Next-gen Urbee docking station

Parking / Charging system based on the new urban sharing e-bike business model, Urbee

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IPD Graduation project @
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1 PREFACE

The start point of this project was firstly a graduation project proposal about solving the struggling situation of public bicycle parking in urban scenarios. The topics in the proposal partially matched with the ongoing BSS (bike sharing system) project, Urbee in QWIC, an Amsterdam-based e-bike brand. The company also wanted to looking for improvement of their public docking stations. Besides the parking, some more aspects were included, for instance, the intuitiveness for users, the security of station, and the futurity of the system, etc. With some back and forth mail communication, the project was formulated.

During the project, 22 compact weeks, an unique solution which is exclusively designed for Urbee is finished. The solution provides many opportunities for Urbee as a new generation BSS in the near future. Firstly, the specific method that increase the efficiency of space use. Secondly, the diverse, modularized options of station installation that customers can choose the most suitable one. Thirdly, the “parking is locking is charging” solution that improves the easiness of using the system. Lastly, the nomadic style of the next-gen Urbee docking station with non-excavating installation. These aspects are the main structures in this project that are elaborated in the report.

Although this project is about customizing the docking solution for Urbee bikes. However, to propose a solid solution in the context, the design has to be constructed from the ground up, and be validated. The direction and concepts of the project were created from measuring and sketches instead of referring to existing solutions. The mindset and approach of finding design opportunities through *prototyping*, which was the main design methodology used in this project. In this report, the process of finding solutions and formulating concepts are fully stated in the chapter *embodiment*. The design methodology and the process to discover opportunities in this report can provide interesting insights for non-industrial readers

This project cannot be finished without the supports from the supervisory team. Firstly, I would like to thank QWIC for offering this interesting and inspiring assignment as my master graduation project. Marijn’s helps and advices as an industrial designer in the industry were always helpful. I had a wonderful time in the QWIC office with the welcoming colleagues. Secondly, Sacha, project coach from TUD, always providing valuable and experienced advices from academic point of view, which gave me more aspects to enrich the content of this project. With Sacha’s advices, the basic form of this project can be shaped. Lastly, I am extremely grateful to Bruno, the Chair of this project, who gave me excellent guidance in this project. Not only about the project, but also the attitude towards addressing topics as an experienced industrial designer, which I have learnt and seen during this project are invaluable. Bruno also provided me a spatial corner in his studio with a group of lovely colleagues. Most of the extraordinary ideas are unfolded and realised in this amazing place.

In this report, the project are categorized into three main parts, the context research, the result presenting, and the embodiment. The directions and challenges setting can be found from chapter 3 to 6. The result and concepts explanation is mainly stated in chapter 7. The design process and the future product development are included in chapter 8 to 10. I hope you enjoy your reading.

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2 EXECUTIVE SUMMARY

To meet the potential trends of the future BSS, there are some qualities and directions that the next-gen Urbee docking station should possess. Furthermore, along with the Urbee's unique business plan and target customers, the next-gen Urbee docking station will need some exclusive design requirements. These demands, requirements and directions are formulated from the literatures of BSS trends, internal analysis of Urbee and QWIC and prototyping design methods. The collected information is directly reflect on the outcomes of this project. the most important outcomes and challenges in the Urbee project will be briefed in this chapter.

2.1 qualities

2.1.1 better space efficiency and adaptivity

Unlike common city BSSs (bicycle sharing system) that are run by municipalities, Urbee is the bike sharing system that targets private companies. Accordingly, the provided space and environment for installing Urbee docking station might not be as sufficient and perfect as the common city BSSs. This also limits the companies with insufficient space conditions to implement such system. The aim to tackle this topic is to enable the Urbee docking station to provide diverse options that the customers can choose the most suitable one. Furthermore, by effectively downsizing the footprint of a station, and increasing the parking ratio of the docking station. The customers then can efficiently use their space. The outcome to this aspect are:

- The modularized docking station design that provide four main types of efficient parking arrangement. The amount of bikes is changeable depending on the space dimension.
- The parking ratio of the next-gen Urbee docking station is averagely 1.85 m^2 / bike (average of all types of configurations), which is approximately 32% less of space is used, compare to the current Urbee station (2.71 m^2 / bike). The biggest space efficiency disparity is 44% less space use per bike.

2.1.2 high mobility

One of the features in the future BSS needs to have ability to actively react to the market demands. The docking station will need to have higher mobility to adjust its location or scale to meet the actual demands of use. Also, it can be easily recalled for the seasonal maintenance or system upgrade. A nomadic, or semi-permanent concept is applied to the next-gen Urbee docking station to realise the moveable station . There are some achievements that allow the docking station can be easily relocated but remain stable when it is fully assembled.

- No excavation construction is needed in the station construction. The modification and damage to the environment is minimised. The next-gen Urbee docking station can be directly settled on the existing floor and be removed without damages to the floor.
- The docking station can be installed and assembled by 1-2 workers without heavy equipments, includes crane or tractors. Station components are pre-made without extra on-site machinery.
- A disassembled station (10 docks) can be transported by a M-segment vehicle, for instance a cargo van.

2.1.3 improvement of user experience

The improvement of the operational experience is based on three aspects, the parking, locking and charging of the Urbee bikes, which are the primary motivations of this project. To make the system intuitive and easy to use for the end-users, the operation process is being rearranged and simplified.

- Parking is charging is locking, in one push. Users do not need to manually plug in charger or use chain lock to fix the bike. Bike identification and smartisation process will make the return of bike much simpler.
- Getting a bike from the dock is also simplified. After entering the given code to the smart lock mounted on the rear tyre, both locks on rear tyre and on the dock will be unlocked. Users can intuitively pull the handle underneath the seat out of the dock, and be ready to ride.

2.1.4 stable and secure

The security of the docking station in the public is vital, especially for the semi-permanent facility. This topic serves as the premise when address the design of the construction or the components. In the public context, the docking station need to be robust to endure the deliberate damage and stealing.

- Two pre-cast concrete weight blocks in the both ends (approximately 70 kg / block) serve as the stabilizers of the whole station structure. Integrating with the docks (roughly estimated 15.5 kg / dock), which can create good stability to the whole station.
- The mechanism of locking bikes is designed for fail-secure, which ensure the bikes can be properly locked when the power is being cut off.
- The combination of box-like structure and tube structure create a robust body of dock. As well as the interlocked components which provides a complete security and protection of the internal component from vandalism and weather.

2.2
result

After 20 weeks of context research and product development, it does provide many opportunities that a next-gen Urbee docking station can possess to become an alternative 4th generation BSS. The image of the next-gen Urbee docking station can be determined after the project. A lower threshold for implement Urbee system for customers, which also helps Urbee to increase the business expandability. A higher mobility and adaptability that system could be quickly adjusted, according to diverse environments and needs. The higher smartised system which provide more intuitive and easier user experience.

context research → **structure / mechanism design** → **concept realisation**

context research

Field research
Location study
Product requirements
Challenges
Design vision

structure / mechanism design

Architectural
-Station footprint
-Arrangement configurations
Functional parts
-User experience refine
-Locking mechanism
-Charger solutions
Quick prototyping / validation

concept realisation

Construction prototypes
Product design sketches
Style research
Technical drawings
CAD modelling

There are three main phases that are involved in this project duration. Context research, structure / mechanism design embodiment, and concept realisation.

Context research

The goal of this phase is to understand the BSS industry and Urbee that can formulate the potential direction of this project.

The reasons of redesigning the system will be firstly clarified in this phase. By knowing what should be refined and improved, and why the improvements are necessary, the design vision would be precised. In order to keep the vision focused, the product requirements will be listed in this phase. Multiple aspects of the E-bike rental systems will be researched and will serve as the preparation for the design process. The aspects mainly include: future trends of BSS, cases studies, behavioural research,and concept ideation.

The future trends of BSS come from a series of evolution from the past. Through the literature review and case study, the ideas and potential demands of the industry can be clearly seen. Also, some demands are exclusive for Urbee system. Therefore, internal analysis of Urbee system and its current products are important for understanding the direction of developing its successor.

In this phase, in order to keep focus on vital topics, the product requirements and challenges of the project will be formulated. The requirements and challenges are extracted from the result of context research, which are the practical and essential aspects of the product. The outcomes and findings of context research will serve as the base and criteria for the following phases.

Structure / mechanism design embodiment

The concepts and design will be materialized in this phase. The design phase will mainly focus on finding solutions for the aforementioned challenges. The aspects will be addressed separately and integrated afterwards. In this phase, quick, part-task prototypes will be built to instantly validate assumptions and ideas via actual using it. Also, the Urbee bikes will be measured and tested to find the exclusive solution for Urbee service.

There are two main parts in this phase, the architectural part and functional components. In architectural part, the solution for space efficiency; lower threshold for station implementation; diverse options of parking arrangement; and station adaptability will be expected outcome.
Second step will focus on the functional components. The intuitiveness and speed of use, locks and charger, will be separately focused. As well as the security and anti-vandalism solutions will be covered in this phase.

Concepts realisation

The collected information and fundamental dimensions will be the bases of concept realisation phase. In this phase, the dock will be addressed in a feasible perspective. Firstly , the form of product will be firstly studied, Then the construction among all the separate components and pieces of information will be formulated. Secondly, the concept of and assembly methods of that are designed in the production perspective will be realised. The primary drawings and prototypes will be firstly used to find the design possibilities as the future product. Lastly, the form and style of the next-gen Urbee dock will be focused.

The building of the basic architecture and concept of construction provide a correct base that the further product development and detail can depend on.

4
DESIGN BRIEF

4.1 background

4.1.1 The previous three generations

There have been three main generations of sharing bike development history in the past half-century (DeMaio, 2009), in terms of technological application and user's transporting experience. The first generation systems started from the free public bicycle services in Europe. For instance, White bike in Amsterdam, 1965; Yellow bikes in La Rochelle, France, 1974; and Green bike scheme in Cambridge, the UK,1993. Those schemes were not designed for point-to-point traveling like the sharing bike service does nowadays, instead, users needed to return the bikes back to the same place where they rent it. Furthermore, the schemes had confronted severe stealing and vandalism issues due to their free charge policies (Shaheen et al, 2010).
Learning from the failure of its predecessor, the second generation systems emphasized their theft and vandal-resistant design. The coin-deposit systems (charge per use and refund after return) were introduced firstly in Copenhagen, 1995, named Bycyken, and several Scandinavian cities (Shaheen et al, 2010). However, due to its anonymity policy of use, the system remained vulnerable for vandalism and theft (ITDP, 2013). Also, the second generation system were not reliable nor supportive for users to choose bicycle as their new transportation alternative. The completeness and supportiveness of system became the main focus of the third generation systems (Shaheen et al, 2010).

In the third generation system, the solutions to improve the accountability, security, monitoring capacity, and ways of charging are mainly looked into (ITDP, 2013). With the IT-based system and user registration data, company could properly monitor and manage the status of its bikes and stations. Due to the membership registration and credit card-based payment, the resistant of vandalism and stealing were improved. Moreover, the formulation of the bike-sharing network in the cities effectively and notably change the user's transporting behaviour all over the world.(Shaheen et al, 2010; ITDP, 2013)

1st
1965, White bikes (or free bike systems), Amsterdam
-All free

2nd
1995, Coin-deposit system, Copenhagen
-Designated stations with locks
-Deposit to unlock

3rd
1998, IT-system, Copenhagen
-Designated fixed docking station
-Check in/ out interface
-Information to locating / reserving / accessing bikes

figure 1. Witte fietsenplan, Amsterdam

4.1.2 The fourth generation

There is and will be the fourth generation presently and in the near future. With the technological evolution with time, the included technology in new generation BSS has not been completely defined and kept outreaching. While there are some clues and basic directions that can be seen according to previous generations and the related technological application.

Based on the features that the third generation systems have had, the fourth generation systems will provide services that are more actively and smartly respond to the market demands according to the user behavioural and preference data collecting.

Furthermore, the mono-modal system will no longer fit to the newly developed urban transportation scenarios; the flexible and multi-modal type of systems will be introduced to increase the market penetration and meet the market demands(Bradshaw, 2014; Shaheen et al, 2010).

The fourth generation bike sharing schemes are commonly featured with following relevant aspects: moveable docking stations, application of e-bikes, improved locking mechanism, and bike redistribution solutions (Shaheen et al, 2010).

4.1.3 Urbee

Urbee is an E-bike rental business model which appears in this generation and is designed to meet these trends. Urbee started up by receiving grant from AKEF (Amsterdam Climate & Energy Fund) in 2016(AKEF, 2016). The sustainability and its convenient renting and billing procedure are the keys of this service.

This original business model serves as an e-bike rental system for professional or business use. Private owned companies can request for a parking / charging station and install it in the designated place. The company can provide e-bikes to their employees who need short-distanced traveling instead of providing cars instead of providing car, owing to the fact that 80% of car journey are under 20 km (AKEF, 2016). The e-bikes, compare to the gasoline cars, cause less environmental pollution and have comparable easiness and mobility.

Quotations about new generation of BSS

“ a fourth bikesharing generation is proposed:
demand-responsive & multimodal systems. ”
(Shaheen, S., et, al. 2010)

“ - increased system flexibility
- improved distribution
- integration with other transportation modes
- include electric-hybrid bikes and GPS tracking
- crowdsourcing and participatory platforms ”
(Bradshaw, B. 2014)

“ New Developments and Trends:
Modular, movable stations: These stations do not require excavation and trenching, which reduces implementation time and costs. Also, because the stations are easily movable, the system can be optimized once demand patterns reveal themselves through usage. They can also be removed during winter months. ”
(ITDP.2013)

“ Shaheen, S....identified BIXI as marking the begining of bikesharing's fourth generation. A major novation attributed to the scheme is its use of mobile docking stations which allows stations to be removed and transferred to different locations. This enables stations to be relocated according to usage patterns and user demands. ”
(Shaheen, S., et, al. 2010; Bradshaw, B. 2014)

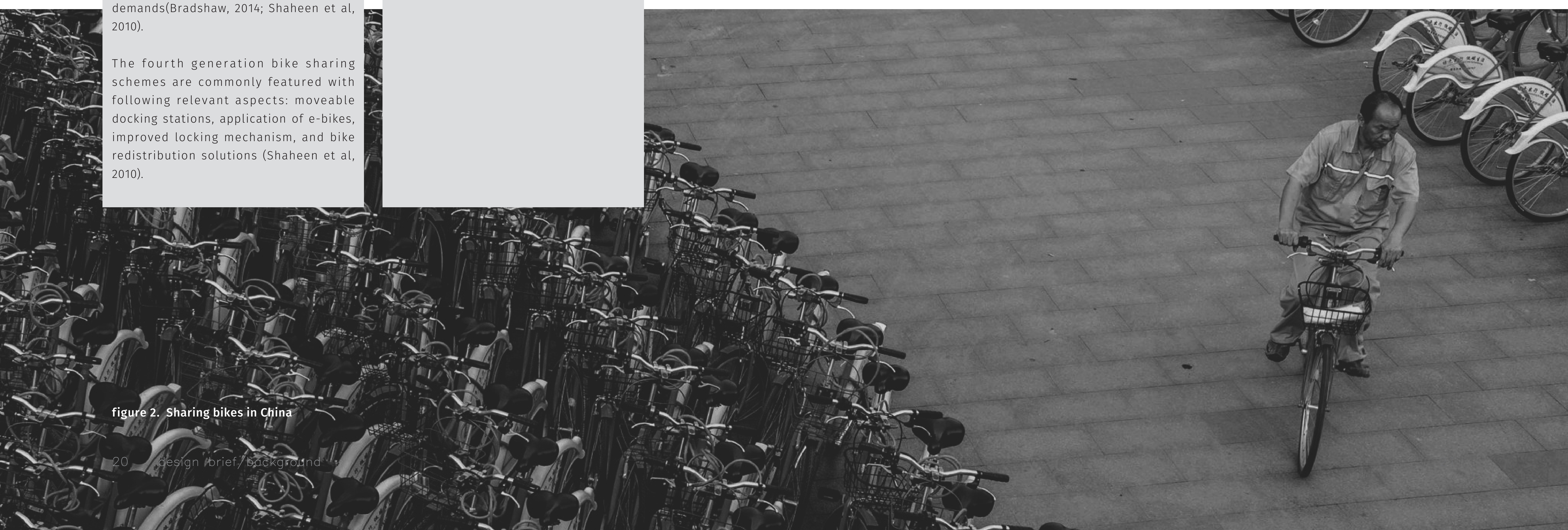


figure 2. Sharing bikes in China

4.2
problem definition

Although the first generation of Urbee has been put into practice, the e-bike and service itself has room for improvement. Considering of its originality and the demands of market expansion, the completeness and functional integration of this service should be further refined. The design vision in this project will base on Urbee's current business model. For each stakeholder, the problems could be categorized into six challenges. All these challenges will be elaborated and addressed in different stages of the project. The challenges are:

- For Urbee's customers, downsizing the station footprints, semi-permanent structure vs. security solution and the station's modularity;
- For improving end-user experience, Intuitiveness and system readiness;
- For Urbee, station aesthetics and production feasibility.

(The description of challenges will be elaborated in Chapter 6.)

The current Urbee docking station design does not sufficiently meet the both requirements of the 4th generation of BSS trends nor the Urbee business strategy. The bike sharing station in the 4th generation should have more mobility to actively adjust for the changeful user demands.

Moreover, the Urbee docking station should have better environment adaptability because of which the station might be installed in various environments for different types of clients. Therefore, the modular design of both the station and the included components will be focused on increasing its flexibility and compatibility to adapt different space plans. For customers, the convenience of implementation and arrangement is important. By improving the installation process and lower the requirement, the acceptance of this service could be raised.

Another vital aspect is Urbee's end-user experience. In order to provide end-users a more easy and intuitive operational process, the readiness and ease of use of the docking station will be focused in this project. To improve the user experience, an automatic and simplified parking / charging procedure will be the basis when addressing this topic.

4.3
Stakeholders

Urbee
Urbee is a start up BSS company. Urbee is responsible for running and expanding this service. Urbee is the contact point for its customers. Urbee has three shareholders, QWIC, Scopei and DBR. Besides QWIC, Scoei is responsible for the electronic locks and the mobile application; DBR is responsible for the bikes maintenance.

Qwic
QWIC is an e-bike company and is one of the main three partners of Urbee. QWIC is responsible for the hardware parts of Urbee, which includes mainly hardware integration and e-bikes development. Urbee bikes are designed by QWIC in-house product development team. Other partners of Urbee are responsible for the smart lock verification and bike tracking / maintenance.

Customer
Urbee's customers will rent a station with monthly fee, and provide its users a comparatively lower bike rental price. They need to provide their private place for station installation. Customers are not responsible for the condition of Urbee bikes. Customers can suggest Urbee system to their employees for the business-purpose transportation.

End-users
End-users will log on to the Urbee mobile application, and the website will provide a code and tell user which bike is available. End-user will be asked to return the bike to the same station where they rent it.

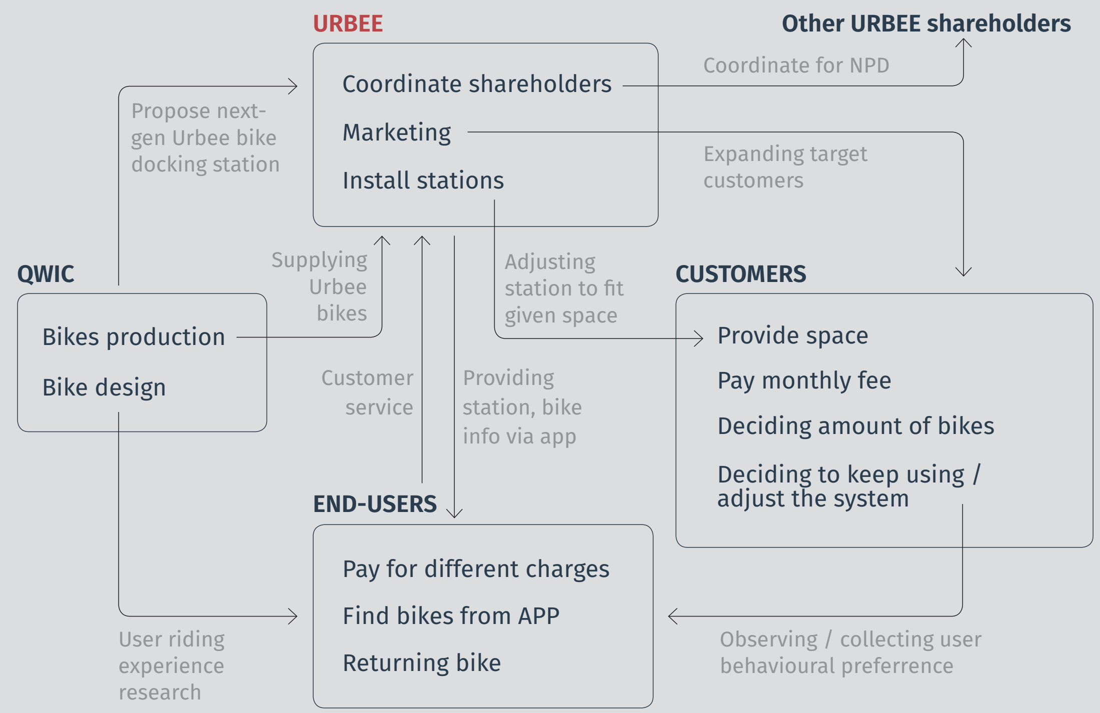


figure 3. stakeholders

5 CONTEXT RESEARCH

The context research has four main focuses. Firstly, looking into the current docking station of Urbee, to find what are the essential parts that need to be improved. Although the current station was built in different perspective from this project, it also provides many clear clues about its compromises or difficulties when confront circumstances.

Secondly, understanding the future demands and trends of BSS docking station. There are some keywords that repeatedly appear through reviewing papers and literatures, which picture the future of BSS. By comparing with the Urbee business model, The potential and exclusive qualities behind those keywords can be found.

Thirdly, studying BIXI, one of the earliest 4th generation BSS case. The on-site installation and transportation of its station architecture are focused. To find inspirations from viewing the advantages and disadvantages of this successful cases. Lastly, the semi-permanent construction in various cases are looked into. The semi-permanent condition is defined in the BSS station context.

figure 4. current Urbee station

5.1
current Urbee docking station

There are many aspects in the current Urbee station that are regarded inadequate to satisfy potential demands of Urbee users and its future expansion strategy. Some of them make the user experience difficult and confusing. For the equipment wise, the original design direction and its lower readiness make the docking station incapable to provide better user experience and become a future service. The basic elements of current Urbee bike station are listed in figure 5. The aspects are listed in the next page.

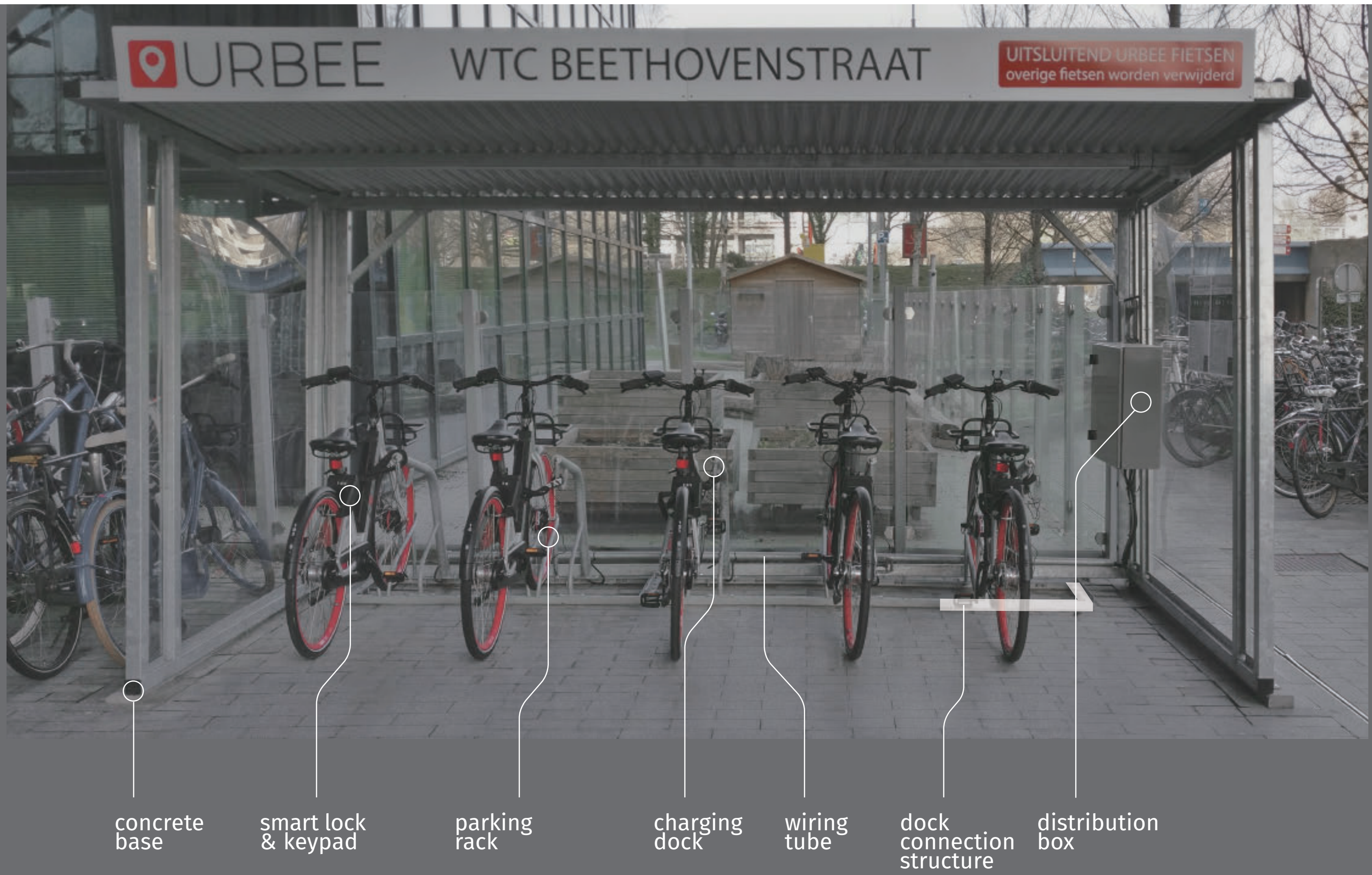


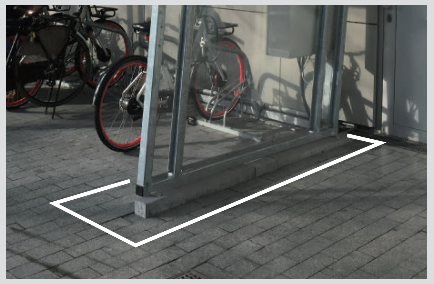
figure 5. current station elements

fixed station dimensions

The unified design of fixed-sized station has limited changeability to fit in various given areas. (W:230 cm * L:460 cm).

overly wide space

The spacing between bike makes the use of space inefficient. The spacing should be more compact as well as user-friendly according to the spatial demands.



reconstruct floor

To install a station, it needs certain reconstructing on the finished floor, in order to ensure the station is fixed and sturdy. Thus, the fixation makes the station unmoveable

mannual locks and power plugs

Two power plugs are provided(the original one on the top of battery; and the one underneath the seat). However, to finish the parking / charging / locking procedure, users need to lock and plug the bike manually and separately.

small and inconvenient power plug

Many parts in the station that are off-the-shelve and temporary components. The exclusively designed components also increase the vandalism resistant ability of docking station.

components in regular spec/ temporary solution

As well as the regular parking rack that Urbee applies currently, users need to lift the heavy e-bike to properly park it in.

