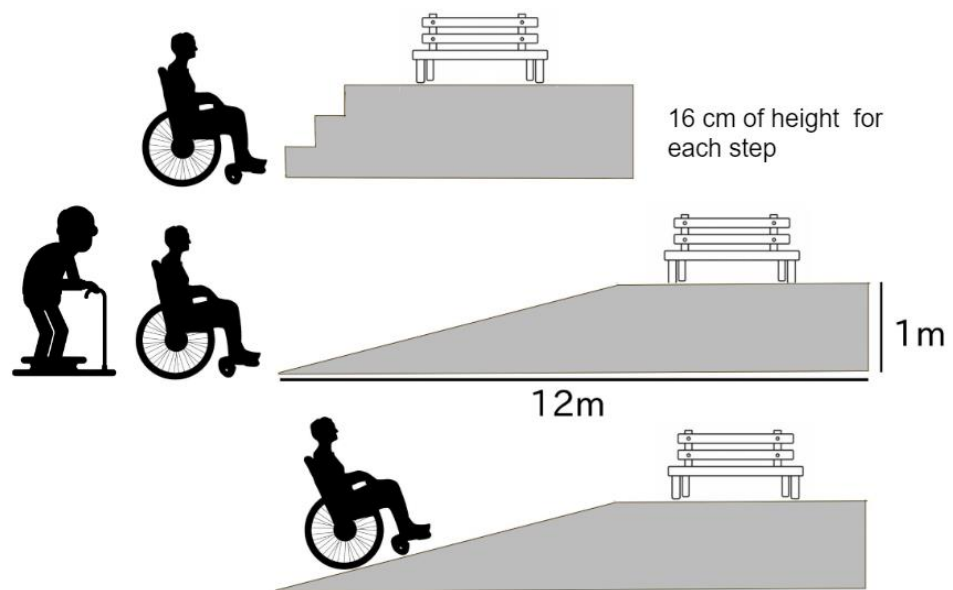
24 years old, born in Jönköping.

Lack the freedom of mobility, where he finds obstacles is a challenging daily task, sometimes he needs to find new routes to get to his destination.

Tyson is a clever student, he likes to explore and find new spaces where he can use to interact with. Sometimes, Tyson finds new spaces, but these new places are not designed according to his needs, where he can't move around these spaces and sometimes he can't even reach them because of the obstacles where his wheelchair can't avoid.

Tyson always thinks about solutions to this problem, and would like to create these solutions so all people with the same type of mobility challenges can use them.

Appendix 4, scenariosketch.



Removing obstacles and creating a solution for it.

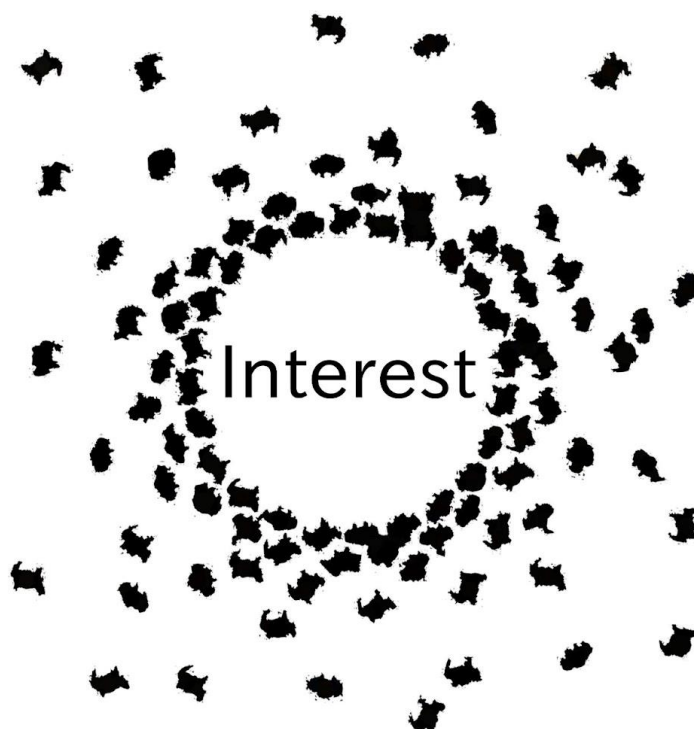
- Height
- Sharp edges
- Toys...



Space for children showing activities.