5.2
case study- BIXI, Montreal

The docking stations of BIXI system are regarded as the first put on practice fourth-generation BBS station (Shaheen et al, 2010). Due to its non-excavating installation and relocating capacity, BIXI station can be easily removed seasonally for maintenance, and free the site for other uses. Compare to other traditional docking station, BIXI station has higher mobility and lower installation requirement. The design of the station integrates all the necessary components (docks, terminal, way-finding panel, and solar panel) on the platform. The platform is not fixed on the ground, while it is stable and heavy enough to be a public facility.
However, to relocate a BIXI station, a crane truck is needed to lift and transport the station. Only one station will be moved in one trip. Also, there are two or more workers that are needed to relocate and install the station. They need to tighten the rope on the docks, operate crane machine, avoid the damage on the station, and ensure the security around. The process of removal / installation remains inefficient and complicated.

figure 6. Bixi installation (Bixi, 2017)

a crane truck is needed to remove the station

sufficient space is needed near station

ropes fixing on the station and dock in right position

operating crane to put the station on truck platform

fixing sation on truck / finish the removal

figure 7. removal of BIXI station (Bixi, 2009)

5.3
semi-permanent structure

According to the definition of the word semi-permanent, the object is neither temporary nor entirely permanent. In the Urbee's context, the station should function as the fully permanent facility that can endure regular use, vandalism, and weather. On the other hand, it is still viable to move and reuse these stations with the proper and relatively simple operations. Some designs and cases in this context are shown below.

figure 8.Jean Prouvé prefab shelter, assembled base with metal anchors (Wallpaper* magazine, 2015)

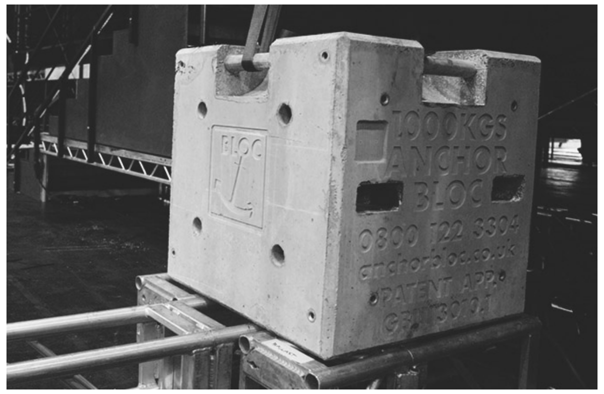


figure 9.concrete anchor with multiple functions (Anchorbloc ltd, 2017)

figure 10. Vending machines in Japan, the moveable street facilities. (Akaihane-fukuijp, 2017)

5.4
4th gen BSS station and Urbee

The trends of the 4th generation BSS is that the system has capability for analysing and reacting to the changing usage patterns, in order to increase the bike accessibility and service convenience. To improve the system in design perspective, many papers (Bradshaw, 2014; ITDP, 2013; Shaheen et al, 2010) suggest that the transformation and mobility increase of the docking station will be the direction. The changes are made to enable the station to actively respond to the user demands and increase bikes accessibility. Mobility of BSS stations becomes vital in the future BSS business strategy, and provide the higher coverage and penetration of the urban traveling.

Some 4th gen regular bike BSSs (Mobike, China; Sobi, North America) have dockless design. Those BSSs use emerging real-time positioning information and payment technology to maximise the mobility and flexibility in order to meet the user demands.

However, in the Urbee context, the Urbee e-bikes need specific docks to recharge the battery and certain protection to secure the e-bikes from stealing and weather damage. In this case, station-based scheme is needed to preserve Urbee bikes. Therefore, the mobility and environment adaptability of Urbee docking station design can be seen as the main topics of improvement.

The benefits of the mobile stations are, the station can be removed for maintenance in the riding off-season (winter or rain seasons), and free the space for other purposes. To achieve the high mobility of station, the installation methods are important and need to be specifically focused.
Non-excavating installation is one of the vital requirement in implementing mobile docking stations. The installation do not need excavation and trenching on the existing floor, which can reduce implementation time and costs (ITDP, 2013).

figure 11. NY city bikes in snow (Mark Lennihan, 2014)

6 DESIGN DIRECTION

This chapter will clarify the main directions of this project which conclude the insights from the context research. The design vision about the next-gen Urbee docking station will be firstly stated. To achieve the design vision, there are product requirements that are categorized into three main stakeholders. Moreover, six challenges will then be listed to clarify the main design qualities that will be focused in the future design process.

6.1
design vision

- A nomadic docking station, semi-permanent, architecture design that can fit to different given spaces with high system flexibility and modularity. To meet the diverse demands of private BSS in the future, the implementation of system should be flexible.

- Single design of dock will be applicable for all configurations and spacing plan. Urbee does not need to redesign the station for all given spaces. Reducing the complexity and difficulty of installing a new station.

- The simplified operational procedures. One single-hand push to finish parking, which allows end users to intuitively and easily return their Urbee bike without extra plugging / locking procedures.

- Lowering the threshold of installing the next-gen Urbee docking station, the customers do not need to find a perfect space for Urbee station. The space determines the amount of Urbee bikes, and there are multiple configurations can be used.

- Without the street infrastructure when installing, and the station components are designed as modules that can be disassembled. The docking station can be easily and flexibly moved to other space with minimum personnel or equipment requests.

figure 12. Kyrgyzstan nomadic tents, a housing structure designed for adaptability and mobility.

6.2
requirements

The requirements of design can be categorized into three groups: requirements for Urbee, customers, and end-users. The requirements serve as the qualities that are must-dos and the goals to achieve in this project.

For Urbee, the mobility and compatibility of stations are required. The expected release date of next-gen Urbee docking station will be within 1-2 year. Thus, the solutions should be practical and reachable in terms of technological application and product development process. Besides, the locational requirements are also being determined according to the Urbee system and future sharing bike station trends. The stations will be able to be moved and relocated due to the station demands of other areas or the maintenance needs.

For Urbee's customers, the requirement focuses on the configurations and security solutions. Firstly, the space efficiency will also be the most important topic to address. Secondly, the station and docks will be able to fit to diverse urban environments. Also, the different shapes of customer's parking space and spatial demands will be met. Thirdly, the infrastructural needs of installing and constructing Urbee stations will be minimised. Lastly, the moveable station will need to address the theft issue, which is vital to have a solution to prevent the stealing of both station equipment and bikes.

The intuitiveness and convenience of use will be mainly focused when determining the requirements for end-users. The simplification of renting / returning procedure is one of the most important topics in this project. One move to finish all three procedures (parking, locking, and charging) are firstly required. Secondly, the easiness and intuitiveness that guide user to understand the returning and renting procedure without instructions is needed. With these product requirements, the characteristic and direction of Urbee station are able to be defined.

6.3 challenges

There are six challenges in design process that will be addressed and assessed in stages of the project. Each challenge focuses on finding solutions to the certain aspects of next-gen Urbee docking station. With these prioritized challenges, the design problems can be specified and classified in the different stages of design process. The challenges are:

1. Downsizing of station footprint

Considering of the feature of Urbee's business model, the location for installing Urbee station are mostly private or semi-private. Unlike most of the public BSS which are held by government, can be installed on a perfect and designated location. In Urbee's context, station will not have indulgent space for parking space. Therefore, finding solutions that make the space be more efficiently used is the first challenge in the project.
In order to efficiently put more bikes in the designated location. The methods that can effectively narrow the gap between two bikes but not sacrifice the usability is the main focus in this challenge. This challenge is the most important one which will propose the space efficiency. solutions for the docking station.

2. Modularity

One of the the characteristics of Urbee station is its location. Due to the most of the given places are privately owned by the Urbee customers, the space might be insufficient and have more limitation compare to the BSS run by municipality. By providing a sufficient options of parking configurations, the threshold for the customers to implement such a system is being lowered. multiple configurations will be suggested depend on the location.
The modular design of the station will make the station body has more flexibility and compatibility to adapt to different environments. The environments factors include the area dimension, parking patterns, and the connection to the current facilities (e.g. access to power source, connection to floor). The components in the station (including docks, structure, and wiring, etc.) can be (dis)assembled freely in order to fit in the space.
There are more aspects that will also be addressed in the modularity challenge. The practical aspect includes the equipment and staffing needs to install / relocate / transport a station. The modularity solution do not only reducing installation cost, which are: redesigning station for locations, the amount of workers, and time-consumption; but also the expandability of the service to the future applications, for instance, a solar panel roofs, station lighting, or the advertising signages, etc.

3. Semi-permanent vs. security

This challenge mainly addresses the practicality of the moveable feature of the Urbee station. Furthermore, the extensional problems of station mobility also need to be taken into consideration. For instance, the security of a mobile station and its bikes; and the non-excavating installation methods which makes the station less protected, etc.
The nomadic style is advantageous to make the station be removed in unsuitable time for cycling (ig.rainy season or winter) and maintain the equipment in the off seasons. To make the used parking space to be free and reused without damage, the non-excavating installation method are needed to be specifically designed.
There is a contradictory between the station mobility and its anti-vandalism ability. This type of nomadic station, the security to the bikes and parking area becomes vital. Unlike most of the 3rd generation sharing bike stations that are fixed at certain locations and not able to be moved. the Urbee station need to possess the particular design to prevent from vandalism and stealing.

4. Intuitiveness and system readiness

The third challenge mainly addresses the easiness of the system for end-users. A simple push that can finish the bike return procedures (parking, locking, and charging) is the original motivation of this project. Few aspects will be touched in this challenge: the solution of locking / charging mechanism and its position; the user-friendly operational procedures.
To realise the intuitive renting / returning procedure, the docking that can achieve the intuitive requirement needs to be designed. Accordingly, the position of locking / charging mechanism on the bike also need to be reconsidered. To downsize the station footprint, the gaps width between bikes would be calculated and narrowed, which also influences user's operating postures and the position of verification interface on docks.

5. Aesthetics

The Urbee stations are also regarded as the facility that have promotional and branding purposes for both the service itself or the advertisers. The style determination of the station body and its equipment should take the company identity into account. The language of QWIC and Urbee will be researched in order to align and expand the company's design language.

6. Feasibility

In this challenge, the practical aspects of station will be focused. To make the design and concept reachable, the practicality of each concept and decision will be separately assessed. The production of the design will be regarded as the premise of developing the concept. The production aspects are included, such as the robustness of the dock as the public facility and the durability of the construction.

7
FINAL DESIGN

There are three sections in this chapter, the essential concepts and outcomes of the next-gen Urbee docking station will be presented. The first section is system modification which states the suggested changes that can improve the user experience. Secondly, the main ideas and design qualities of the station architectural will be proposed and visualized. Lastly, the design of the dock and internal components will be specified.

7.1
system modification

There are some changes made to the next-gen Urbee station after the redesign of the current system. To clarify the differences, the operational and systemic aspect will be separately stated. The operational differences are mainly about the changes in the journey of use and the changed functions that optimize user experience. The simplified and intuitive operation of Urbee system for end-users are realized.

The systemic differences are the changes in the hardware and system in order to realise the expected improvement of user experience. Although the current smart lock can cover the demands of keyless rental experience. However, to lock bike on the dock still need an additional chain lock that need to be operated manually. In the next-gen Urbee docking station, another solution is suggested. The given code for the smart lock can be synchronized with the dock lock. Thus, both locks will be unlocked at the same time when the given code is entered to the rear-tyre smart lock. To realise this, many technological changes will be applied and interconnected. There will be a identifier mechanism to firstly recognize the Urbee bike, and identify the serial number of the specific parked bike. After all this identifying procedure, the bike will be locked and power will be transferred.

The modification of both system and jounrney of use are charted in figure 13.

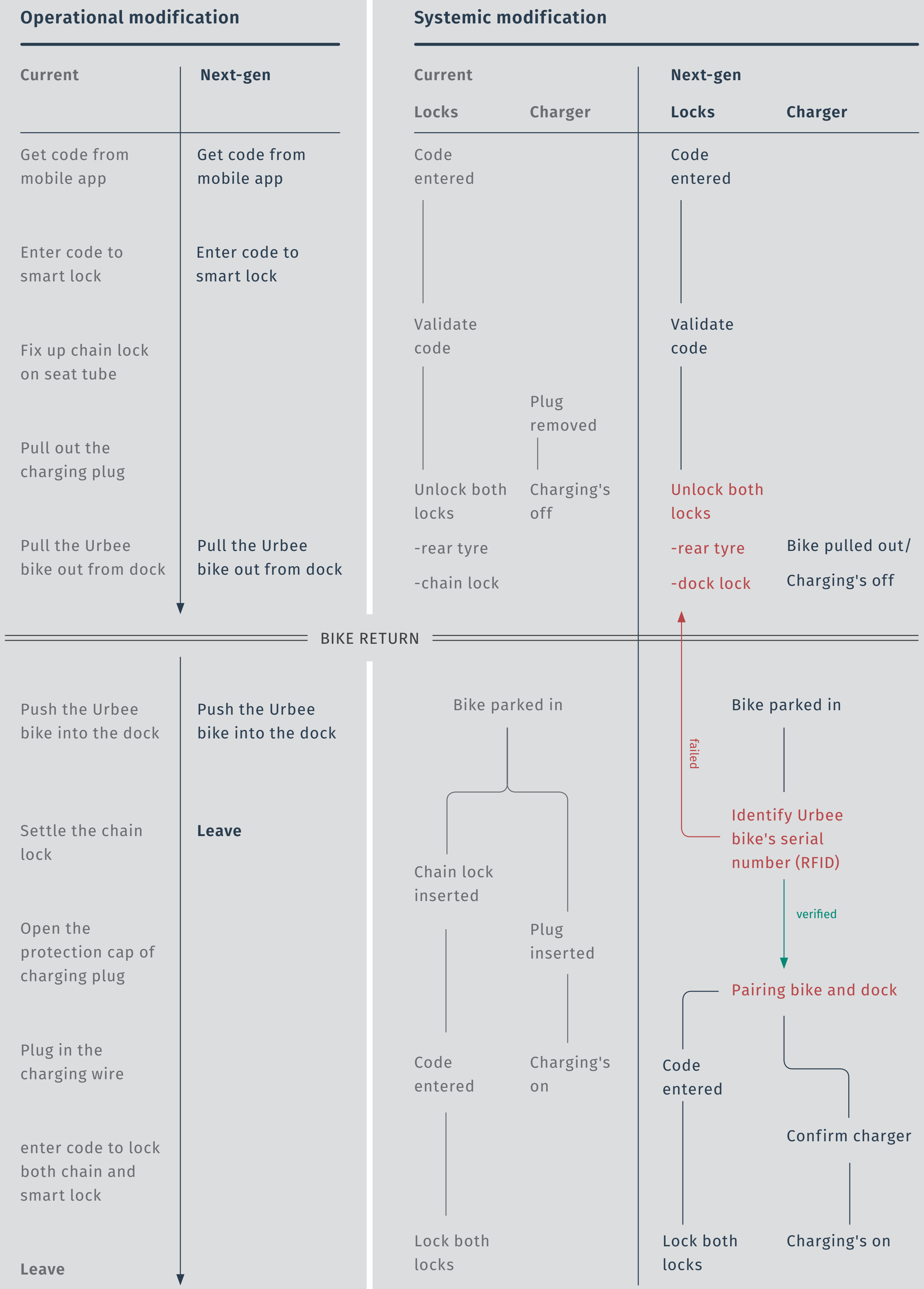


figure 13. modification of system and journey of use

7.2
next-gen Urbee station

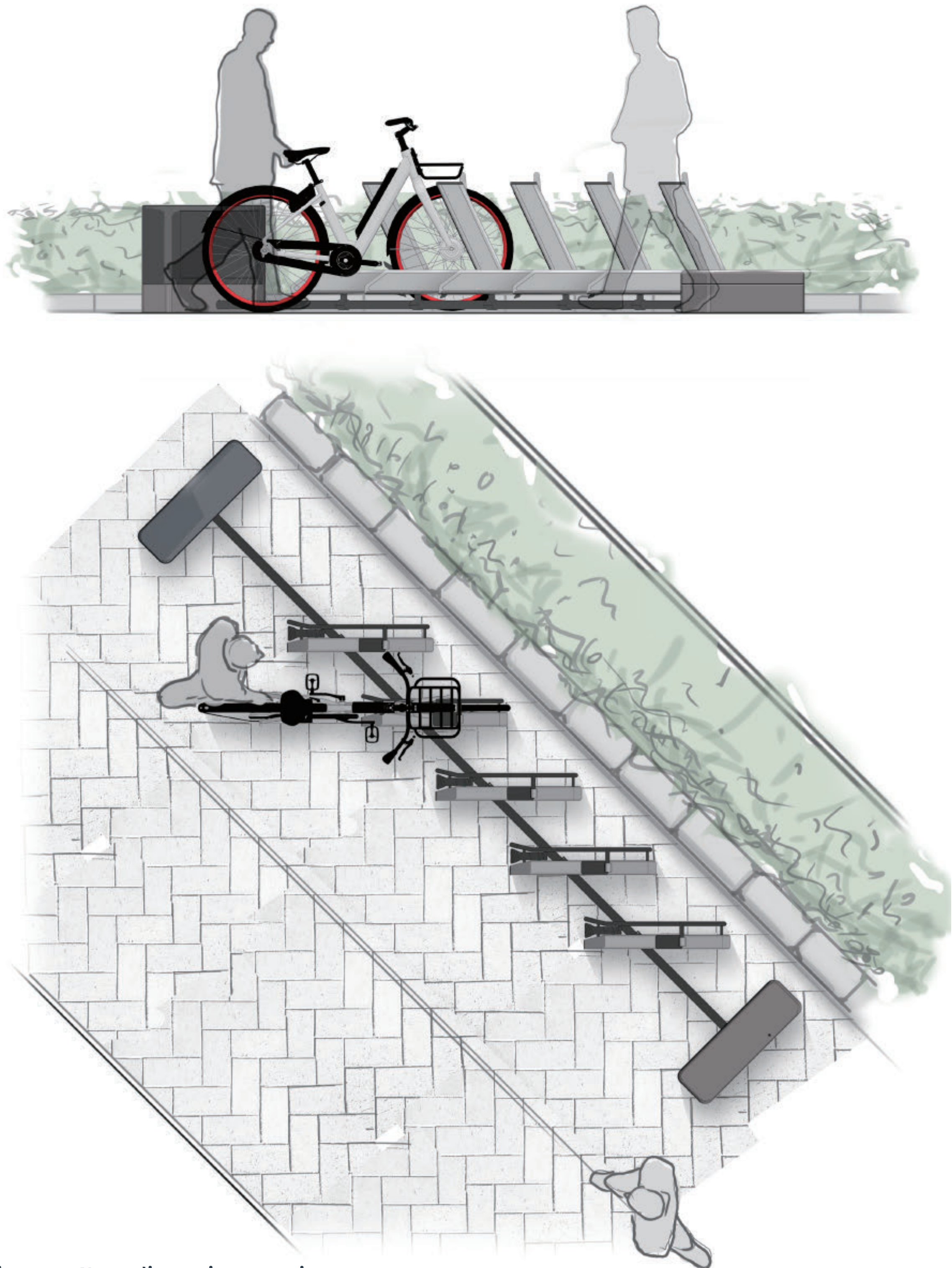


figure 14.Nomadic station overview

7.2.1 Nomadic construction

A nomadic station is designed for the Urbee that can easily and quickly set up and relocate the station. The station, after being assembled, can instantly provide service. Another nomadic feature is that the next-gen Urbee docking station have high adaptability to environments and demands. It provides multiple configurations (figure 18) , optional elements for customers and fulfil their needs.

To set up a nomadic station, no excavation construction and heavy equipments are needed. The next-gen Urbee docking station can be fixed on the existing floor with overground structure, and be removed without damages to the environment. The station can be set up by 1-2 workers, the station components are designed to be moved and carried by hand or simple trolley. Also, the components are pre-made, and be assembled directly workers do not need to do additional machinery on-site.

figure 15. scenario rendering

Transportation

Taking Volkswagen Transporter's load compartment as the dimensional reference, which might be a cheap, regular vehicle option for transportation. The disassembled station component and 10 docks can fit in the load compartment of the van. The station then can be assembled on-site with 1-2 workers without heavy equipments. This way of installation and transportation provide the high efficiency and mobility to set up a BSS station compare to others.

A next-gen Urbee docking station can be disassembled and transported by a M-segment vehicle, namely cargo van. The transportation scenario is illustrated in the figure 16.

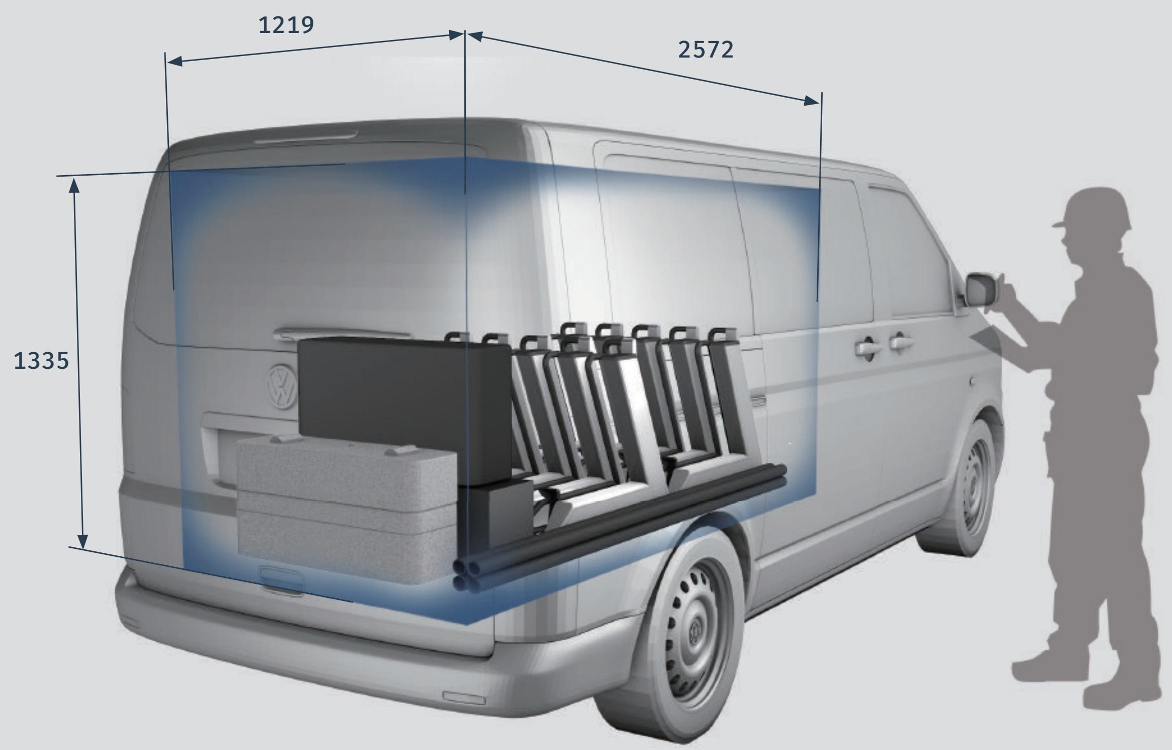


figure 16. Load compartment model: Volkswagen Transporter T6

7.2.2 Station elements

figure 17.station components

The station consists of five main elements. To realize the high mobility and flexibility docking station without excavating the ground, the precasted, piled concrete weight blocks function as the base that secures and stabilises the whole station. The base concrete block weighs approximately 70 kg / block (800*250*160 mm), integrates with the weight from docks, which can provide sufficient stability. The modular blocks are placed on both ends of the station. One side will connect to the power distribution box. Another side, besides reinforces the station, concrete blocks can serve as the definition of the station area.

The beam structure is the central reinforced tube that all docks are mounted on. It functions as the main structure of the station, as well as the wiring way that encloses and protects the cables. Depending on the requested configuration and the amount of Urbee bikes, the length and corresponding drilled holes would need to be predesignated and made in factory.

The branch connections are the elements that position the docks. The clamp mechanism can be freely attached on the beam structure according to the hole position. The clamp would ensure the perpendicularity of the dock.