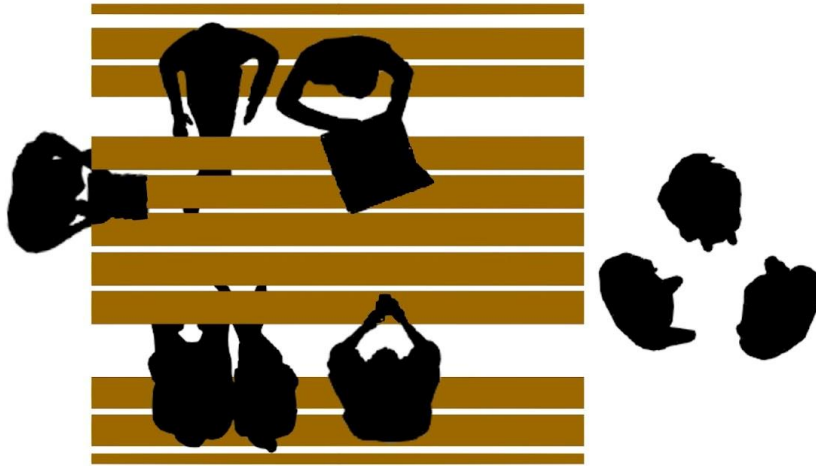
No space for the people, crowdedness and no interest.



Creating interest for the people.



Space for people



Creating space for the people.

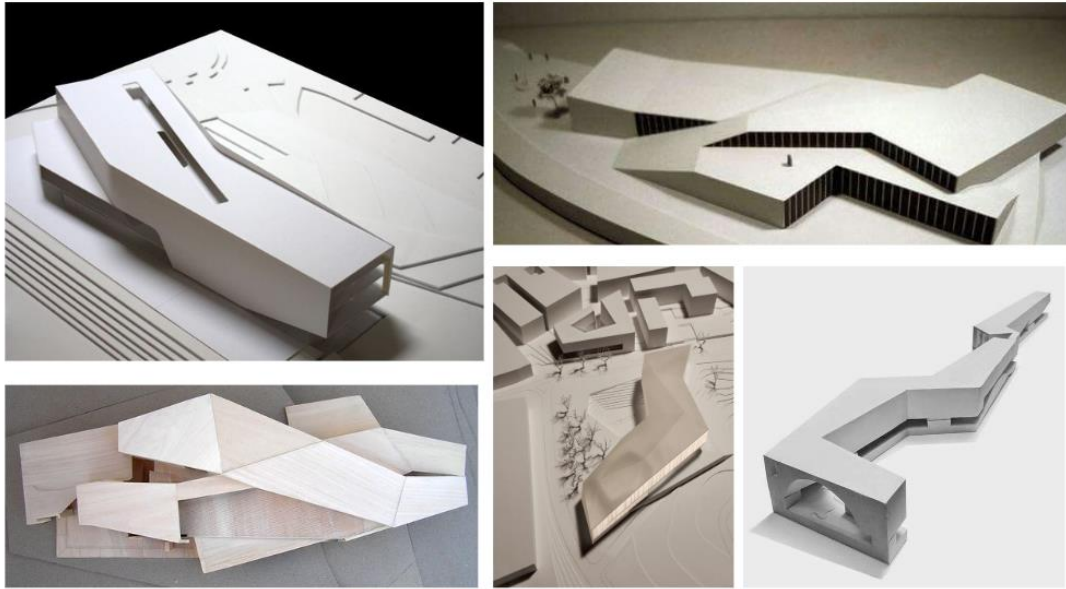
Appendix 5, Mock up.



A rough 3D printed mock up

Appendix 6, prototype & prototype moodboard vision.

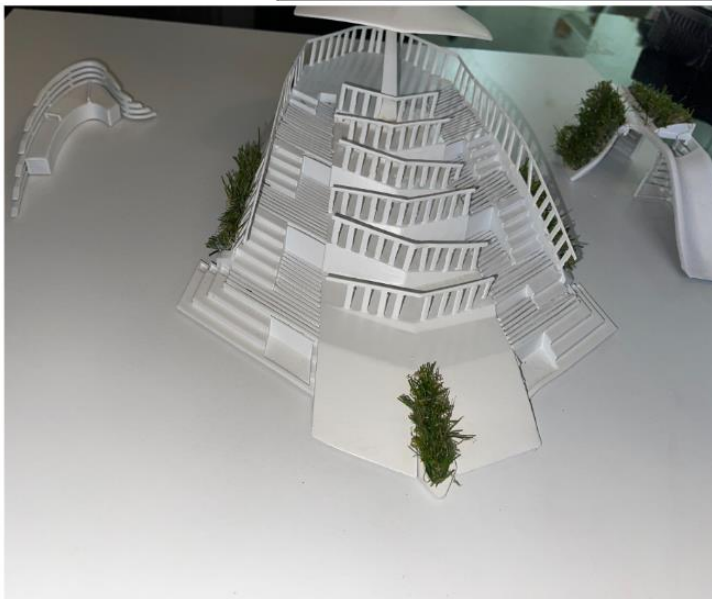
Prototype scale moodboard



Mood board visualization for the prototype.