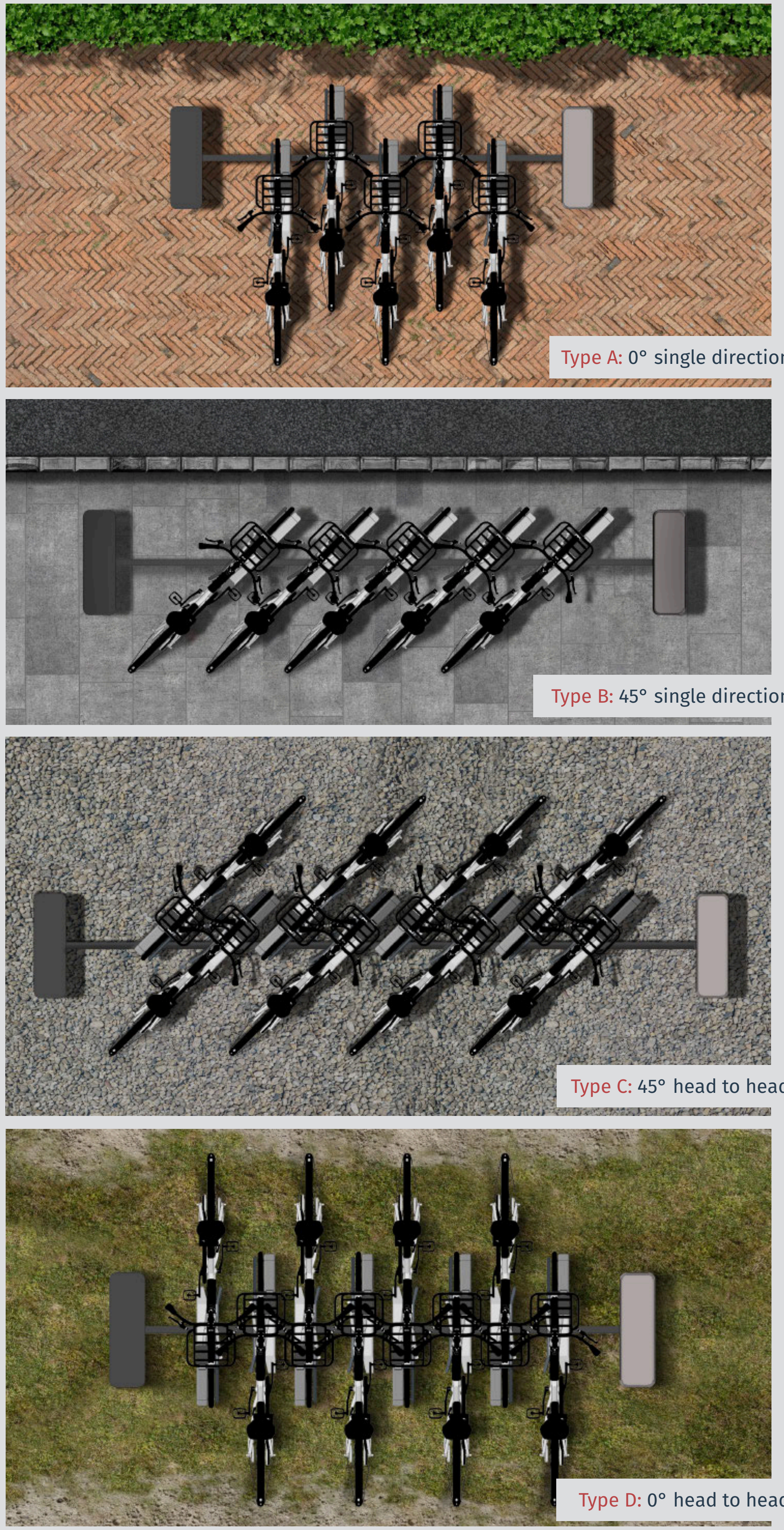


figure 18.parking configurations

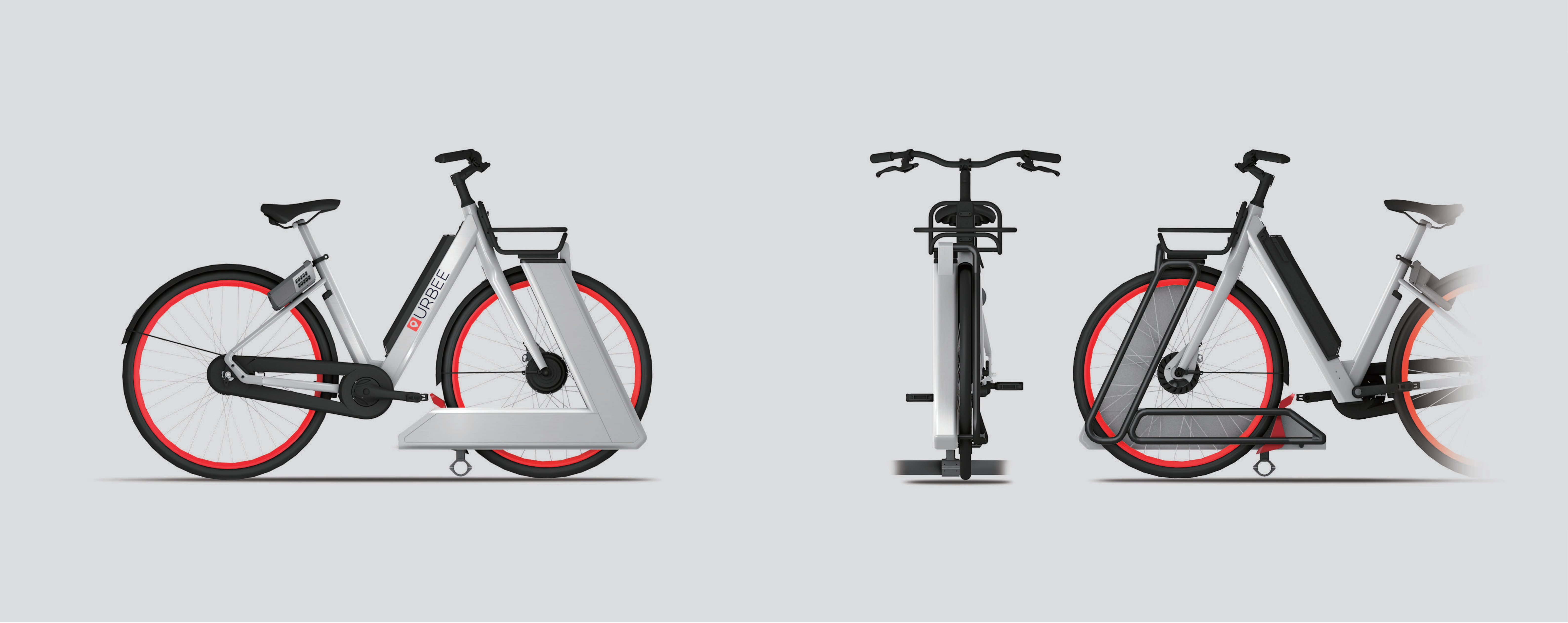
7.2.3 One dock for all configurations

It is one of the main features of this modularized station design that one single model of dock and the same set of station elements can be used in diverse configurations and environments.

There are two main types of bike arrangements. The first type is single sided parking, all bikes parked and pulled on the same side and direction. This type of arrangement can be installed against the building. Another type is head-to-head parking. This arrangement is for more open space, which bikes can be parked in opposite directions from both sides of station. Depending on the length and width of the given space, each type of arrangements has two angular options, 0° and 45°. Therefore, there are four main configurations that customers can choose from that fits their space best.

Also, the amount of bikes in the station is changeable, it will depend on the user's demands and the scale of expected rental service. The roof option in the further product development can also provide in / outdoor options to install the station. By broadening the diversity of options, the additional BSS demands can be meet, also, the threshold for customers to install a Urbee station is being lowered

7.3
dock



7.3.1 ramp principle

The ramp principle is firstly designed. The ramp principle provides the opportunities to minimize the gap between two Urbee bikes, as well as solve the handlebars struggling in such shrinked parking space.This principle make the planning and arrangement of Urbee station flexible.

With this principle, besides downsizing the parking space, the simplification of docking station components is another important advantage. In the current cases, the high-low parking racks are usually applied to the docking station. Which means, two types of racks need to be separately produced and installed. Also, Urbee bikes weigh around 25 kg, to lift them to the higher rack is not as easy as lifting normal bikes. Another common way to is to leave extra space in between two bikes, as the solution of current Urbee station, which is not space saving especially for private properties. The dock with ramp principle on, however, can be applied to all types of configuration and amount of bikes, only one model of dock is needed. Therefore, the complexity and cost of the docking station will be increased. The ramp principle is able to address the efficient space saving , configuration variety, and docking modularity.

The wip ramp are the final ramp design for the ramp principle. It is the transformation of ramp principle that involves the locking function into a new design. From static part to the dynamic multi functional part, the wip ramp does not only create the height difference for parking arrangement, but also switch its role to the locking part that secures bike.

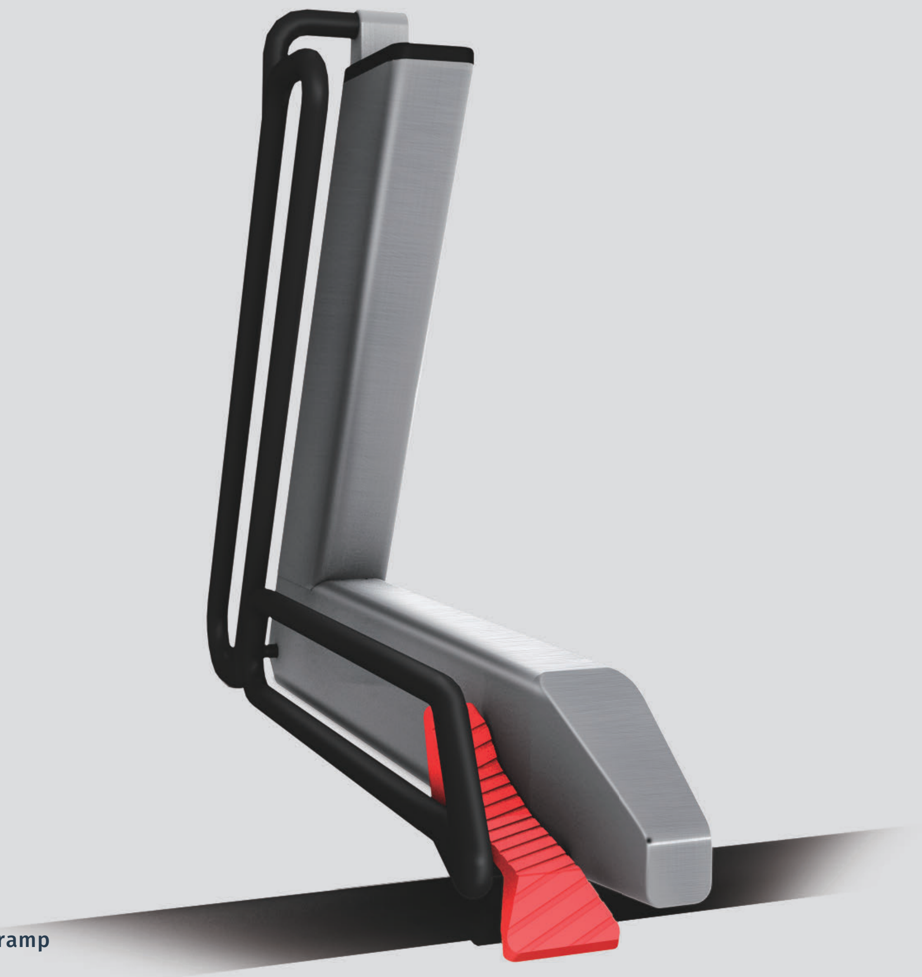


figure 19. wip ramp

How wip ramp works

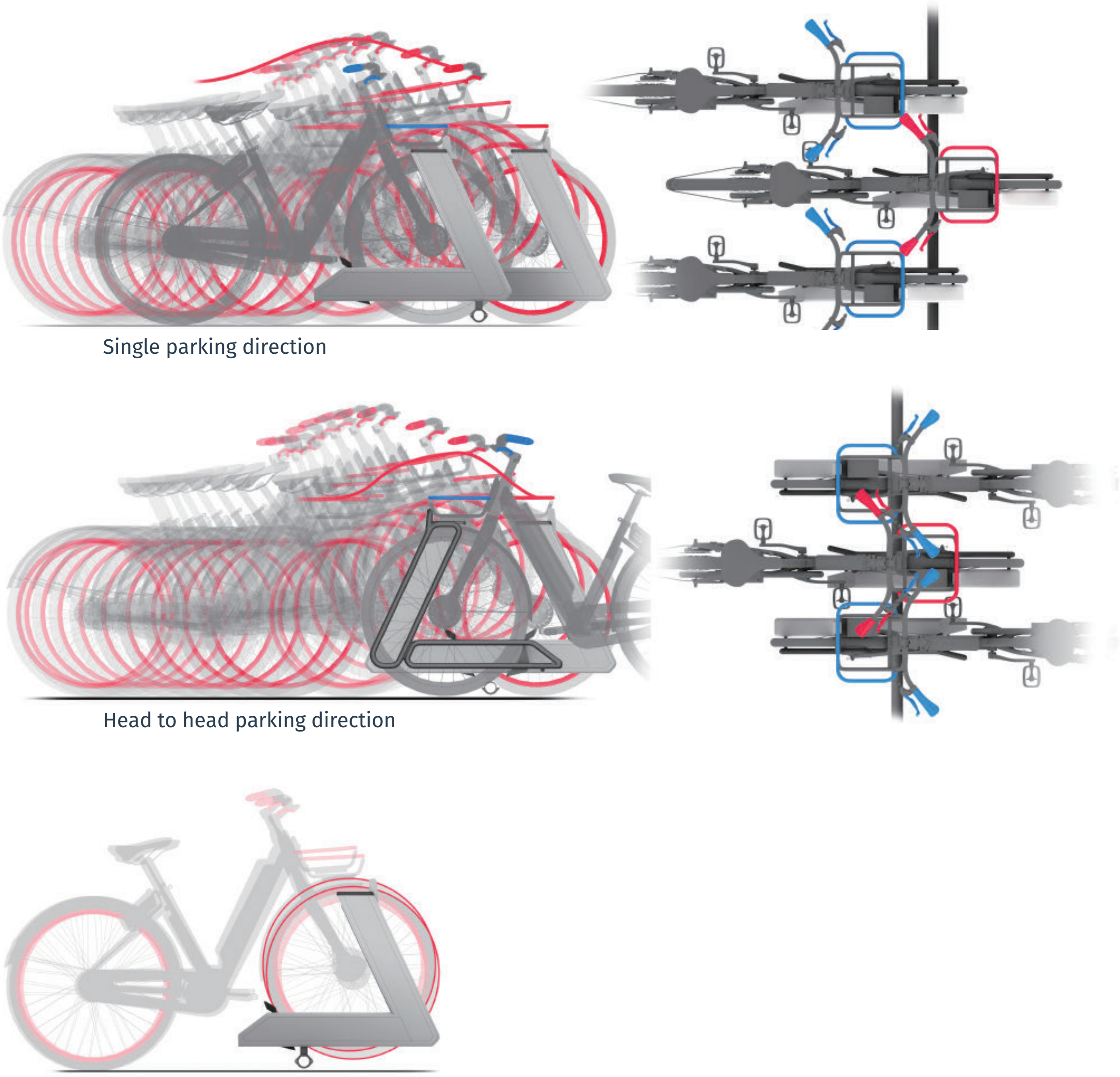


figure 20. bike motion

7.3.2 dock components

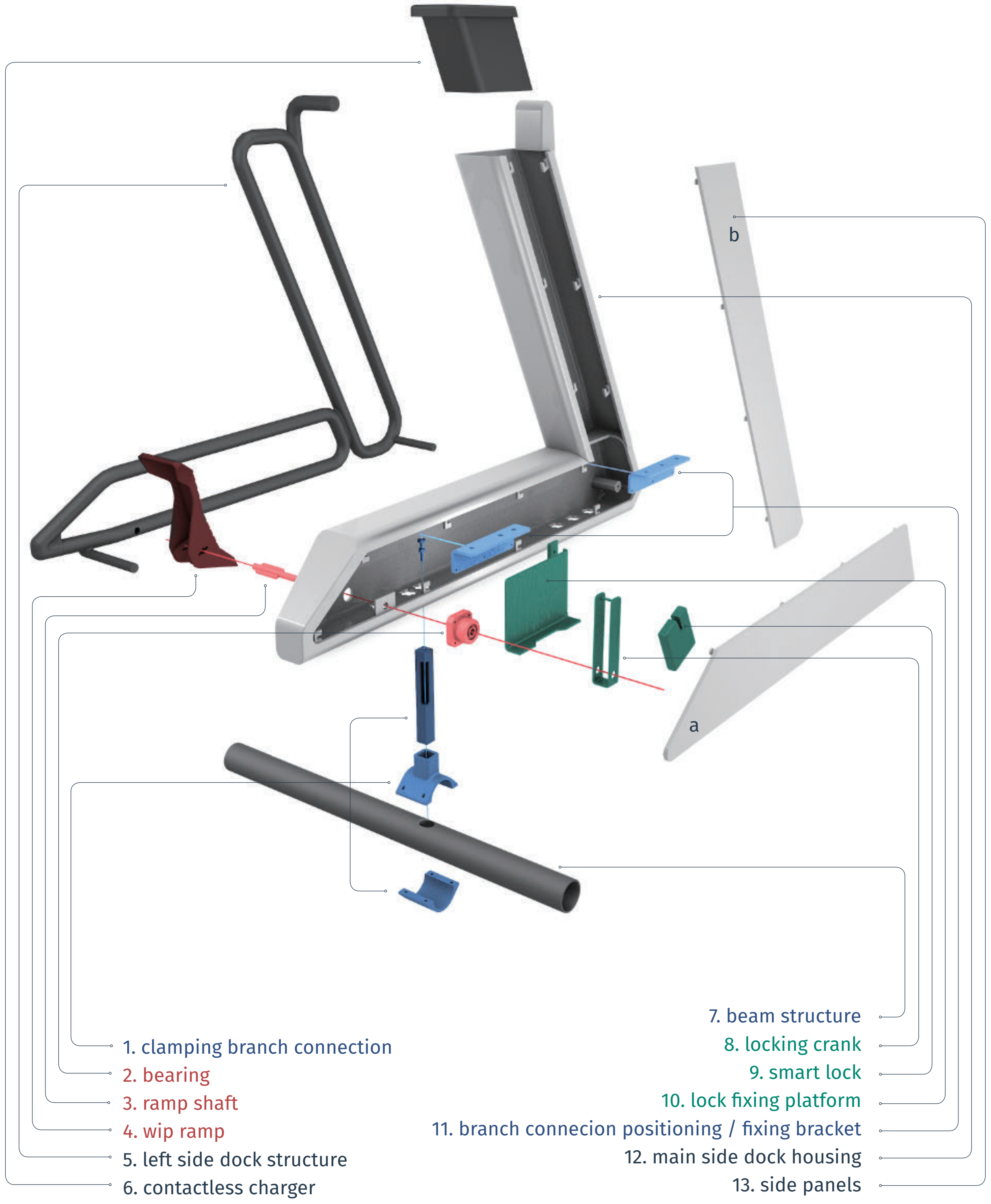


figure 21. dock exploded view

Wip ramp
parts: 2, 3, 4

Wip ramp takes the most impact in the regular use. The construction of wip ramp can ensure its endurability and smoothness.

Smart lock
parts: 8, 9, 10

The lock of Urbee dock consists of three main components: Smart lock, lock platform, and locking crank. The platform provides the sufficient space and support for the new smart lock in the future. The crank is driven by wip ramp. the crank will engage to the smart lock to fix the wip ramp in locking position.

components interlock
parts: 6, 12, 13

The interlocks of side panels will ensure the internal components to be consealed. There are certain steps to (dis)assembled. To assembled, firstly, slide lower side panel(12-a) into mounting points on main body (11); secondly, upper panel(12-b); lastly, the contactless charger module (6), and lock the module. The whole housing of dock will be firmly constructed.

Assymetric frame
parts: 5, 12

The Urbee dock is constructed in assymetric way. The aim is to reduce the overall weight yet remain the strength. All the functional components are integrated into right side of the dock.

Fixing/ positioning
parts: 1, 7, 11

The fixation and positioning of docks needs to be accurate to ensure the right functioning. The beam structure (7), in order to remain the firmness of structure, needs to be pre-made according to each configuration.
The clamping branch connections (1) will be fixed on the beam according to the hole positions (figure 23). Through the holes on the bottom of the dock (12), the branch connection will be fixed with the internal brackets. And the installation of dock is finished.

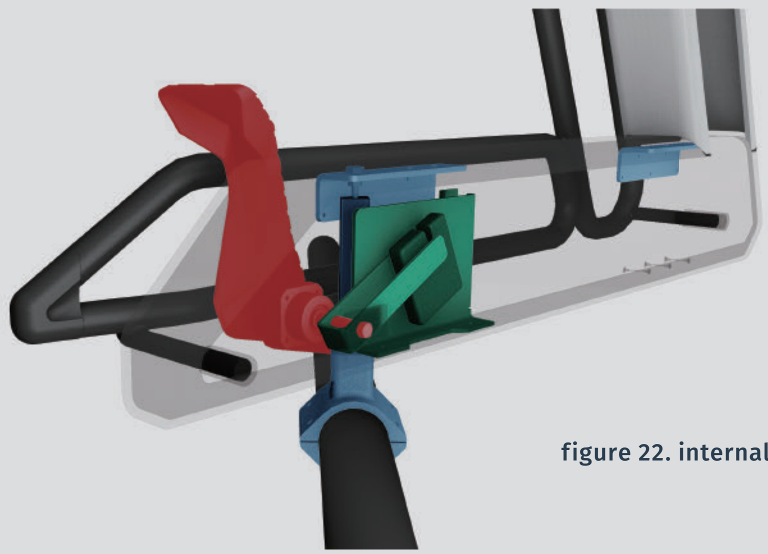
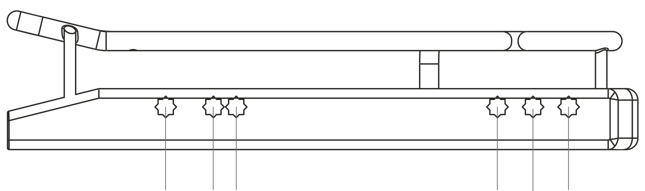


figure 22. internal component assembly

Hole positioning on beam structure/
Installation Guide
(unit: mm)



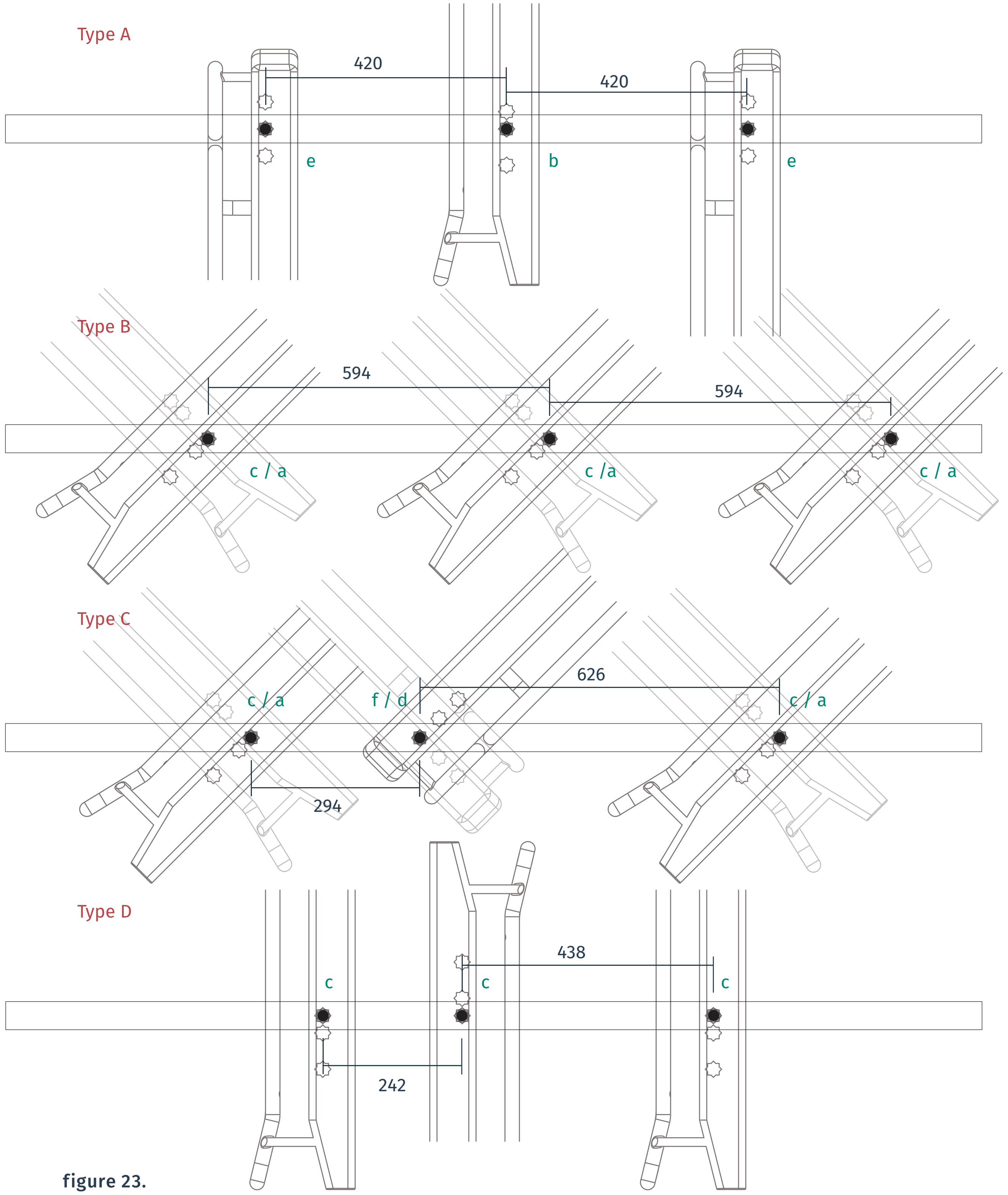
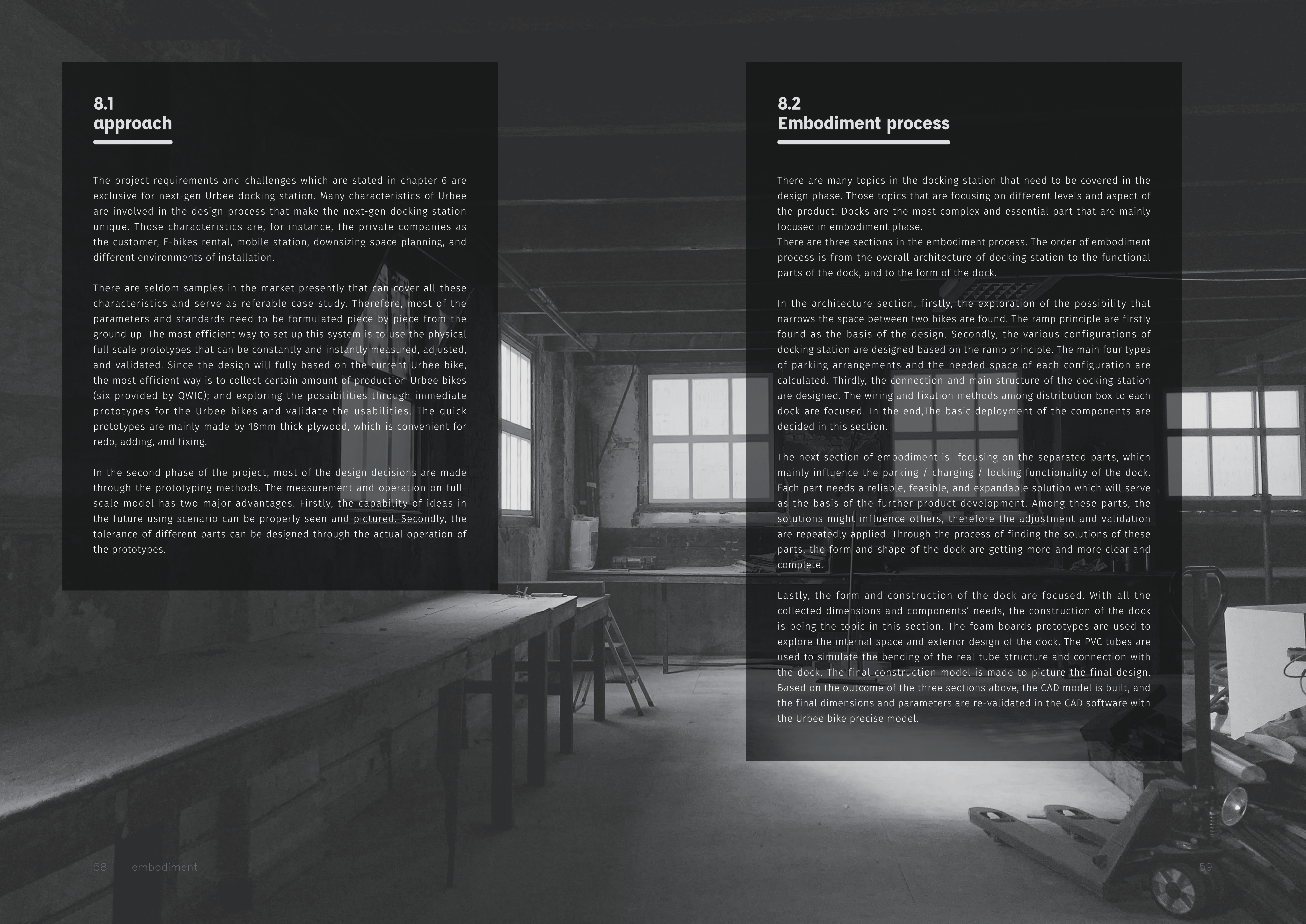


figure 23.

8 EMBODIMENT



8.1 approach

The project requirements and challenges which are stated in chapter 6 are exclusive for next-gen Urbee docking station. Many characteristics of Urbee are involved in the design process that make the next-gen docking station unique. Those characteristics are, for instance, the private companies as the customer, E-bikes rental, mobile station, downsizing space planning, and different environments of installation.

There are seldom samples in the market presently that can cover all these characteristics and serve as referable case study. Therefore, most of the parameters and standards need to be formulated piece by piece from the ground up. The most efficient way to set up this system is to use the physical full scale prototypes that can be constantly and instantly measured, adjusted, and validated. Since the design will fully based on the current Urbee bike, the most efficient way is to collect certain amount of production Urbee bikes (six provided by QWIC); and exploring the possibilities through immediate prototypes for the Urbee bikes and validate the usabilities. The quick prototypes are mainly made by 18mm thick plywood, which is convenient for redo, adding, and fixing.

In the second phase of the project, most of the design decisions are made through the prototyping methods. The measurement and operation on full-scale model has two major advantages. Firstly, the capability of ideas in the future using scenario can be properly seen and pictured. Secondly, the tolerance of different parts can be designed through the actual operation of the prototypes.

8.2 Embodiment process

There are many topics in the docking station that need to be covered in the design phase. Those topics that are focusing on different levels and aspect of the product. Docks are the most complex and essential part that are mainly focused in embodiment phase.
There are three sections in the embodiment process. The order of embodiment process is from the overall architecture of docking station to the functional parts of the dock, and to the form of the dock.

In the architecture section, firstly, the exploration of the possibility that narrows the space between two bikes are found. The ramp principle are firstly found as the basis of the design. Secondly, the various configurations of docking station are designed based on the ramp principle. The main four types of parking arrangements and the needed space of each configuration are calculated. Thirdly, the connection and main structure of the docking station are designed. The wiring and fixation methods among distribution box to each dock are focused. In the end,The basic deployment of the components are decided in this section.

The next section of embodiment is focusing on the separated parts, which mainly influence the parking / charging / locking functionality of the dock. Each part needs a reliable, feasible, and expandable solution which will serve as the basis of the further product development. Among these parts, the solutions might influence others, therefore the adjustment and validation are repeatedly applied. Through the process of finding the solutions of these parts, the form and shape of the dock are getting more and more clear and complete.

Lastly, the form and construction of the dock are focused. With all the collected dimensions and components' needs, the construction of the dock is being the topic in this section. The foam boards prototypes are used to explore the internal space and exterior design of the dock. The PVC tubes are used to simulate the bending of the real tube structure and connection with the dock. The final construction model is made to picture the final design. Based on the outcome of the three sections above, the CAD model is built, and the final dimensions and parameters are re-validated in the CAD software with the Urbee bike precise model.

8.3 architecture

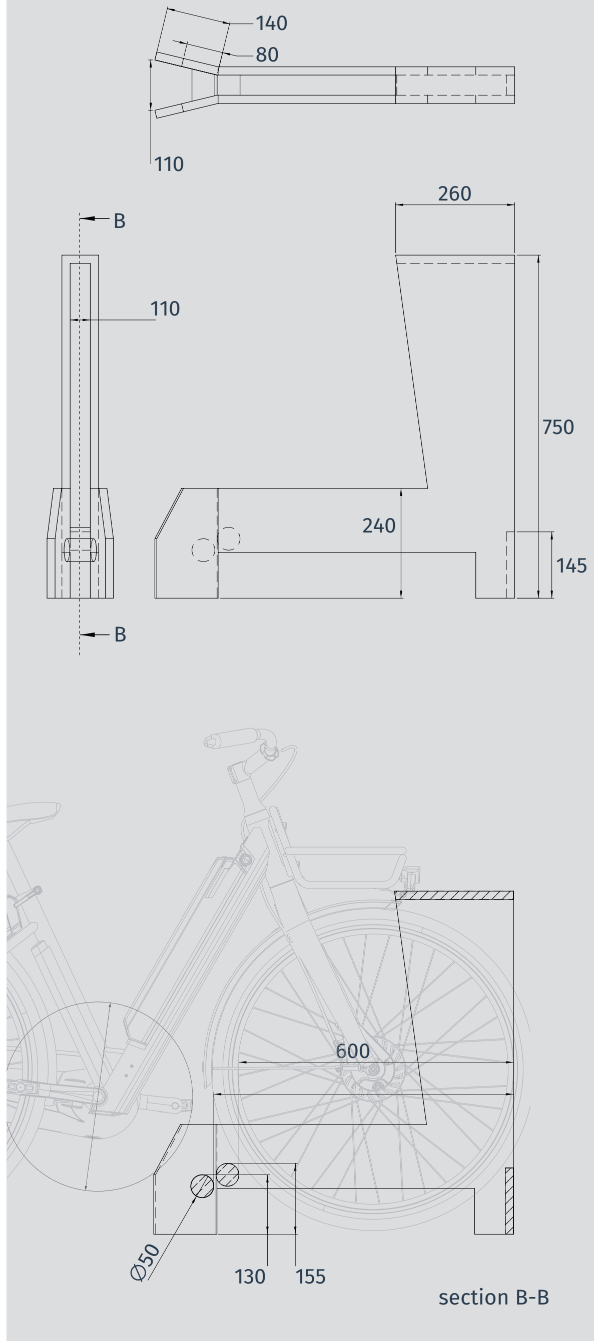


figure 24. basic dimensions of dock

8.3.1 ramp principle

Finding the exclusive solution for Urbee bikes that can narrowed the space is the start point of the embodiment phase. The ramp principle creates the opportunities not only narrowing but other valuable outcomes in the different aspects in the further stages.

The ramp principle is specifically designed based on the dimensions of Urbee bikes. In the first physical prototyping, the task is to understand the Urbee bikes through operating and measuring the positional and dimensional relation between two standing Urbee bikes. By knowing how much distance that handlebar needs to be lifted and combine with the onward distance, the bike can be smoothly go over other handlebars and land right after.

The ramp concept was created when the traditional hi-low parking rack methods were built. The unnecessary height was observed, after the bike was lifted and fully parked in the position. To eliminate the unnecessary vertical distance, the bike's vertical, onward movement and the positions of handlebars are particularly measured and focused.

The dimension and using experience are found by repeated prototype modifications and operation. Therefore, not only the ramp principle is designed, but also the basic outline of the dock is determined, which ensures the dock would not interfere with front carrier, front mudguards, pedals, etc. The primary and workable dimensions and outlines of dock are assessed and determined in this prototyping section. And they will be repeatedly tested and adjusted during the project.

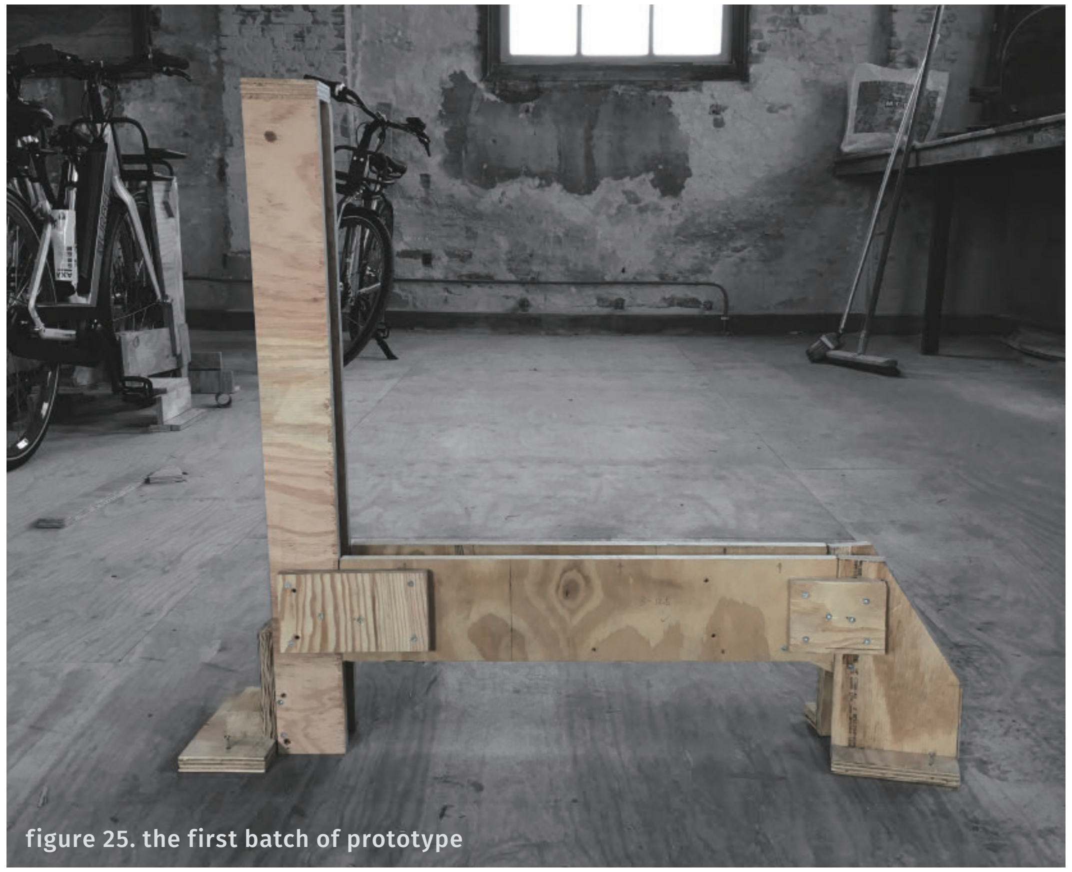


figure 25. the first batch of prototype

figure 26. 5 of first prototypes

8.3.2 configurations

The efficient and flexible space planning is an important requirement in the next-gen Urbee docking station. With the measurement of the Urbee bike dimensions, the possibilities of re-spacing and downsizing are discovered. The calculation is based on both digital and physical experiments. On one hand, the simple CAD model is built based on the primary dimensions in the first prototype. The CAD model serves as the documentation of prototyping outputs. Next, in order to have more precision and flexibility to arrange the parking patterns, the top views of both dock and Urbee bike are imported into Illustrator and the simple assumptions are formulated. On the other hand, the assumptions are physically validated in the plywood prototypes instantly.

There are four main types of patterns (figure 28) that are found compatible and workable with ramp principle, and be used as the basic configurations. The station footprint estimation and distance among bikes are also be determined according to each configuration. Thus, the most efficient parking ratio [m2 / bike] of each configuration can be calculated in the top-view drawings. The needed area for each configuration is also included in the calculation. (The extended length of clearance, for parking preparation (areas with dotted line), behind the bike is 175 cm.)

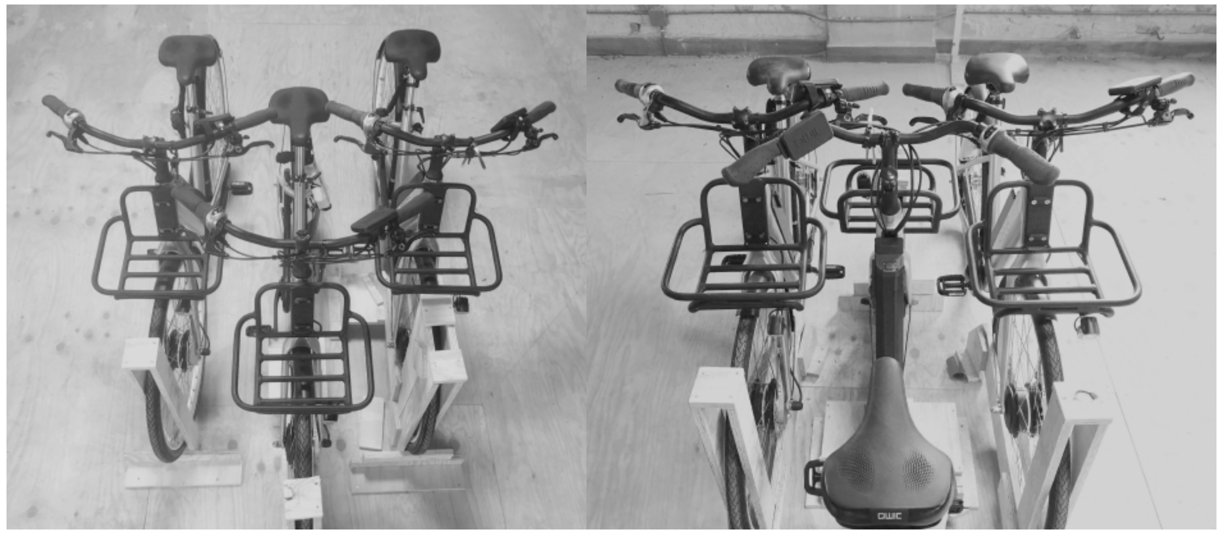
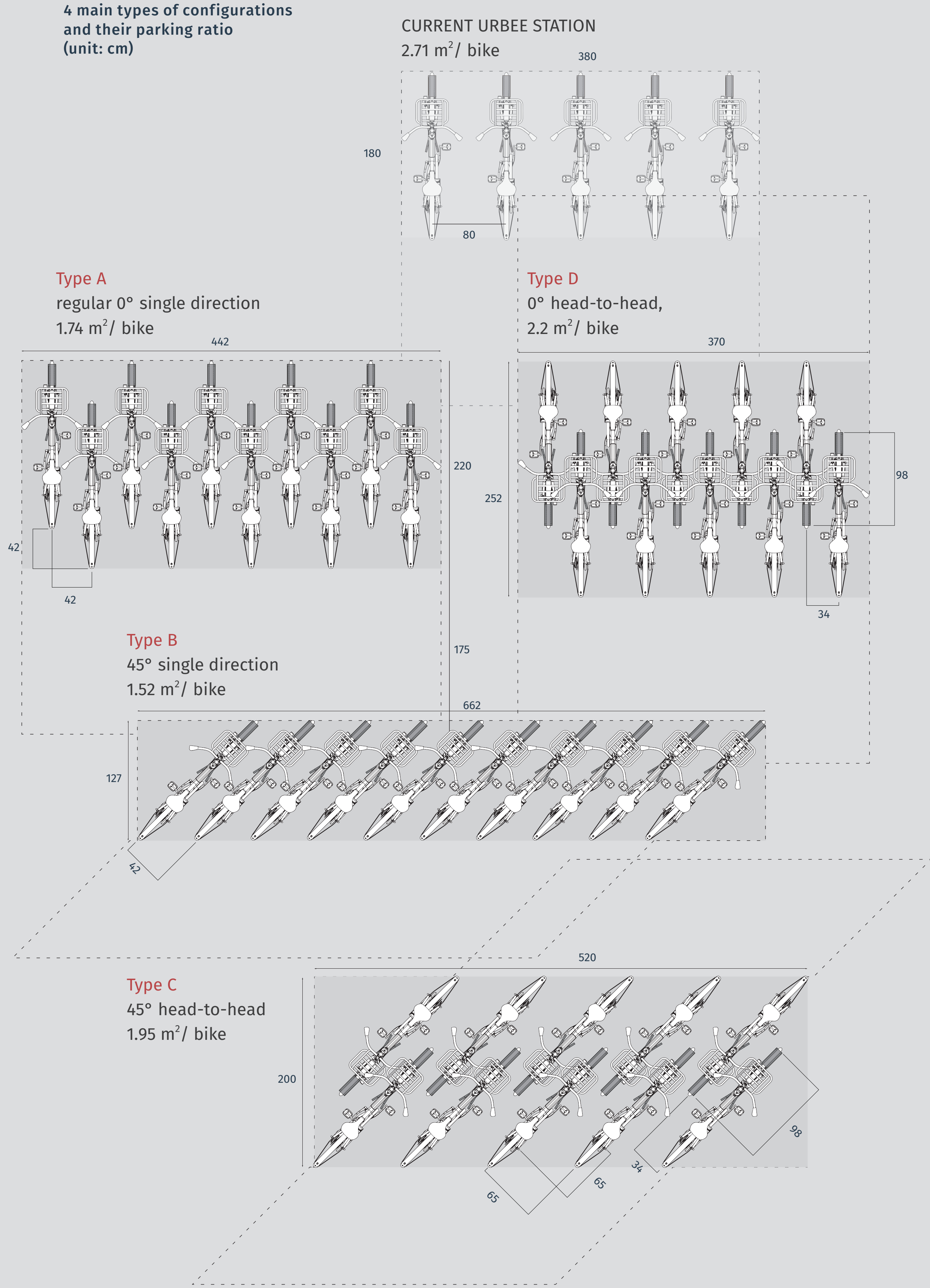


figure 27. two main basic parking directions

figure 28.
4 main types of configurations and their parking ratio (unit: cm)



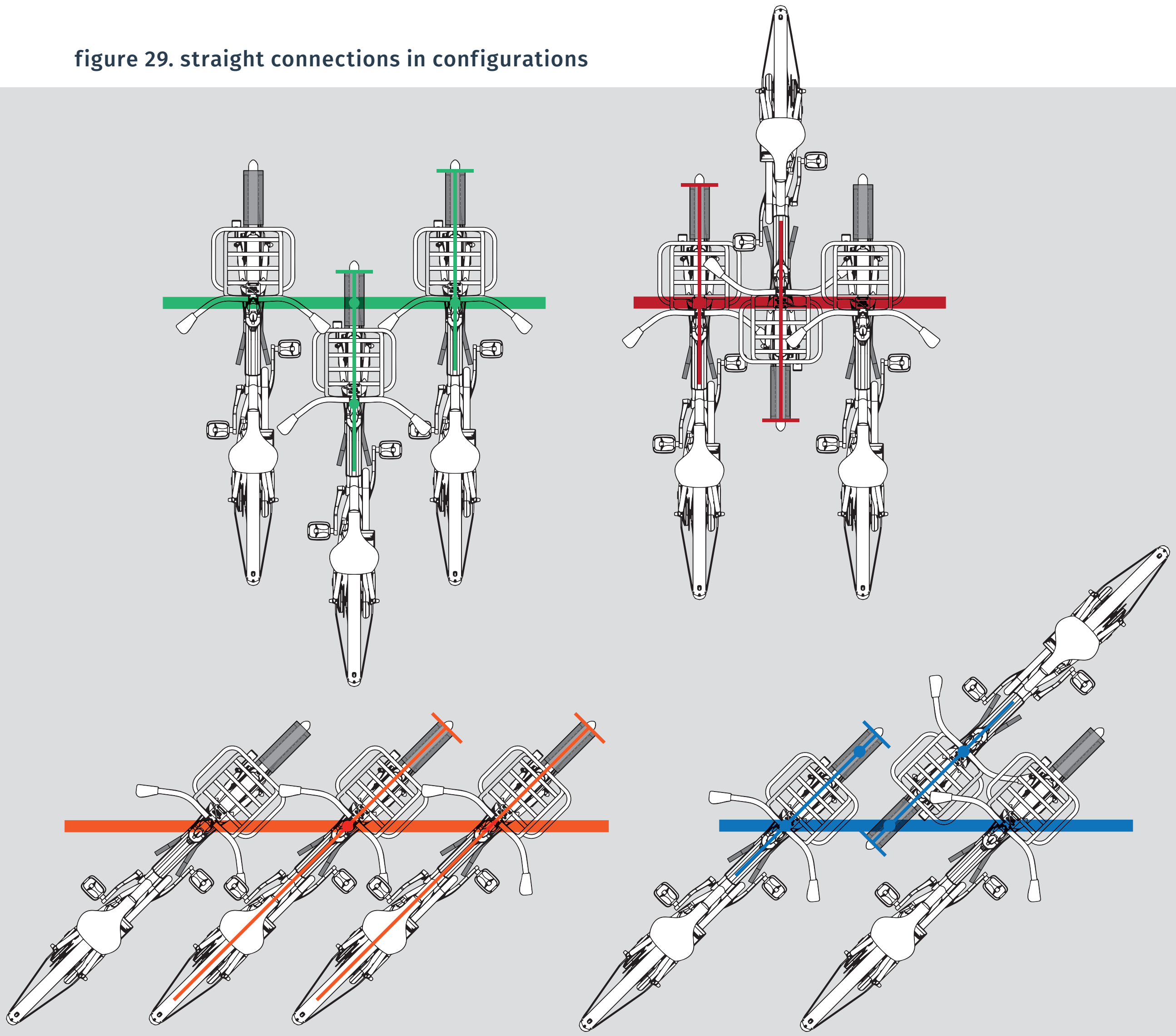
8.3.3 dock connection

To realize the nomadic station design, without underground wiring, it is important to keep the station construction organized and clean. In order to remain the unification of components as well as to simplify the constructional complexity; the connection among docks with single wireway in all configurations are searched.

The collective areas of all configuration wiring scenarios are firstly looked into, in order to find the viable position for wiring. The opened space on the dock allows wireways can go through, the available wiring space can avoid the interference between wireway and front tire.