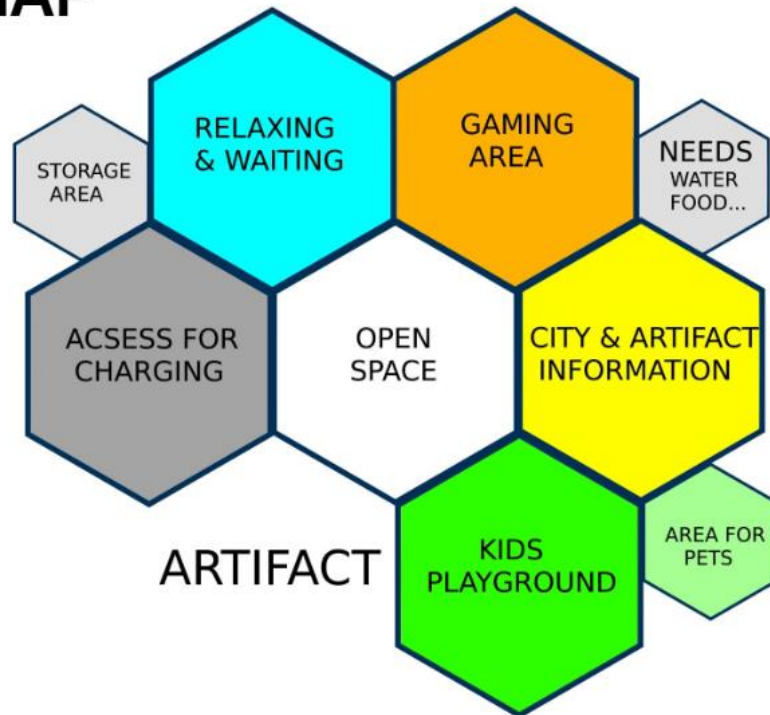
Prototype scale 1:55



Prototype, made by 3D printing techniques and printed in white.

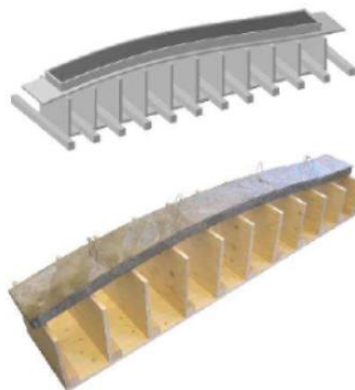
Appendix 7, bubble map for space planning expectations.

BUBBLE MAP



Appendix 8, Manufacturing techniques vision.

Manufacturing methods



Precast concrete

Curvature and double curvature
with lattice and beam support.



Concrete 3D printing



Fabric moulding-
flexible moulds



Wood laser cutting

Saw cutting



Place

Jönköpings municipality



Appendix 10, Vision of the urban furniture.



Appendix TAIDA, TAIDA I

Taida



Tracking



concrete & Wood



A SUSTAINABLE
MATERIAL



TREND

tAlda



Analyzing- Imagining



Durability
Heat resistant
Freeze resistant



A SUSTAINABLE
Long life material
Strength
Less service



TREND



TaiDA



Deciding-Acting



Long Life Products
Simplicity...
Fitting in tho the environment
Less materials USED



Opportunities
Creating new products
Creating new shapes
Easy to produce
Easy to recycle



Look Natural/Brutalism

TAIDA 2

Taida



Tracking



Metal & Wood



A SUSTAINABLE
MATERIAL

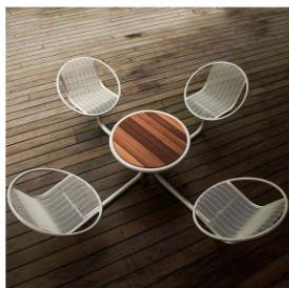


TREND

tAlda



Analyzing-Imagining



Fitting in to the
environment



A Long Life
Materials



TRENDY AND
APPEALING

taiDA



Deciding-Acting



Complex shapes



Play with the form



Huge structures
Big assemblies

TAIDA 3

Taida



Tracking



Plastic waste



A SUSTAINABLE
RECYCLABLE
MATERIAL



TREND

tAlda



Analyzing-Imagining



Create art



A SUSTAINABLE
MATERIAL



TREND

taIDA



Deciding-Acting



Fits and acts like any
other product in an
environment



A Long Life
Materials/Recyclable