Also, to ensure the internal space of wireways (for power and network connection cables), the basic dimension of wireway is presupposed as the round tube with 50 mm external diameter.

figure 29. straight connections in configurations



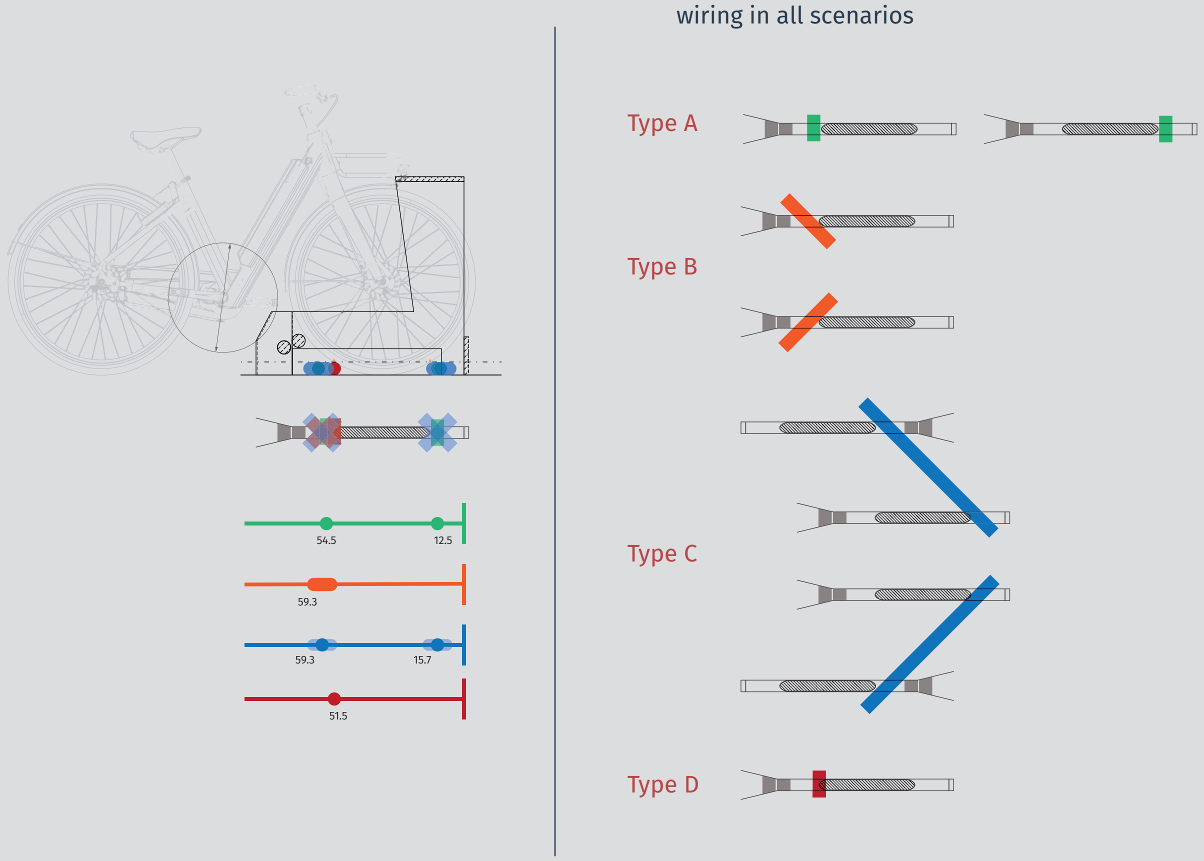


figure 30. collective wiring areas calculation

The result shows that the available wiring space before and after the front tire can achieve the aforementioned requirements. The required wireway area should be remained empty on the dock, that the wiring tube can go through. The wiring in both 45 and 0 degree scenarios can be neatly connected with the single wiring tube (beam structure).

8.3.4 basic construction

A quick foam board prototype is made to propose the idea and to visualise the basic construction of the dock. It can visualize the structure connection between dock and wring structure in different configurations. Also, to realise the wiring space in the sheet metal structure. To simulate the actual wall thickness of material and its spatial formation and connection, the 5 mm-thick foam core boards are used as the basic element in this prototype.

This prototype has the asymmetric form as dock body (see figure 32). In order to ensure the spatial sufficiency, most of the structure, wiring and mechanism are integrated in one side (left side in this prototype); connected with another half of dock that is slender yet reinforced structure. The body is lifted and fixed (with certain designated angles) by the structure which branches out from the main beam structure. To make the ramp mechanism strong enough to endure impact, where receives regular impact from parking, there is the extended foot to the ground.

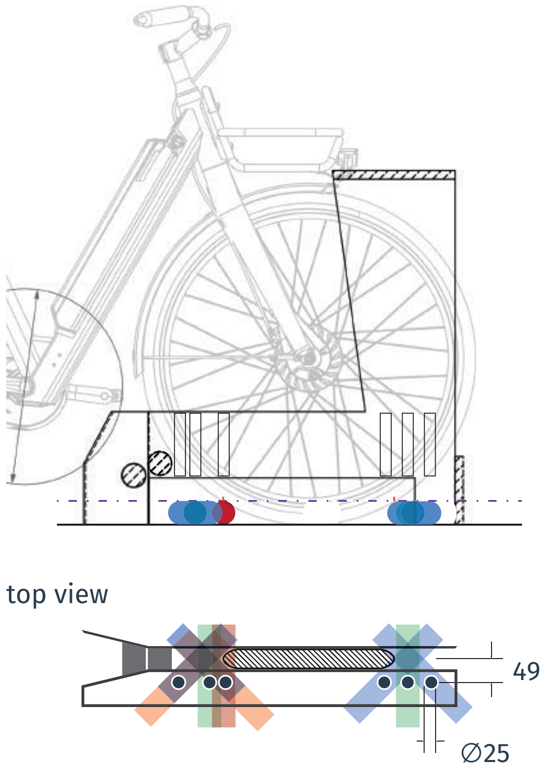


figure 31. connection spot positioning

Depends on different parking patterns, the connection points can be on front or back part of the tyre. The collective spots that can cover all configurations are firstly located in the side view and top view drawing. The 25 mm-diameter tube is set for the connecting and wiring structure. There are six connecting / positioning spots that will be used according to certain configuration, while only one of them will be used in each scenario.

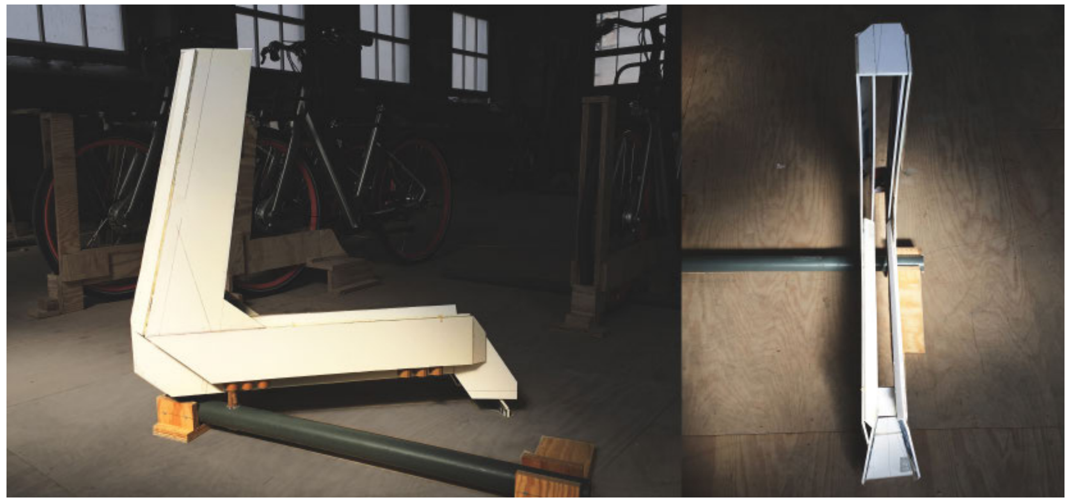


figure 32. foam construction prototype

8.3.5 statoiin architecture

The estimation of The wireway is designed as the main structure of the docking station which connects, mounts and positions docks in different spacing plans. On the both ends of the wiring tube (beam) are fixed to the concrete blocks that are heavy enough to stablize the station in location when undergoing the force and impact from the regular parking.

The main four elements in the docking station are docks, precast concrete weight blocks, beam structure (main wireway), and electricity distribution box. The same deployment can be used in all configurations with limited adjustments.

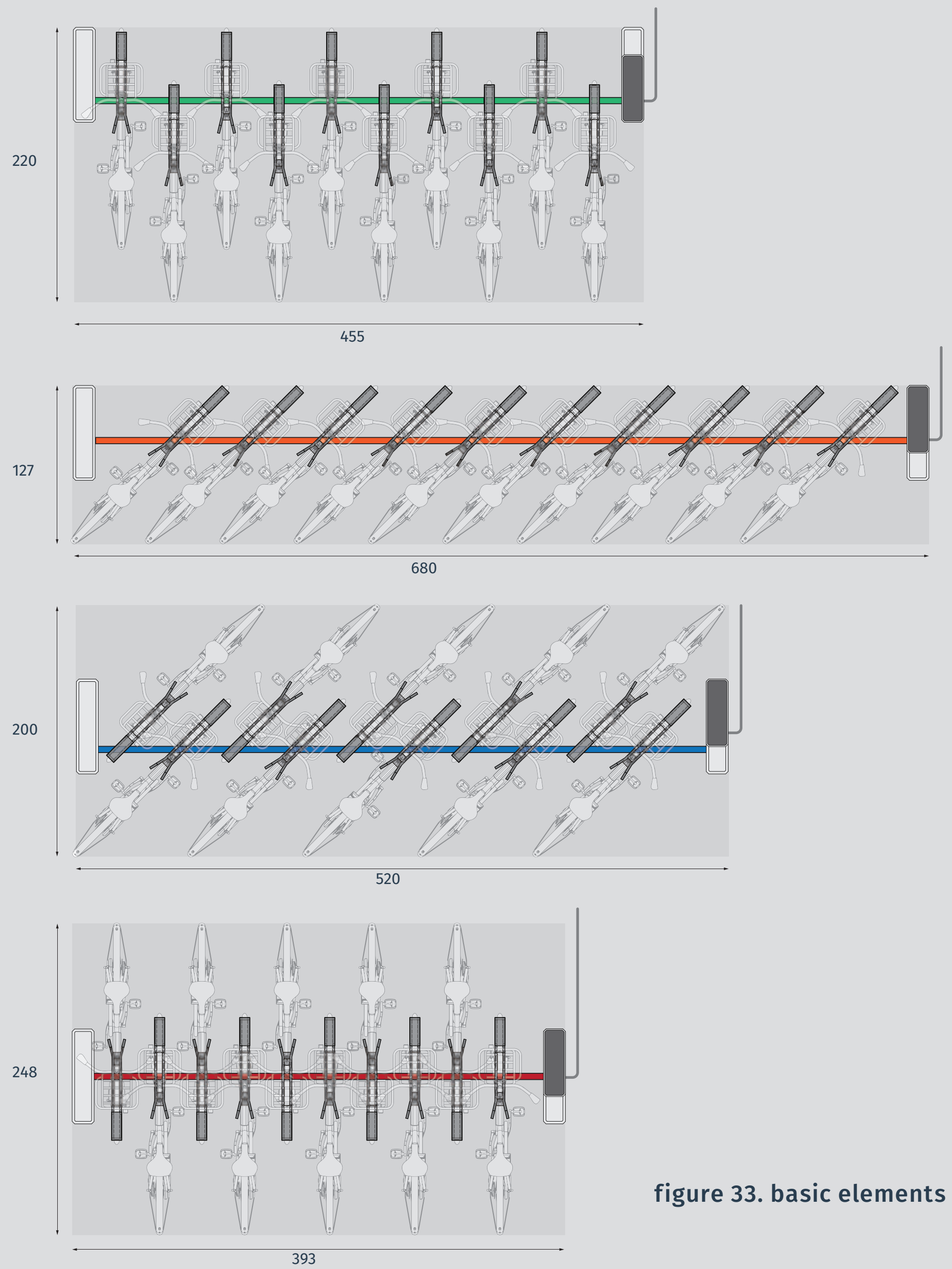


figure 33. basic elements in the station

Movie clips of operating prototypes
Link: https://goo.gl/EfvE5s

8.4
functional parts

The functional parts of the dock which can effectively influence the user experience and the security of the dock will be the main focuses of this section. Those parts includes the locking and charging mechanism. As well as the extended topics of the parts will be covered in this section.

8.4.1 locking mechanism

The development of the locking mechanism on the dock has two main purposes. Firstly, to minimize the modification on the original Urbee bike frame. The focus is to finish the locking on the current Urbee bike without additional mounted parts. Secondly, to ensure the security for non-electric circumstances. Due to the variety of the docking station placement, which might cause the instability of electricity supply. To ensure the Urbee bikes can be properly locked without electricity supply, the traditional non-electric locking mechanism is selected as the solution for these possible circumstances.

Requirement

- The locking procedure can be automatically and intuitively finished by end-users.
- The lock would be directly activated by the movement of parking, instead of driven by electric motor afterwards.
- The dock lock will be unlocked by inserting codes by Smartlock keypad on the rear tyre.
- No matter what is the tyre condition, the mechanism can ensure the bike's security.

The locked position selecting

Using the front tyre as the locked part on bike, instead of the front carrier or front hub, is based on two main reasons. Firstly, it is simpler and more accurate to position the front tyre in valid position. The front carrier could be angled along with the bike frame, when the bike is not straight parked. Therefore, it might be difficult to correctly lock the bike on such placement. The second reason is to avoid damages on the bike. Locking on the front motor hub would cause much repeating collides on the hub and front fork.

The determined part which can be locked is front tyre. When the bike is parked, the mechanism can properly and firmly fix the front tyre without causing any damage on the frame or motor. The locking mechanism can collocate with the ramp principle to properly fix the bike.

Development

There are two solutions that are found in this section that can meet the aforementioned requirements, one is the eccentric cam mechanism, another one is the rotating ramp, wip mechanism.

The eccentric cam

This eccentric cam mechanism functions as a lock after multiple tests of the form and position of the cam. The eccentric cam can lock front tyre finely and meet the requirement of the locking mechanism.
The friction between cam and tyre tightens and fixes the front tyre in the dock. As well as the ramp and the ground provide the reinforcement fixation. To unlock, the cam needs to be reversed few degrees (will be electric geared), give the tyre some space to leave.

The design starts from finding the optimal spot to place the cam axis that can function well. By tracing the movement of the front tyre, it is clear to see the necessary room for pulling out the bike as well as the functional, effective position for cam movement. The diameter of the first test model of the eccentric cam is Ø65. The testing cam works well in normal situation; also, it can compensate the tyre height difference which is caused by the different tyre pressures.

To ensure that the Urbee bike can be perfectly locked even with the flatted tyre. multiple cam shapes are tested. The egg shape is finally found that functions most efficiently. With the longer major axis, the cam can compensate more height difference, also increase the firmness of the locking. The result from the experiment shows that the egg-shaped eccentric cam works finely in all tyre conditions.

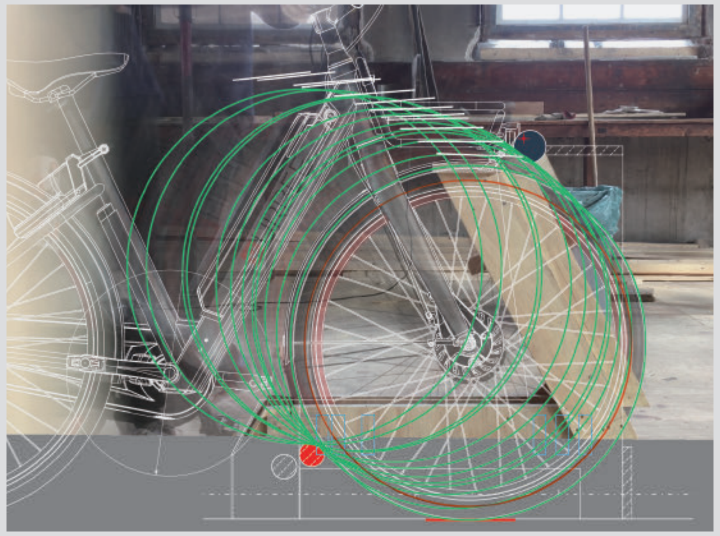


figure 34. front tyre movement with eccentric cam

figure 35. eccentric cam first prototype

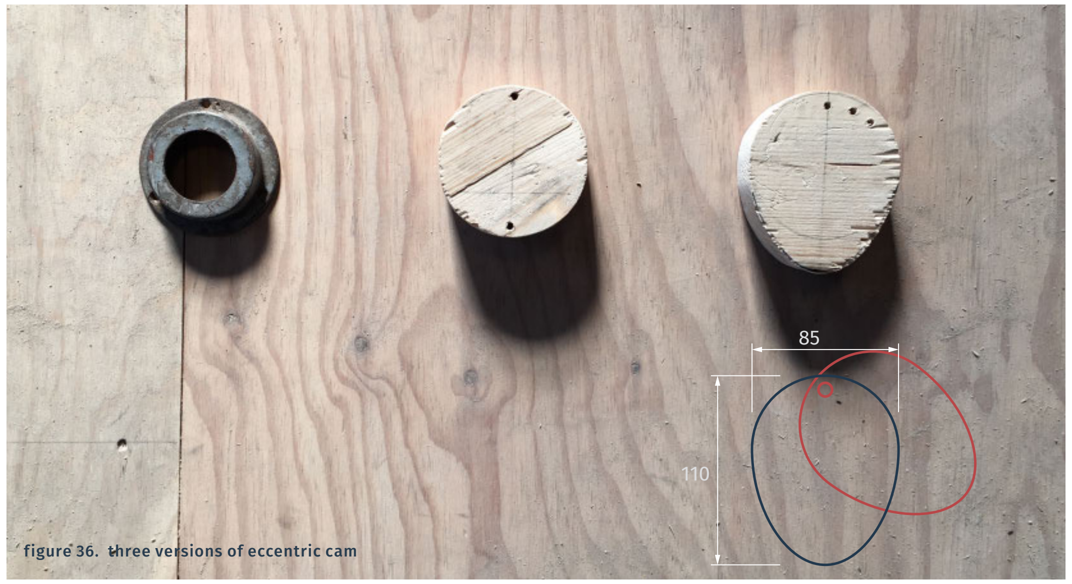


figure 36. three versions of eccentric cam

Second mechanism

Although the optimized cam locking mechanism has strong capability to lock the bike in every condition. However, the eccentric cam takes up too much space because of its movement and the housing that needs to be fully enclosed for security reasons. Moreover, the space of the charger on the top of the dock should also be left for. To address these issues, the second propose is necessary.

The second locking mechanism, wip ramp, is placed in the opposite position of the first design, where near the ramp. With those fundamental dimensions from the first design, the effective locking spots can be reused. The second locking mechanism design is based on the same requirements and its purpose is to integrate the lock and ramp principle into one new design. Also, increasing the locking capability as well as considering the available room for the electronic lock.

Comparison of two lock designs

- Eccentric cam mechanism:

- Can lock spontaneously;
- Take too much space for cam and its movement.
- Mechanism needs to be enclosed for security matters.

- Rotating ramp mechanism:

- Leave space for charger on top of dock;
- Integrating ramp principle;
- The extended length of ramp can both Increase locking capability and easiness of push up the ramp;

The wip ramp

The wip ramp solution is finally selected as the locking mechanism for Urbee dock. Following the requirements from the first design, front tyre is the main part that is locked. The ramp principle, from the architecture section, turns into wip ramp with two modes that can serve as either bike lifter or locking mechanism. The wip ramp integrates the static part into a multitasked, moving part.

To integrate these two functions into one part, there are several steps. Firstly, tracing the movement of the front tyre when it is being pulled out and parked in, in order to find effective position for locking spot on the dock. Secondly, determining the main rotation axis of the ramp in order to ensure the parameters and performance of the original ramp principle are remained the same. Also, the ramp needs to approach to front tyre as close as possible in the locking mode. Lastly, optimizing the ramp contact surface, to ensure it can perfectly fix the front tyre and avoid the interference with the front mudguard. With this design, the locking mechanism can work well both in the normal tyre condition and flatted-tyre condition.

Users can push bike onto the ramp easier.

figure 37.

front tyre movement with the wip ramp

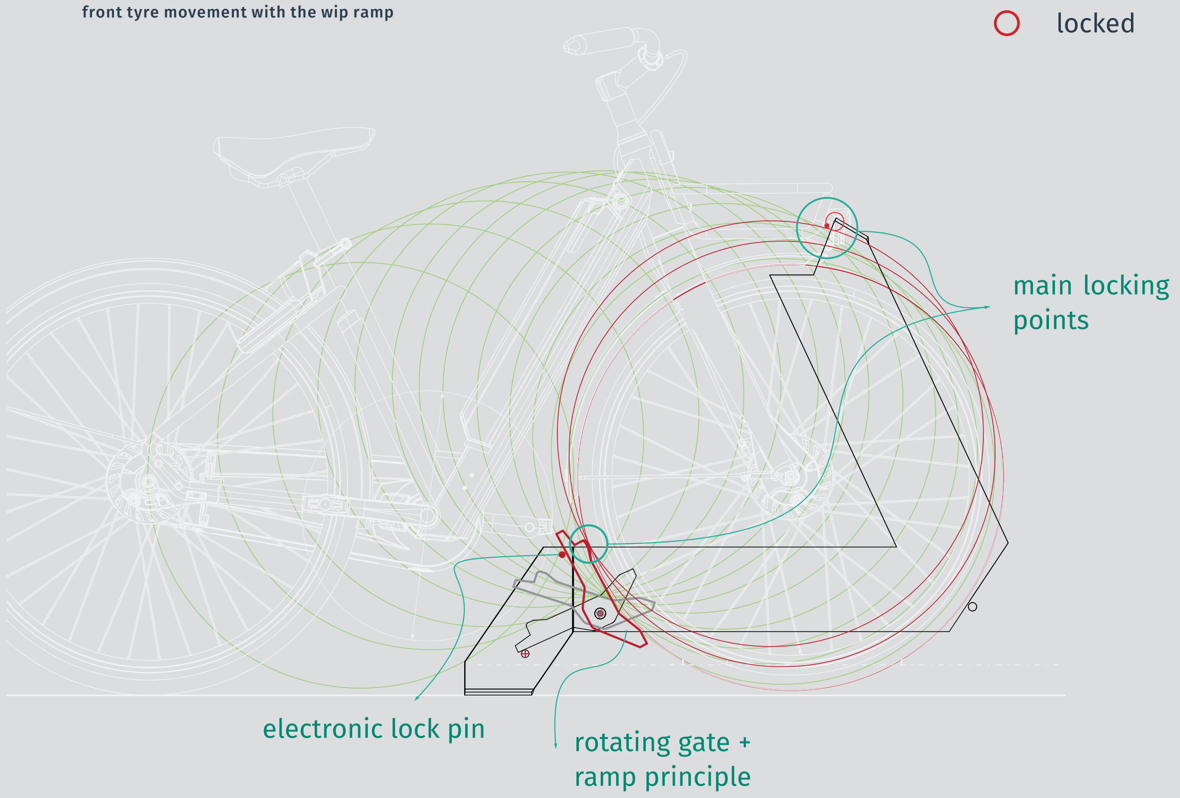


figure 40. evolution of wip ramp

Till the correct locking position, the ramp rotates approximately 88° clockwise and fixes the front tyre in the locking mode. When the bike is pulled out or the dock is vacant, the ramp will return to original position automatically, due to its weight distribution.

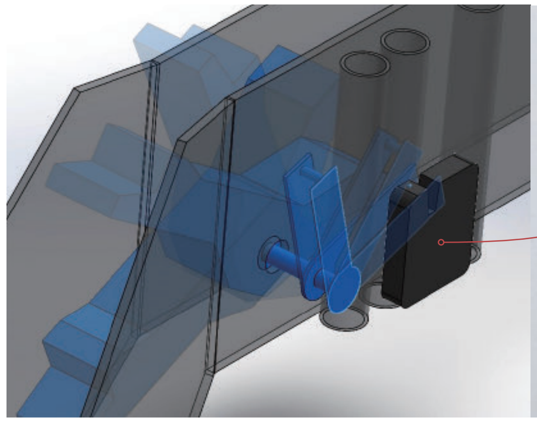
Accordingly, the space for the charger on top of dock is being saved. By extending the "tail" of the ramp, the locking capability would be increased in the locking mode; it also increases the easiness of parking in the ramp mode.

integrate with smart lock

Considering of the production demands and smartisation of the lock system with Urbee smart lock company, Scopei. The existing electric locking methods will be searched and integrated into the current locking mechanism.

Instead of using pin to lock the wip ramp in the designed position, the extended crank can more freely to position the internal lock without being constricted by the form of ramp. Because of the overlapping with the wiring / positioning construction parts. The crank needs to be placed outwards, which also allows the lock to have sufficient space for further component.

To meet the automatically locking requirement, the chosen lock needs to be activated by the movement of the crank, and be unlocked by the codes validation. To more realistically approach to the further production and smartisation development, an off-shelf lock solution is chosen. The fail-secure (remain secure without electricity), electric strike lock is targeted. The simple electric cabinet lock (figure XX)can be easily modified for wanted locking system of the prototype. (Dimension: 66 *56 *13 mm)



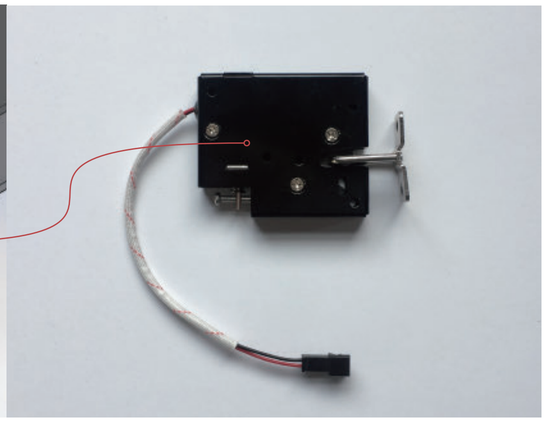


figure 39. Off-the-shelf lock

figure 38. internal crank

8.4.2 contactless charger

To provide a user-friendly, durable, clean charging interface, the contactless charging technology is selected. The technology will be mature and marketable for the time requirement of Urbee docking station in the primary feasibility evaluation. By collaborating with professor Peter van Duijsen, EWI, TUD, the application and implementation of the contactless charger to the Urbee docking station can be realised, in a business cooperation model.

However, in this project, the topic is to formulate suitable conditions for such an advanced technology, instead of putting it into practice. To engage with the contactless charging system, the Urbee dock should ensure there is sufficient room for charger in the expected area. Also the fundamental and practical matters that might influence the charging efficiency should be taken into account in the design phase. For instance, the required area that can achieve the expected power transfer performance; the gap dimension between transmitter and receiver; the material that covers around the charging component.

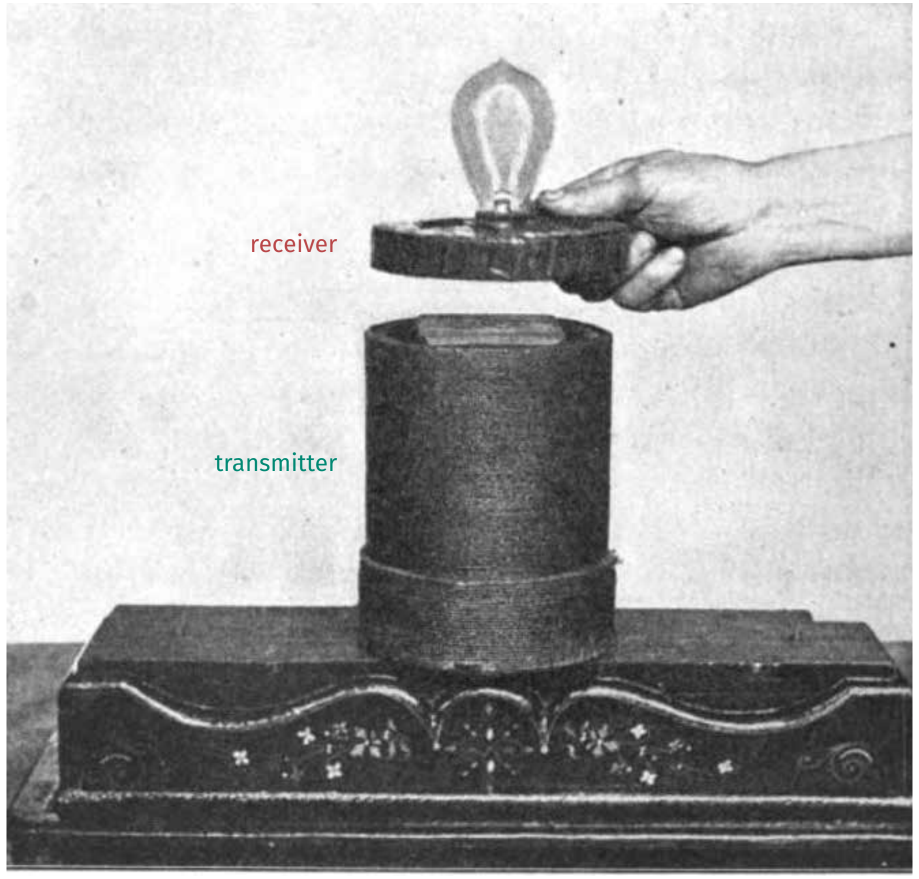


figure 41. A light bulb powered wirelessly by induction, in 1910. ("Wireless power transfer", n.d)

Expected charging performance

- Battery capacity: 14.5 Ah;
- Minimum charge at 42V,2A = 84W; Preferably 168W;

Design requiremen

According to the Tripartite Meeting which included QWIC, contactless charging lab from TU, the requirements for creating ideal charging environment are listed.

- The dimensions of transmitter and receiver are shown in the figure;
- Rearrange the front carrier's bars and vertical position to fit and protect the receiver;
- Covers around the component should not influence the magnetic field, should be aluminium or plastic;
- Preventing the damage that is caused by regular parking;

The concept

To stabilise the charging performance, the gap dimension between transmitter and receiver is a vital factor. The optimum dimension should be constricted in 5 to 10 mm.

The concept is to make the gap constricted in the same distance, in all kinds of condition. The solution for stabilising and standardising the charging performance is making the receiver (mounted on front carrier) to be directly hung on the transmitter (on dock). In this way, no matter what condition of front tyre has or ground, the tolerance would be unified and minimized. The front tyre would be lifted by 10 mm from floor, which will not influence other parameters in the previous sections.

The rough dimensions of transmitter / receiver are decided after the discussion with prof (figure 43). Peter van Duijsen. The contact area and component housing volume are roughly estimated, which are adequate for the charging system to achieve the expected charging performance. Charging performance is based on the current Urbee station's wire charger efficiency that the contactless is request to at least reach the lower efficiency version charging.

figure 42.
prototype to proof the "hanging" concept/
validation the request dimension of charger

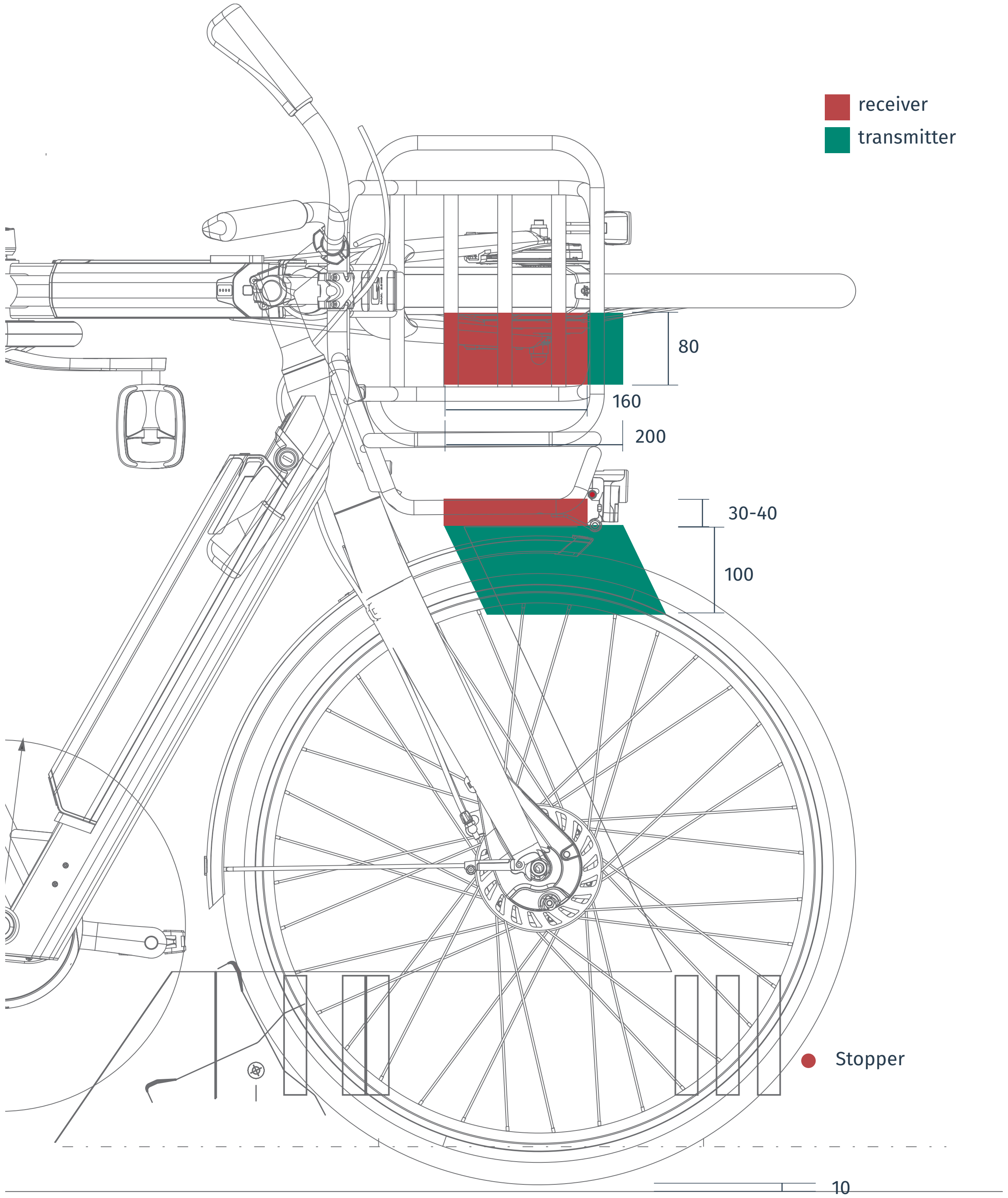


figure 43. contactless charger dimension

Front carrier modification

To mount the receiver on the front carrier, some changes need to be made to the design of front carrier. Considering of the limited space above the front wheel movement range and underneath the front carrier, a functional receiver has constrictive space to be placed. To ensure there is enough room for the components, the bars of the front carrier need to be rearranged. Moreover, the integration of front light and receiver is an expected solution to simplify the components that will be mounted.

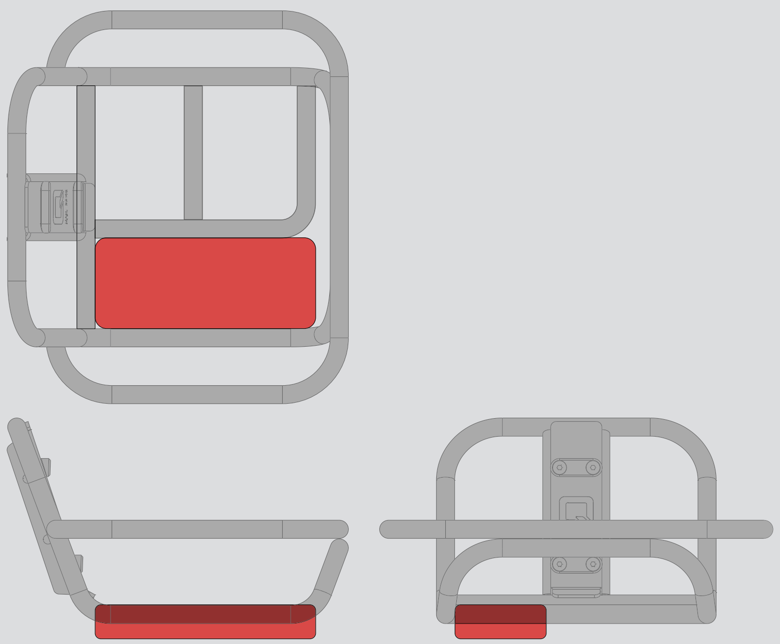


figure 44. front carrier modification

housing material

This requirement will be mainly tackled in the next section of form and construction design.

Damage prevention

It is vital preventing the direct and first collide between transmitter and receiver when parking and reduce the likely damages. The first touched part is replaced. Since the front tyre provides a good quality of cushioning. Without adding more materials and components, a simple adjustment can address this issue. The idea is to manipulate the position (inwards and upwards) of stopper (in the figure 43), the front tyre then become the first contact point. The bike, after touching the stopper will slightly slide back, the charger will gently connected.

figure 45. contactless charger prototype

8.5
form

After the previous sections, with all the fundamental dimensions and hard points that are set for docking / charging / locking of Urbee bikes, it is adequate for the design of construction and form of the docks. Also, the requirements and components that will be used are clarified. Therefore, the elements in the dock will be firstly organised; the deployment of the internal components will collocate with the exterior design of the dock in the later subsections. There are three subsections, internal components deployment, forming, and styling.

8.5.1 internal components deployment

In this subsection, the deployment of the elements are pre-assembled in the estimated internal space. With the CAD model, the better positioning and adjustments of components can be more realistically determined. The assembled elements are essential for the matters of locking and constructing. The deploying and shaping of these elements are based on the firmness and assembly purposes. The elements are:

- 4 bolt bearing flange, for the working smoothness and accuracy of the wip ramp and the crank; (red parts in figure 46)
- Branch connection and its fixing screws, square tube with wiring outlet(blue parts)
- Attached fixing bracket, for the branch connection;(orange parts)
- Attached lock platform, for fix the smart lock which will engage with the wip ramp crank and lock. (teal parts)

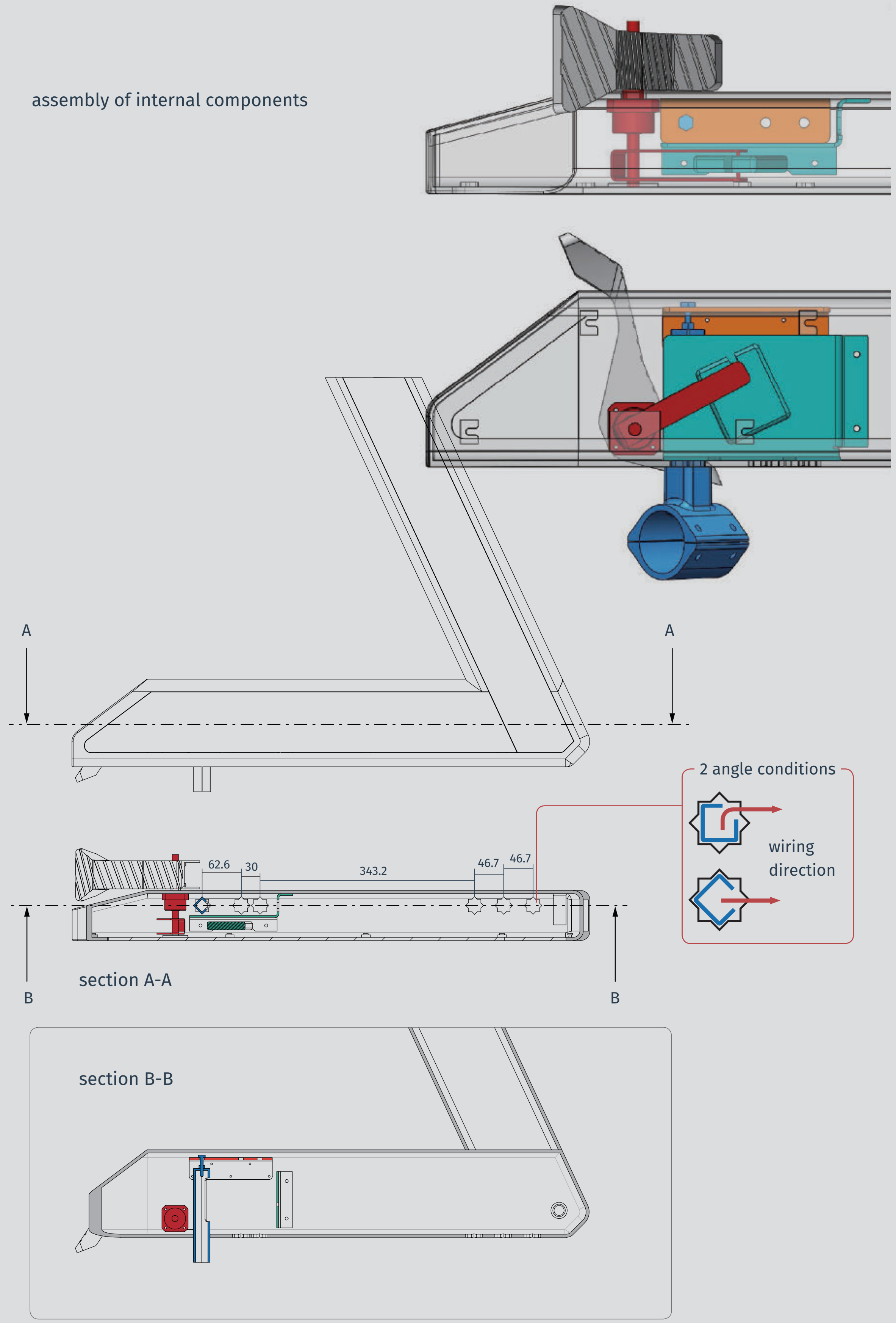


figure 46. internal component

8.5.2 dock construction and form

The construction of dock will be the consequences of exclusive features that are designed for Urbee docks. For instance, the connection between beam structure and the docks, which make the docks have unique way of fixing and the "floating" stance. As well as the wip ramp makes the dock has unique driving methods that will be fundamentally different from the regular design of BSS docks. These features provide plenty opportunities to form an exclusive dock structure, which should be developed from the ground up.

There are many places are redesigned and re-decided with time, compare to the early prototypes. A total different perspective in terms of manufacturability and firmness are focused, in order to understand the overall construction of the dock. The final construction design divides dock into two halves, the main side, with most of functional parts; and the left side, with simplified structure.

The main side

Most of the components(fixing mechanism, wiring, smart lock, contactless charger, etc.) are all integrated in the right side of the dock. It is also where the major weight distribution is. The parts that construct the main side of dock are bending sheet metal. Considering of the heaviness, the material will be aluminium or aluminium alloy.

The form of the dock should firstly ensure the internal space is sufficient for housing all of the components and parts, especially contactless charger and locking mechanism. Also, how do those parts be assembled and interlocked together for security purposes and disassembled for maintenance, will be addressed.

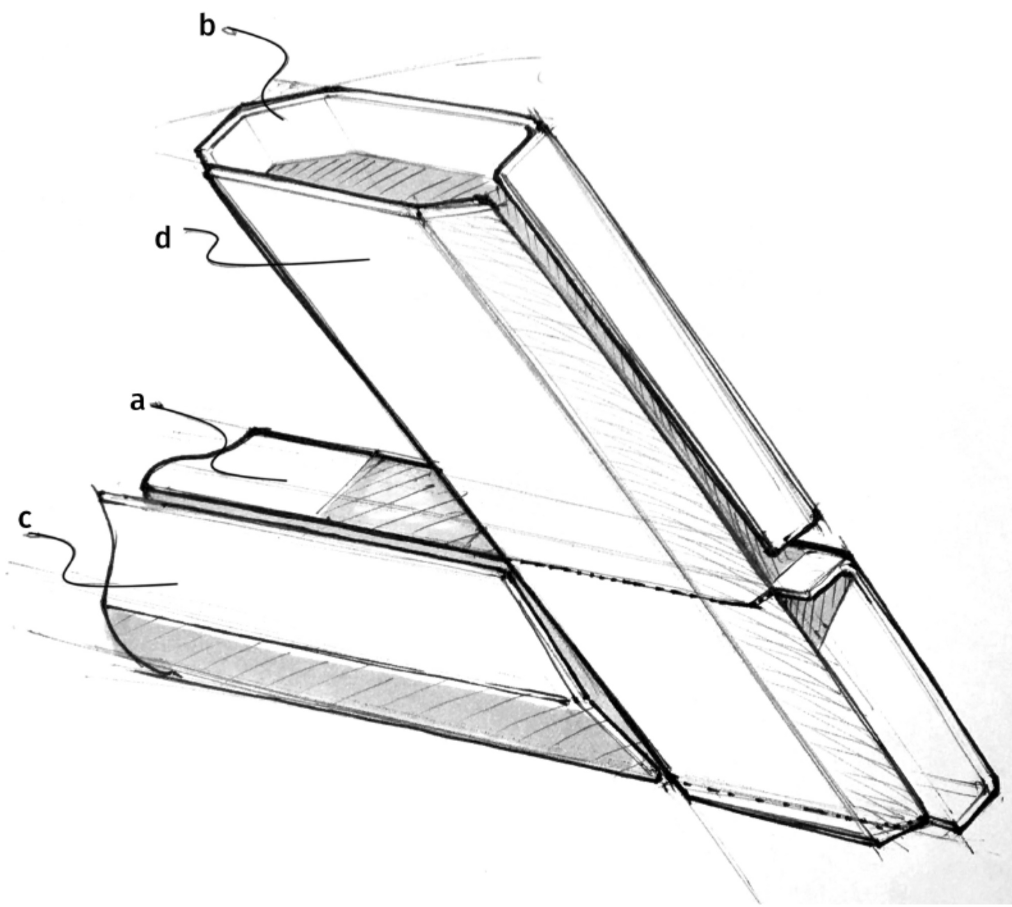
The left side

The task of the left side of the dock is to constrict the movement of the bike for locking and support the front carrier when the bike is charging. The main aim of designing the left side is to reduce the extra and unnecessary material use and the weight. By only keeping the essential connections among fundamental points, the left side can be simply constructed with bending tube structure. With the total different requests from the main side, the overall form of Urbee dock will be asymmetrical in terms of volume, shape and material.

Construction

The basic construction of the main side consists of four sheet metal parts, which form a box-like robust structure with sufficient internal space. Two of the U-shaped parts(a,b) serve as the main structure that support and reinforce the whole dock. In the production stage, these two parts will be welded together for forming the firmer dock body. Other two parts(c,d) will be interlocked with each other as well as the main structure. The detail design that addresses the security and maintenance will be elaborated in the next phase.

The left side of the dock will be formed with tube structure (∅ 25) that are relatively simple and light yet strong enough to properly constrict and secure the Urbee bikes.
With these design directions, the reduction of the dock's weight, enclosed components, asymmetrical construction, the form of the dock is more specified. The durability and security will be ensured.



The first construction prototype

The first 1:1 construction prototype follows the aforementioned design directions is made. The purposes of this foam board mock-up are, firstly, to understand the overall volume of the dock with the estimated internal space. Secondly, to understand the relation and connection among the four separated parts of the main side construction. Thirdly, the basic construction of the left side, and how does the simple structure connects to the main side. Lastly, understand the proportional relation when the whole dock (main and left side) is assembled.

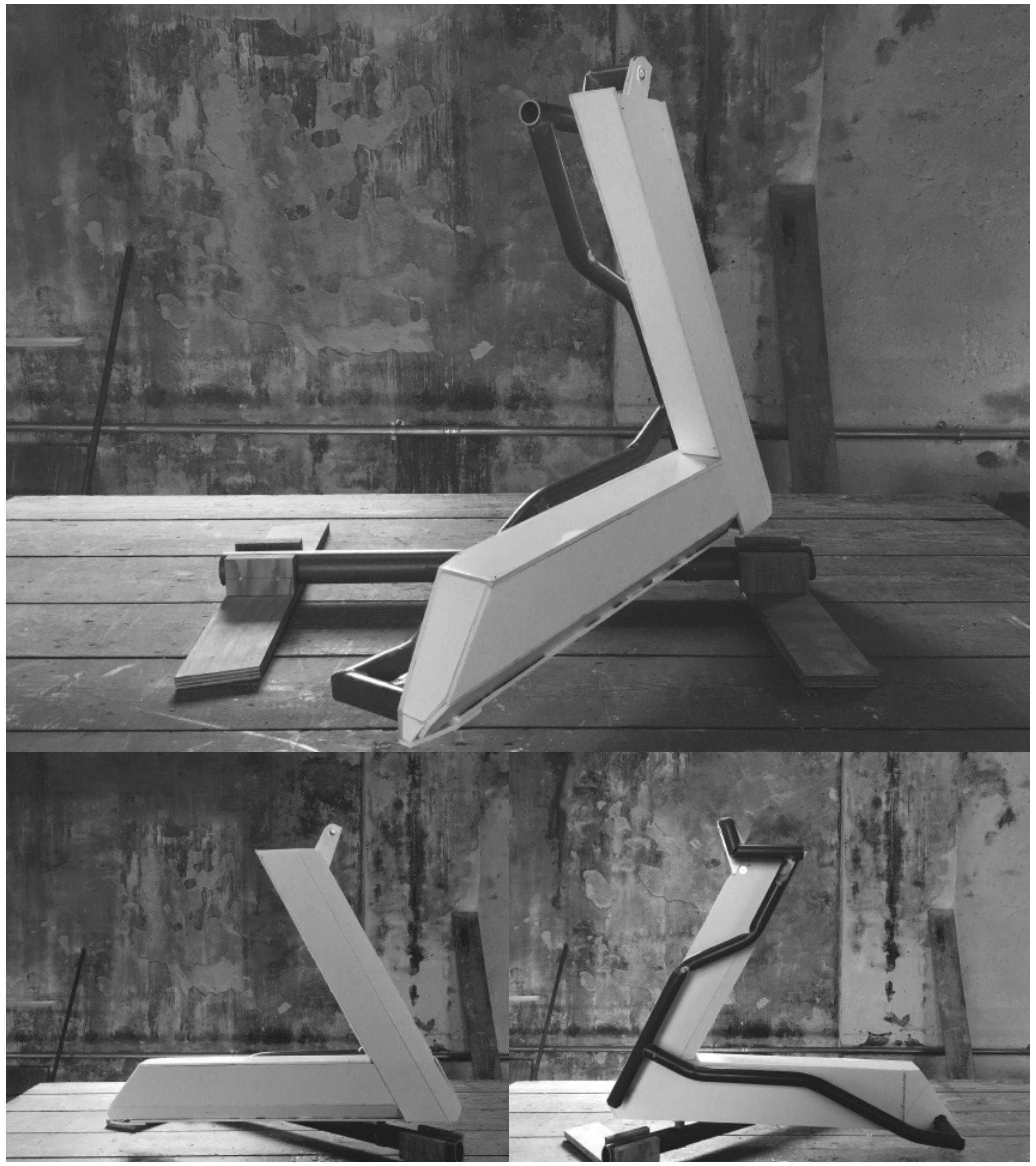


figure 47. construction prototype

evaluation

The overall volume and combination of tube structure and main side are workable. However, there are many places need to be further developed.

- The form of the main side parts are too complex to produce. Some surface translation are not spontaneous and reasonable. The surfaces need to be rearranged in terms of forming and rationalisation.

- The complexity of the tube structure. To cover all the fundamental designated points, the form of the tube structure are getting complex and unnecessary. The linkages among fundamental points with tube structure could be addressed in a more elegant and understandable ways.

- The clearness of usage is one of the weaknesses in this prototype. The form of tube structure will make the entrance / usage of the dock not intuitively understandable. To solve this, the shape of the tube structure should be more reasonable, the alignments with the main side should be more clear and correlated.

- Inconsistent style language used in both halves. The dock need to be harmonised and unified in the same style language, also with Urbee bikes.

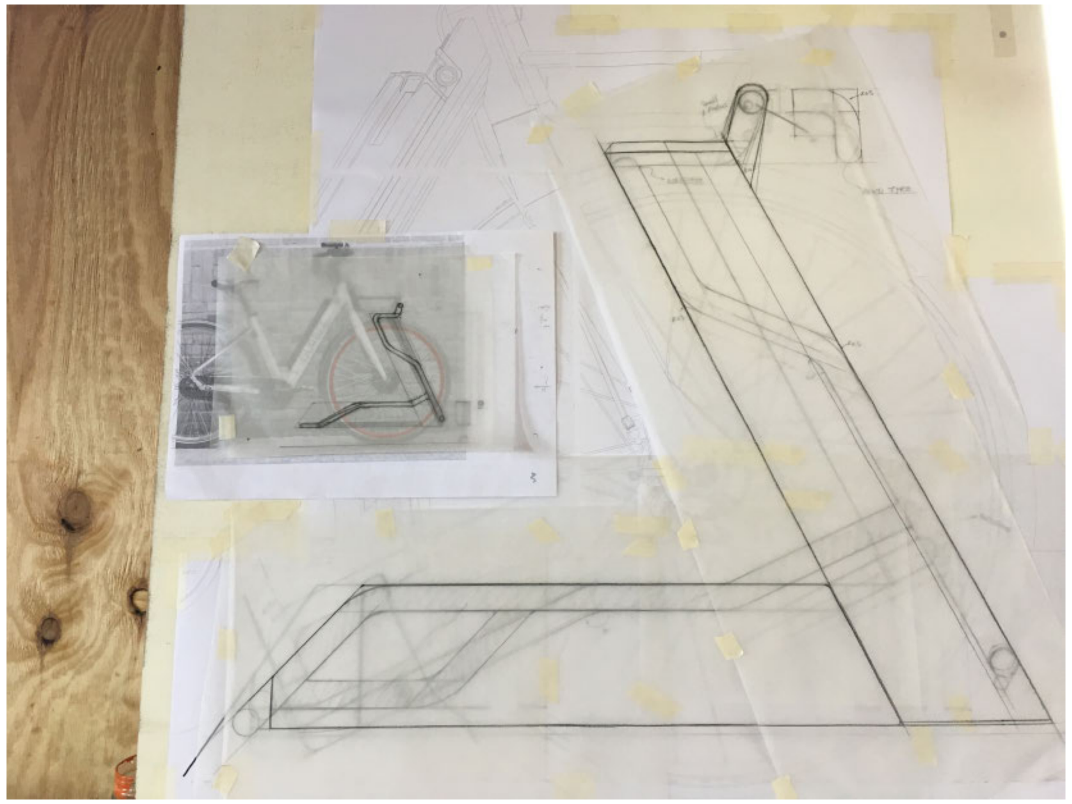


figure 48. full-scaled drawing

8.6 styling

The start of style defining phase, two main aspects are focused. Firstly, rationalising the construction and form. Through making the 1:1 side-view drawing and exterior style prototype, the relation among parts and possibilities of manufacturing are clarified. Secondly, the alignments of style language. The mood board organising and sketches help to find the harmonized looks of the dock that all the visual elements have to be correlated. Also, increasing the understandability, the surfaces, angles, and lines need to be aligned. This helps user can more intuitively use this product. Lastly, the building of CAD model. The CAD model can be used for testifying all of the decisions and elements can work as expected, including the configurations. The final design of the project can be settled.

To find and align the styling language that is used on the Urbee bike, the mood board is used. Some classic products / architectures design examples provide an overall image of the coming styling direction. There are topics that will be focused in the styling process.

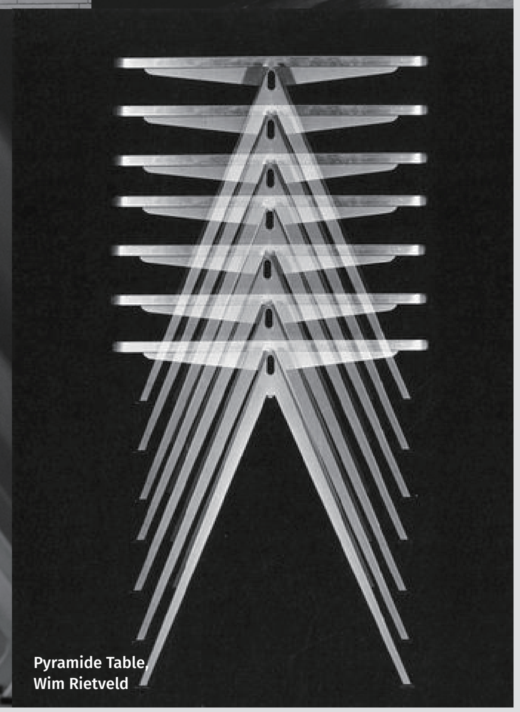
- The continuity style from Urbee bike. The cold, repeated straight lines with soft, approachable edges. The finish of material underpins the quality of QWIC bike. Aligning the language with Urbee bike can make users easily associate the docking station with Urbee bikes as a whole package of service.
- The soft touch of edges. The products which have soft, rounded edges and corners can provide a friendly / quality user experience. Like what Urbee bike provides to its users, the quality of the edges can express the direct identity of the brand.
- The construction of multiple elements (both exterior and interior) yet remain harmony and consistent in the product.
- The repetition when the docks are placed in a row is an unique visual effect in the BSS, which should take into consideration. How does the landscape remain clean and organised in all the configurations.
- The surface finishing, the brushed aluminium is the method that Urbee bike has on the final surface treatment. The brushed surface is helpful for hiding and diluting the mild scratches of public facility. Urbee docks should include the same finishing on the dock surface.
- The highlighted part. The two red inner rims of tyres are the iconic features of Urbee. Besides the rims, most of the parts are kept low-profile. The proportion of this visual effect should be continued in the Urbee docking station.

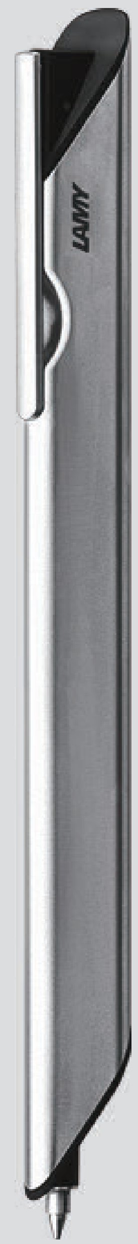

Hitachi Elevator HF-1, Naoto Fukasawa


Rotterdam Erasmus MC facade, Jean Prouvé


Alessi 4060, milk jug, Richard Sapper


Liège-Guillemins railway station, Belgium, Santiago Calatrava


Pyramide Table, Wim Rietveld

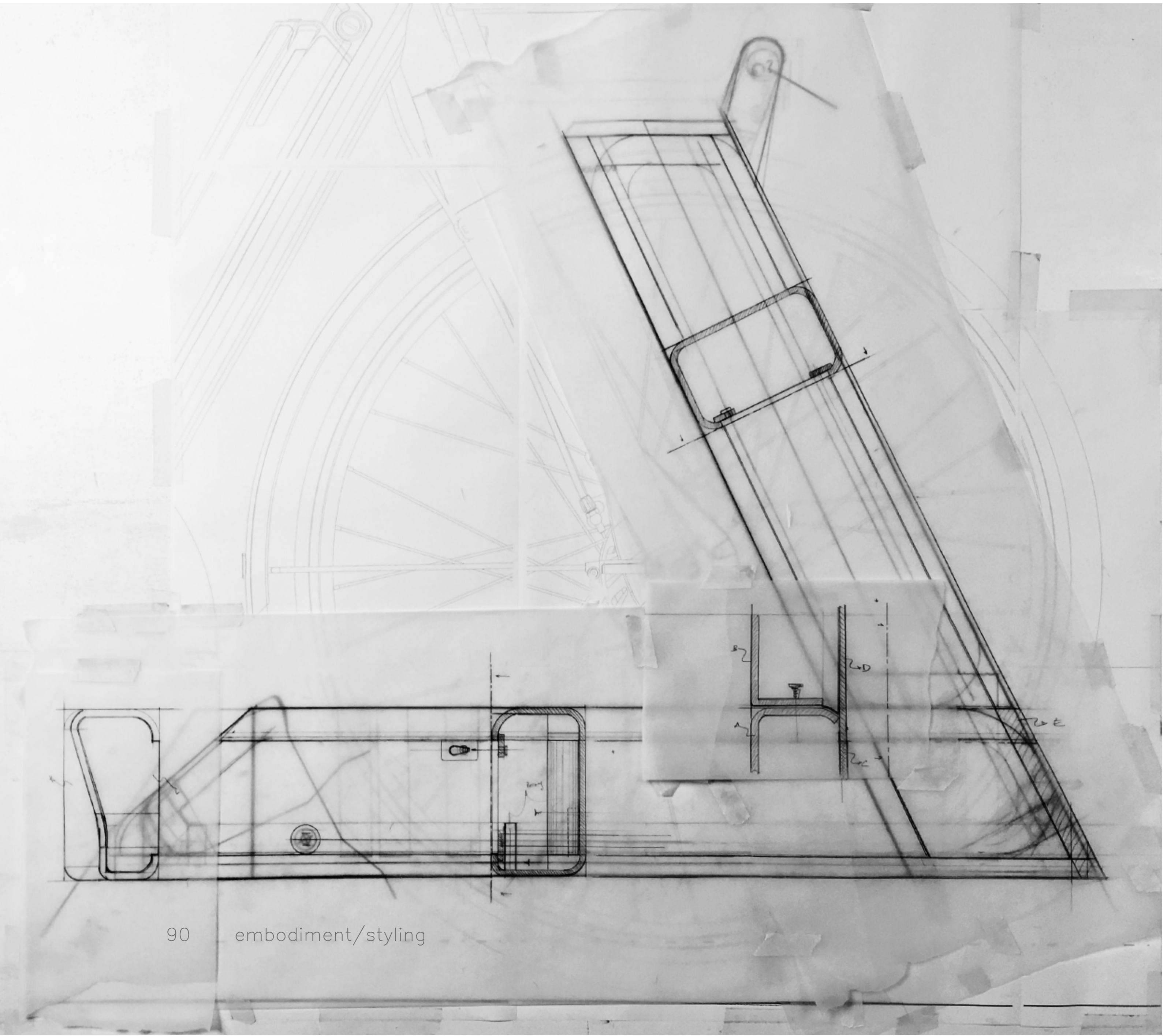


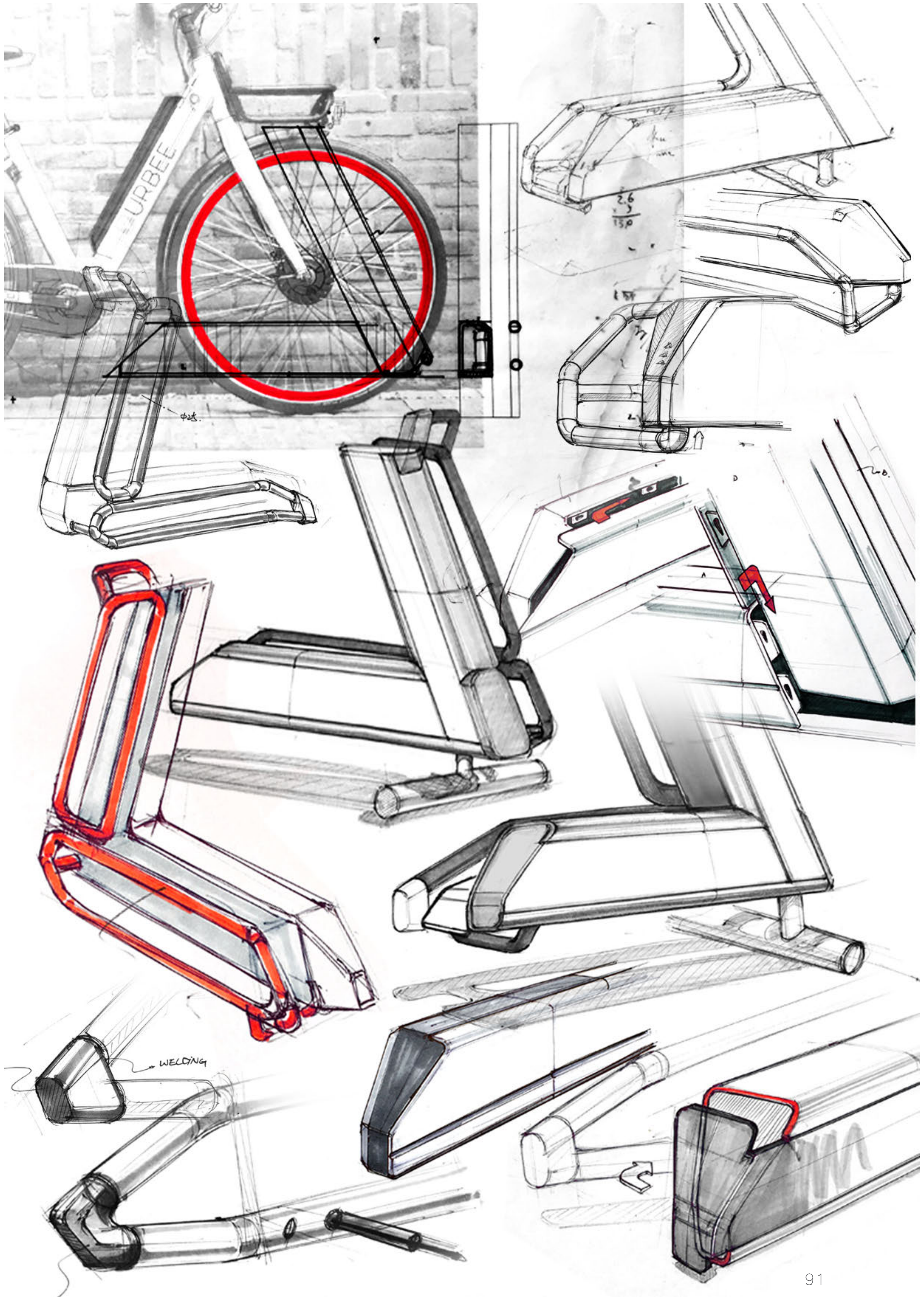
LAMY dialog, Richard Sapper

Drawings

Large amount of rounded edges are used in the design, in order to echo the brand identities of Urbee, as well as to make the dock more friendly and approachable. Sketches are used to firstly define the visual elements that will be repeated in the product, and have a primary image of the overall looks. In the sketch, the ideas of the construction and parting methods are also be visualised for communication.

The full-scale side-view drawings on tracing paper is the first step to realise the ideas. Drawings are used to make understanding of the internal space, relations among all the rounded edges, and the connections of all parts. This drawing can be also used as the template to test the precision of the prototype.





The style prototype

The style prototype are mainly made of foam boards, bended PVC tubes, and wip ramp is made of aluminium. In this prototype, the volume and the overall construction of the final design can be evaluated. With the basic function of interlock mechanism, the steps of assembly and ideas of anti-theft solution can be simulated. The most valuable outcome of this prototypes is to precisely picture the form, edges of the final design.

figure 49. dimension testification

figure 50. style prototype

CAD assembly model

After the style prototype, the CAD model is built. The CAD model serves as the summary of the all the aspects in the project, which includes parts, components, precise dimensions, and style. The slight adjustments are keeping in the modelling process that all the pieces of elements can engage each other. In the configuration assembly, the multiple docks are placed on the beam structure according to the configuration, The hole position and station architecture are validated.

9
EVALUATION

In the evaluation section, the outcomes of the project will be evaluated based on the challenges that most of them were determined in the very beginning of the first phase, context research. These challenges serve as the criteria to evaluate the outcome of the project.

During the product development in this project, the focuses to some challenges were shifted or altered due to the newly discovered topics or issues that need more dedication to be overcome. However, the challenges are not separated topics in this project, one concept will have certain good or bad influences to some of the challenges.

Take wip ramp as an example. It plays an significant roles when addressing different topics which makes this concept be evolved and transformed with time. Wip ramp is original solution which is advantageous to downsize the parking space, component modularity and security; while it might increases NPD (new product development) cost and the cost per dock. Using the challenges as the criteria to evaluate the project can clarify the overall outputs and achievements of the project.

Moreover, the outcome of next-gen Urbee docking station will be evaluated in a larger perspective which is the problem definitions of the project. To understand whether the outcome achieve the goal or solve the problems that are found in the context research.

9.1 challenge

Downsizing of station footprint

The efficiency of use the private space is a vital topic for Urbee system. This challenge has been focused the most and has great outcome to effectively increase the parking ratio. It increases the amount of bikes that can be parked in certain area without sacrificing the usability.

The most efficient ways of arranging parking space is suggested. The solid fundamental dimensions are repeatedly tested during the project for different purposes. Combining with the ramp principle, these are the most valuable outcomes in this project that can be the basis to develop products upon.

Modularity

With the modular design, the next-gen Urbee docking station provides diverse configurations and changeable amount of bikes. This challenge makes the Urbee system has high adaptive flexibility to different environments.

In this challenge, beside the expected outcome, the system flexibility, two more advantages are created. Firstly, the simplification of system complexity. Except the beam structure, all of the components are designed to be repeatedly used and fit to all configurations. Secondly, the modularity allows the station can be disassembled, which is effective to reduce the staffing and equipment requirements for transport and install / remove a next-gen Urbee docking station.

Semi-permanent vs. security

In this challenge, there are two topics that are tackled separately. Firstly, the semi-permanent structure is mainly aimed to find the overground wiring and its protection. This topic then associate to the simplification and compatibility of the construction, which enables the use of structures in all configurations. The outcome of this part realises the non-excavating construction and overground wiring.

Secondly, the security for both station and bikes. For station, the basic dimensions, weight and functions of concrete weight blocks are covered. While the specific design of the concrete blocks are not much developed in this project. For bikes, an exclusive locking mechanism for Urbee bikes is designed, combining with the ramp principle. Which can provide a good protection to Urbee assets against stealth, as well as improve user experience of locking a bike.

Intuitiveness and system readiness

Two main components are included in this challenge, the wip ramp and contactless charger. These two components are designed for meeting the requirement of “parking is locking is charging”.

The wip ramp prevents the modification on the existing Urbee bike frame for additional locking device. And can secure the bike to be locked in all tyre conditions. With the extended crank, it has good expandability for smartisation in the future.

The contactless charger is partially addressed. There are some essential parts of contactless charger that are designed to optimise the charging condition, the constrict distance and component room. The technology is not fully mature at the moment, which make the charger specification uncertain. However, the alternative way, with physical contact charging, is still compatible in the current dock design.

Aesthetics

In this challenge, the focus is not only the aesthetics of dock but also the construction of docking station and the connections among docksing components. With the primary settings of internal space and fundamental dimensions of dock, which the more detailed product development in the future can base on. However, in the other elements of station (concrete weight blocks, additional elements, etc.) are not covered much on their form, and style, etc.

The style of dock possesses a coherent design language with Urbee bikes. However, the components integration cannot be completely touched in the project, which are vital to express the completeness of the service, for instance, the integration of charger receiver and front light.

Feasibility

Although this project is not processing a conceptual design, most of the design and decisions are based on the realistic and reasonable background. However the project focuses are more on the set-ups of the basis of next-gen Urbee docking station. In the stages of production, and manufacturability are not covered in the project. While with the further development on this basis, the next-gen Urbee docking station can be surely realised.

Some parts used in this project are not commonly used in the traditional BSS system. Thus the capital cost or maintenance cost can not be precisely estimated. The system itself is not comparable to the traditional BSS stations, which needs a exclusive financial plan for such a new types of docking station.

9.2
Problem definition

Two main topics are stated in the problem definition of the current Urbee station. One is the compatibility of Urbee docking station in the 4th BSS generation. Another is the system adaptability in the Urbee's business plan and its targeted customers .

Urbee in the 4th BSS generation

The next-gen Urbee docking station does provide opportunities to make Urbee system meet the market demands of 4th generation BSS. By improving the service completeness and increasing its mobility, the next-gen Urbee docking station will have ability to actively react to the changeful demands. The stations can be quickly relocated and removed depends on the market demands. Moreover, flexibility of the system enable Urbee to provide its service to the emerging urban transportation scenarios. The next-gen Urbee docking station does not need long planning time to set up a docking station. It can collect experience and be quickly adjusted after the station is firstly installed, without the costly construction expenses.

System adaptability to Urbee's customers

The concept of next-gen Urbee docking station provides many parking configurations without fundamental cost differences. Therefore, the customers can find the most suitable configuration to implement this system to their space. The non-excavating construction also provides Urbee's customer can freely reuse the space after the removal of the docking stations. The threshold to implement such a system is lower, which is helpful for Urbee to be applied to more places, for instance, hotels or holiday parks.

10 CONCLUSION/ RECOMMENDATION

10.1
project conclusion

This project suggests a direction to improve the Urbee docking station to meet the future trends. The of the service provides opportunities to create a series of exclusive and original solutions for the certain context. In this project, the parking configurations and the docks are mainly focused. The purpose of the project is to lower the implement threshold for customers and make Urbee has high attraction to potential or emerging customers. However, Urbee, as an alternative BSS business model, has so many things that can be reviewed and reconsidered in a broader perspective.

The outcomes of the project suggest the modular solution that Urbee's customers can efficiently use their space to implement the Urbee system without too much burden. The nomadic solution of station structure makes the Urbee can be flexibly and easily react to the changeful circumstances and demands. These aspect ensure the next-gen Urbee docking station to has exclusive and fundamental advantage to broaden their target customers. On this basis, the wip ramp and construction of dock provide the opportunities to optimize the user experience. Also the selection of applying contactless charger and modification of system suggest Urbee a path to realise the 4th generation BSS.

As aforementioned, the next-gen Urbee docking station, however, is such an original subject, which needs further product development process to comprehensively cover all the elements in this service. Those aspects which are important but unable to be touched in this project, due to the time-wise limits, will be briefed in the recommendation section.

10.2
recommendation

The elements that are not fully covered in the project will be categorized into two groups, feasibility and modularity. The further development on these aspects need to be accomplished the complete next-gen Urbee service.

Feasibility

- Clamping branch connection

Although the current clamping branch connection is designed to firmly fix the dock on the beam structure. The attachment of this part however needs strict perpendicularity, which would directly influence the performance of the wip ramp and charging system. Also, for the installation workers, the assembly should be handy and lower error possibility. This part needs to be delicately focused and designed for the assembler.

- Cost calculation

Due to the design has been formulated exclusively(including wip ramp and contactless charger) without off-the-shelf components. Plus there is no alternative BSS which has similar scale and specification to Urbee on the market that can be referred to in terms of finance. The cost calculation cannot be determined. However, the design leaves quite a space for the cost reduction possibility, which includes material and technological aspects. The alternative solutions (for instance, the traditional physical contact charger) can still be applied in the further development.
The cost is one of the most vital part to evaluate the launch of product. In the future, when the marketable solutions are found and ready, the capital cost / station or the cost / dock can more realistically estimated.

- Contactless charger

Although the contactless charger is the optimum way for Urbee project and for the future E-bike charging. This charging method is theoretically workable in the given component room and can reach the expected efficiency. While, the contactless charging solution is still in the experimental stage, which is not ready for production at the moment. The production yield and power transfer efficiency are uncertain in the production level, and cost is not estimable. However, to realise the real intuitive user experience, the contactless charging is one of the keys. Furthermore, the contactless charging is the emerging technology for the E-bike charging which will be mature in the near future; some of the emerging BSS projects are testing this solution of charging (figure 51) (Hideyoshi kume, 2017). Urbee should have primary plan on what role this technology can play in the next-gen Urbee docking station.

figure 51. Bellnix wireless charging bikes (Transphorm japan inc., 2016)

Modularity

- Concrete weight blocks

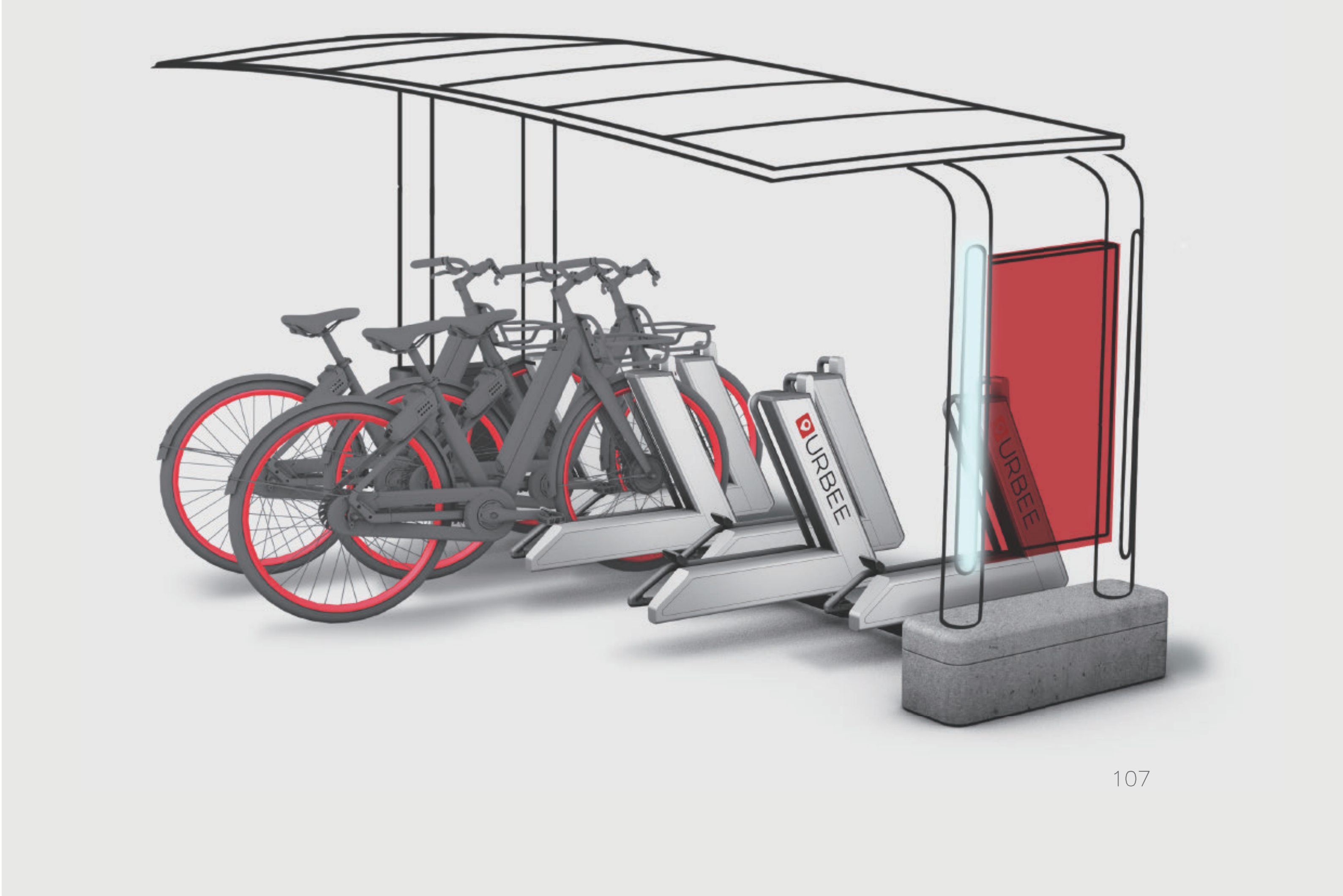
In this part, the formation is determined, while the features and construction are not addressed much. On one hand, the connection mechanism that can ensure the reinforcement to the whole structure still needs to be elaborated. The connection in between beam structure and concrete blocks these two materials that should be able to be (dis) assembled.

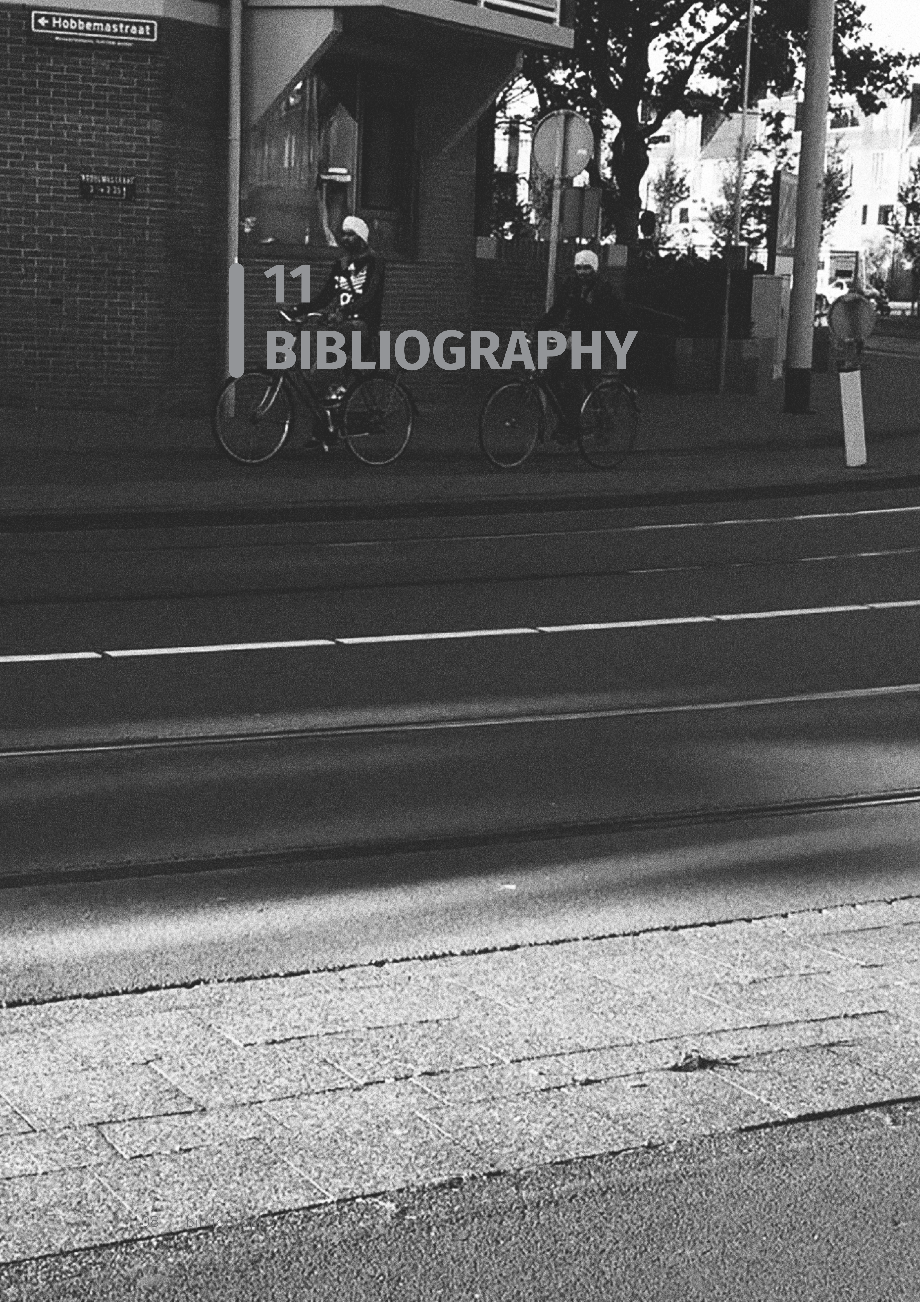
On the other hand, besides functioning as the stabilizer and station divider, the concrete blocks should have a more integral design of the electricity distribution box and other additional components, and make the station more consistent and systematic.

- Additional components

Besides the fundamental components that are included in this project, there are many other components that can be designed in order to provide a more friendly and comprehensive service experience. One of the most important additional components is the roof, rain cover, for the Urbee bikes, which protects Urbee bikes against ultraviolet and rain. The roof will need to be applied to the diverse arrangement as the docks do.

Increasing the visibility and recognition of the Urbee stations is another important aspect and needs more components to realise this. The signages, instruction panel and lighting system are essential components that can make the Urbee stations easily to be seen on the street and build Urbee's welcoming service and brand identity. These components are not covered in this project, while they should definitely be included and designed in the production stages.





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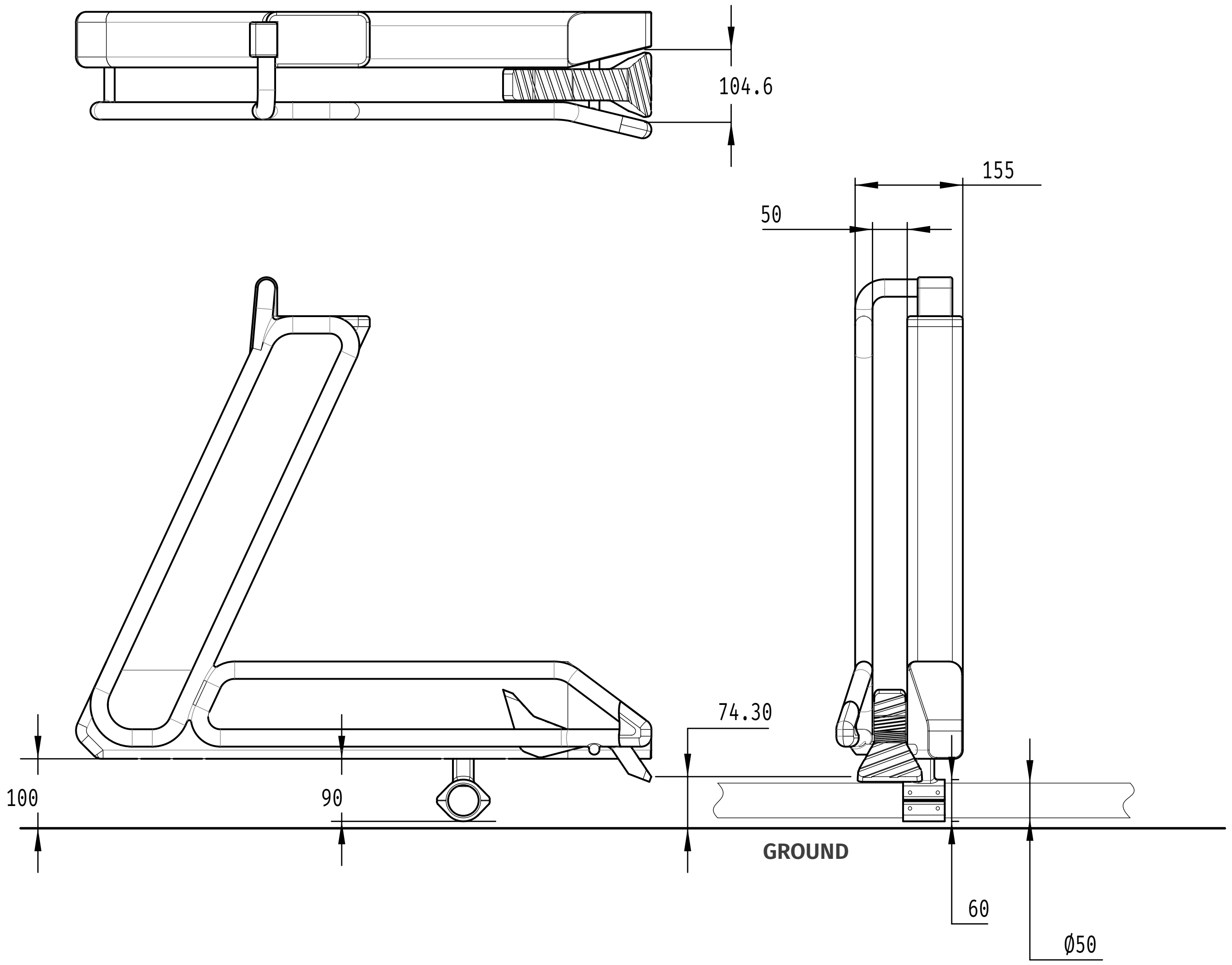
12 Appendix

Technical drawing
- Overall dock dimension
- Mainside of dock
- Wip ramp / locking points dimension
- Leftside of dock

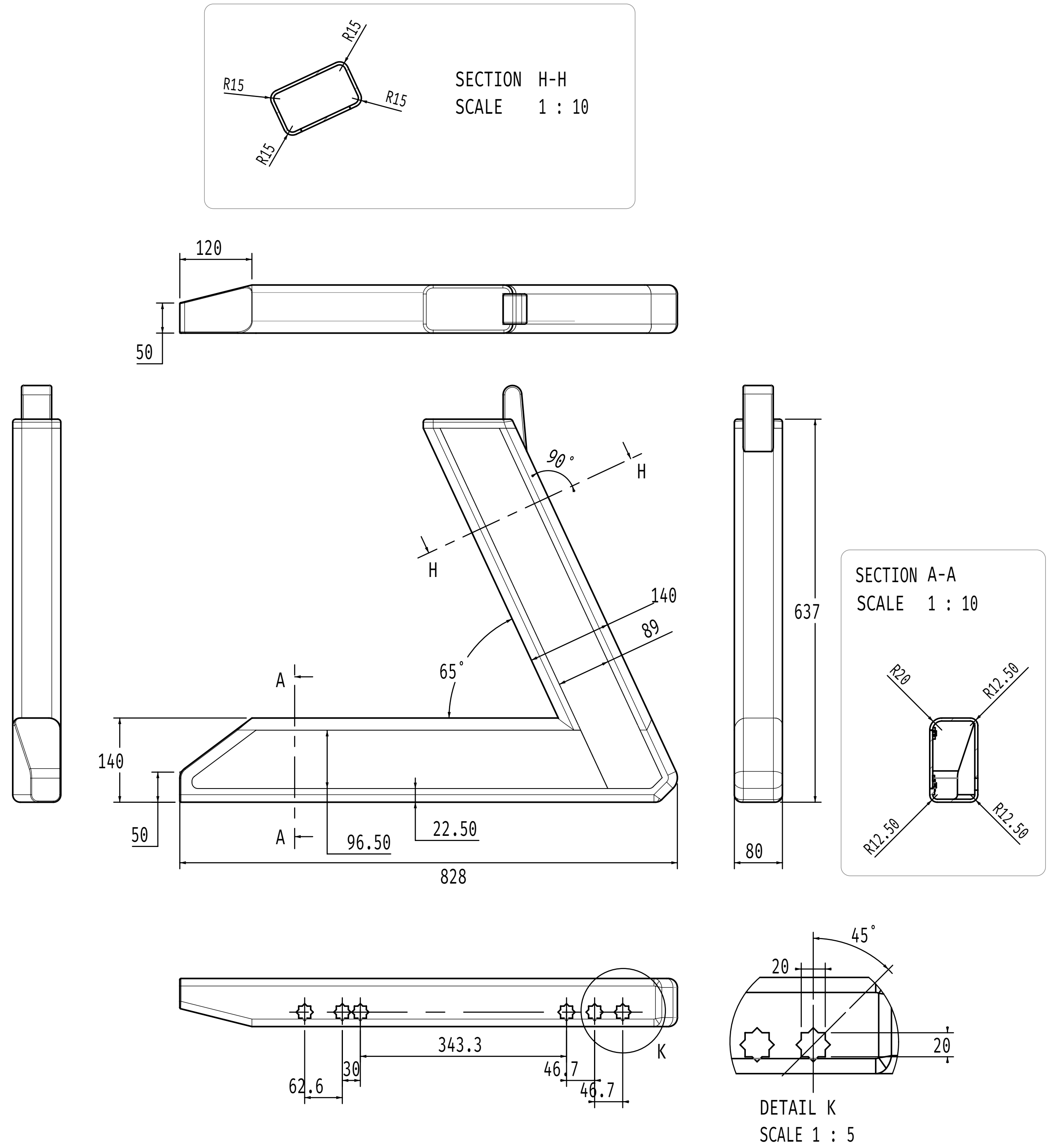
Development of ramp design

Overall dock dimension



Unit: mm
Scale: 1:10

Main side of dock



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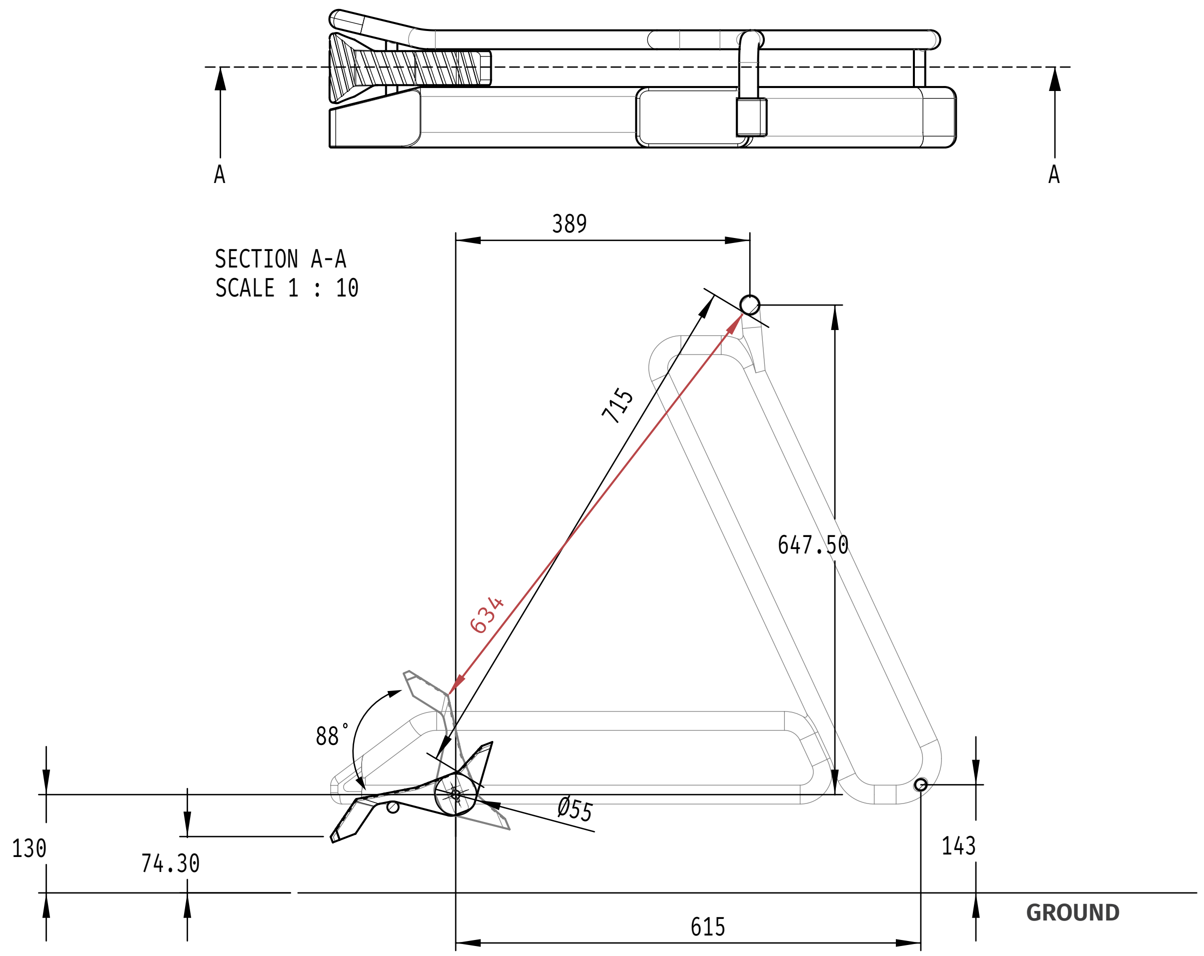
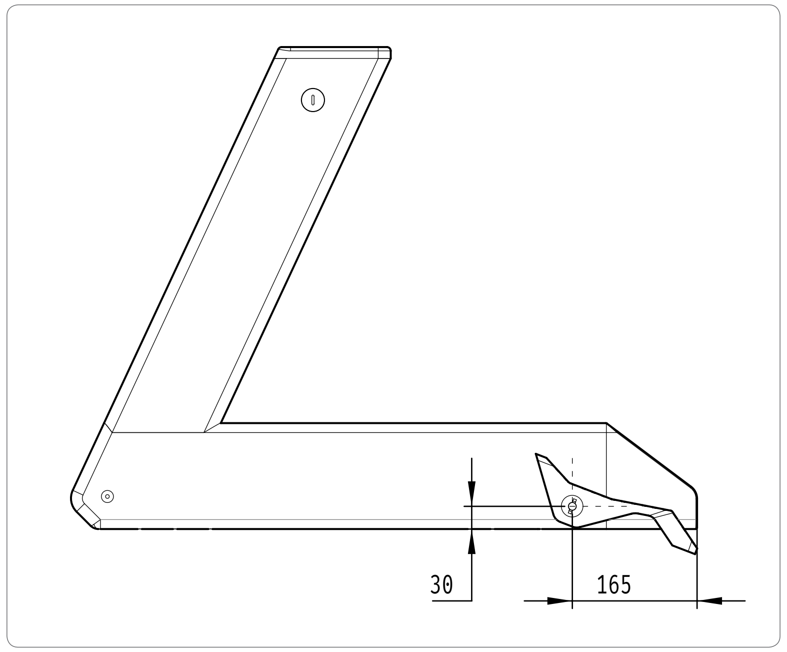
Wip ramp, locking points dimension





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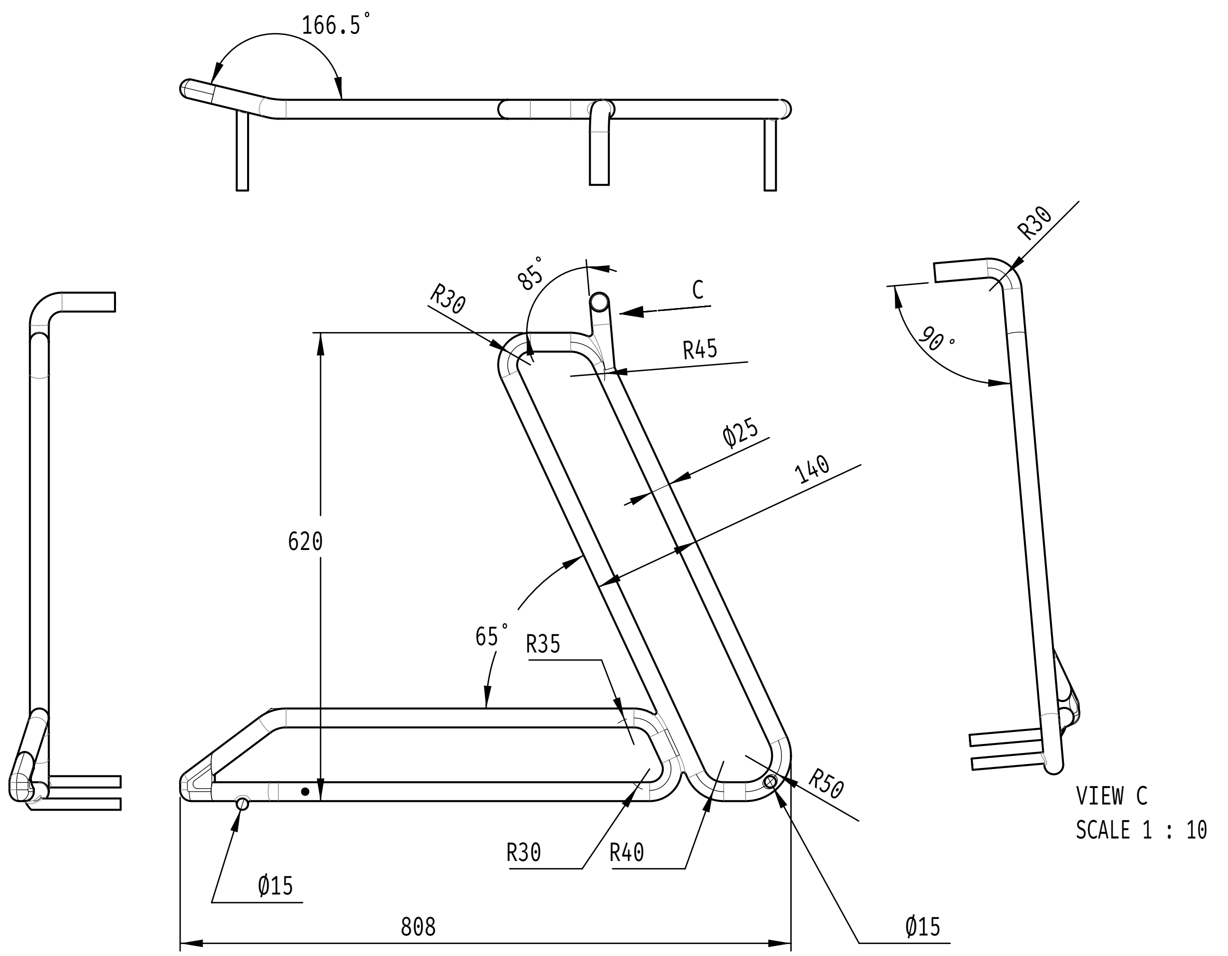
Left side of dock



Unit: mm
Scale: 1:10

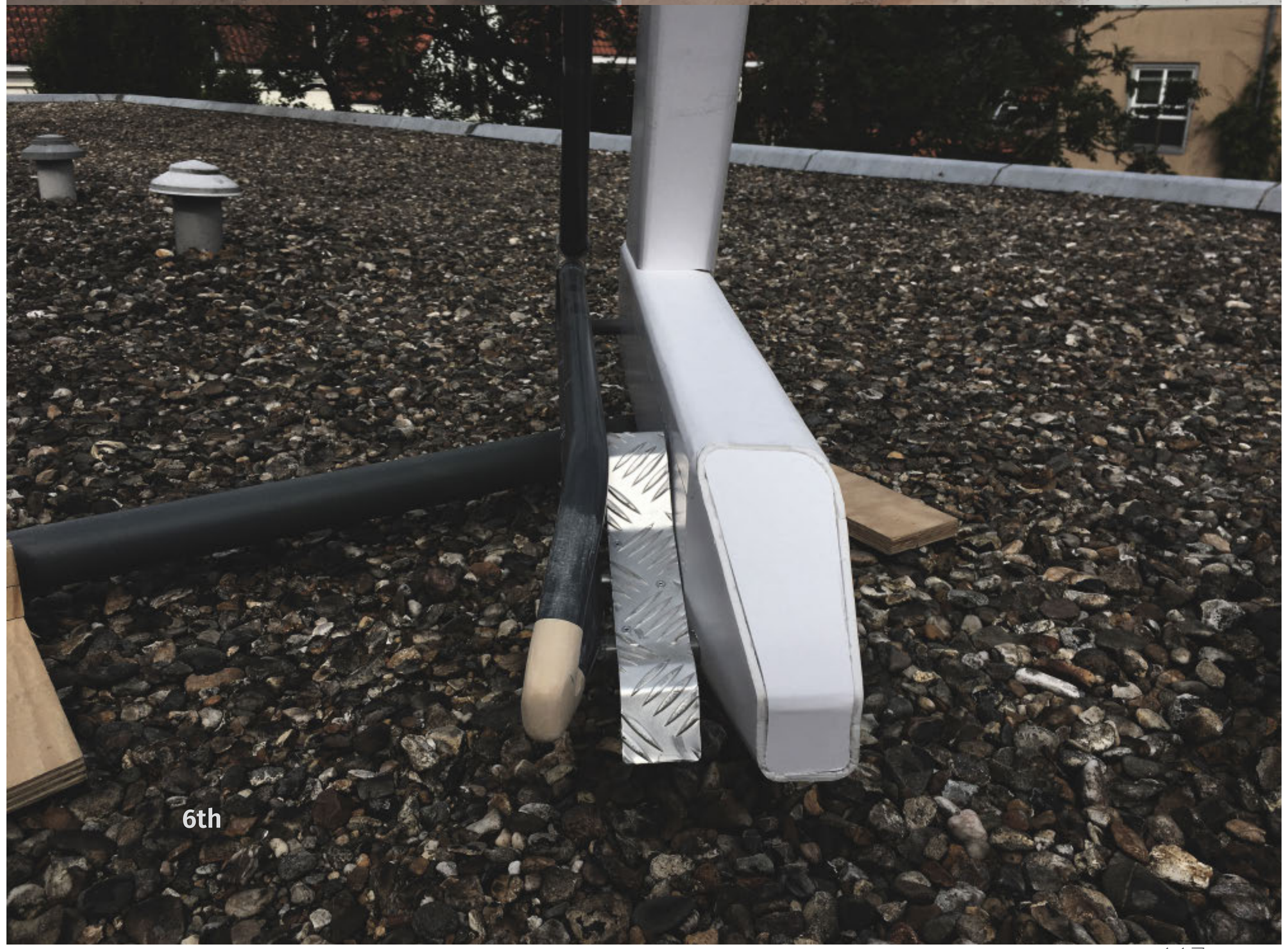

1st


2nd


3rd


4th


5th


6th