GNOME

URBAN BICYCLE & DRIVETRAIN CONCEPT

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GNOME

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Institute of Design
Industrial design
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ABSTRACT

TIIVISTELM

My graduation project is a personal project. As for the subject, I chose to make a bicycle for the urban environment.

The aim of the project was to create a solution for the various problems of a city environment. Problems like storage, theft, maintenance etc. My secondary objective was to keep it highly conceptual regarding the shape, drivetrain and other details but keeping in mind that every piece and part designed should be suitable for mass-production. Money and expenses are not key drivers for this project. This gives me the opportunity to try out new solutions that might normally be put aside due to price issues.

Key words: Drivetrain/Bicycle/Urban

Opinnäytetyöni on henkilökohtainen projekti, jonka aiheena on kaupunkipolkupyörä

Opinnäytetyöni tavoitteena oli luoda ratkaisuja useisiin ongelmiin, joita kaupunkipolkupyöräily sisältää. Ongelmiin kuten varkaus, säilytys, huolto ja niin edelleen. Tavoitteena oli luoda uudenlainen polkupyörä niin muodoltaan, kuin myös voimansiirroltaan. Kuitenkin jokaisen osan ja yksityiskohdan täytyy olla valmistettavissa massatuotannossa. Raha ei ollut rajoitteena projektissa, joten olin vapautettu käyttämään ratkaisuja, jotka muuten olisivat olleet poissuljettuja.

Avainsanat: Voimansiirto/Polkupyörä/Kaupunki

CONTENT

1.

INTRODUCTION

1.Introduction

I have always been fascinated about transportation and my interests have changed along the years from cars to bicycles. I know the world of bicycles quite well since I have worked as a bicycle mechanic, bicycle salesman and, during my internship period in France for **Agence- 360**, as a bike-/ graphic designer.

Before choosing a subject for my thesis I negotiated with **Agence-360** about a possibility of making my graduation project for them. We discussed about various possible projects but unluckily, due to the economical situation, we did not get the third party of the project to work with us. Since we had already talked with **Agence-360** of various possible projects, I had a multitude of subjects to decide from for my thesis. I took an urban bicycle project and modified the brief a bit to better fit my personal ambitions and interests.

In the book I go through the brief history of bicycles and drivetrains. The book will include a few already existing products and models (types of bicycles) that can be seen as competing designs. The book analyses the results and conclusions of this comparison. The book will also present the environment and it's restrictions regarding bicycling. Next, I will present the target audience, which is derived from the previously explained studies. The last chapter contains the work process, conclusions and criticism.

2.1

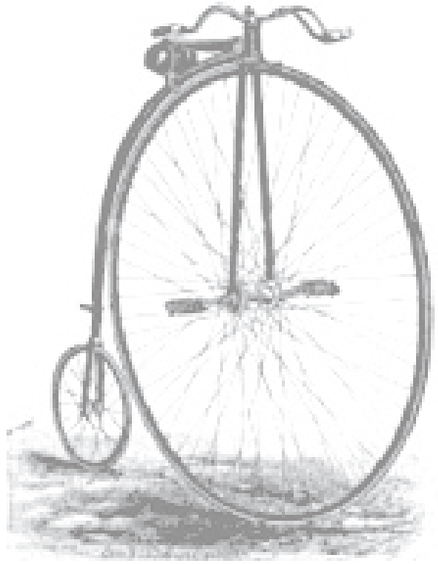
HISTORY

BICYCLE

One of the first attempts to build a bicycle was done by **Baron von Drais** in 1817. He made it as an aiding device for the royal gardeners to do their tudies faster. The design consisted of two same sized parallel wheels of which the front wheel was steerable. The machine was entirely made out of wood. It moved forward by pushing your feet against the ground and it worked as a kind of walking aid. The machine was known as the “Draisienne” or “ a hobby horse.” Its popularity was short lived due to it´s Impracticality.

The next bicycle-like riding machine appeared in 1865. The pedals were applied directly on to the front wheel. The velocipede, ”fast foot” was made entirely of wood. Later it featured metal tires which made it really uncomfortable to ride with on cobblestone roads.

Pictures from: www.pedalinghistory.com/PHhistory.html



The first full-metal bicycle appeared in 1870. Till then metallurgy was not advanced enough to produce small lightweight parts which would also be strong. The pedals were still attached to the front wheel and there was no freewheel mechanism. Solid rubber tires and long spokes in the large front wheel provided much more comfort than it´s predecessor. The wheel size kept on growing when the bicycle makers understood that the larger the wheel, the further you would travel on one pedal stroke. This machine was the first one to be called a bicycle (two wheels). The price was about a workers six months pay but still it was highly popular with young men. If the front wheel should have suddenly stopped, due to the high centre of gravity, the entire machine would rotate locking the riders feet under the handlebar and crashing his head to the ground.

Improvements to the bicycles design started to appear. One of the main features was to put a smaller wheel to the front of a bicycle to eliminate the tipping - forward problem. These bicycles became known as high wheel safety bicycles. The older high-wheel bicycles were now referred to as ”ordinary bicycle” and later as ”ordinaries”.

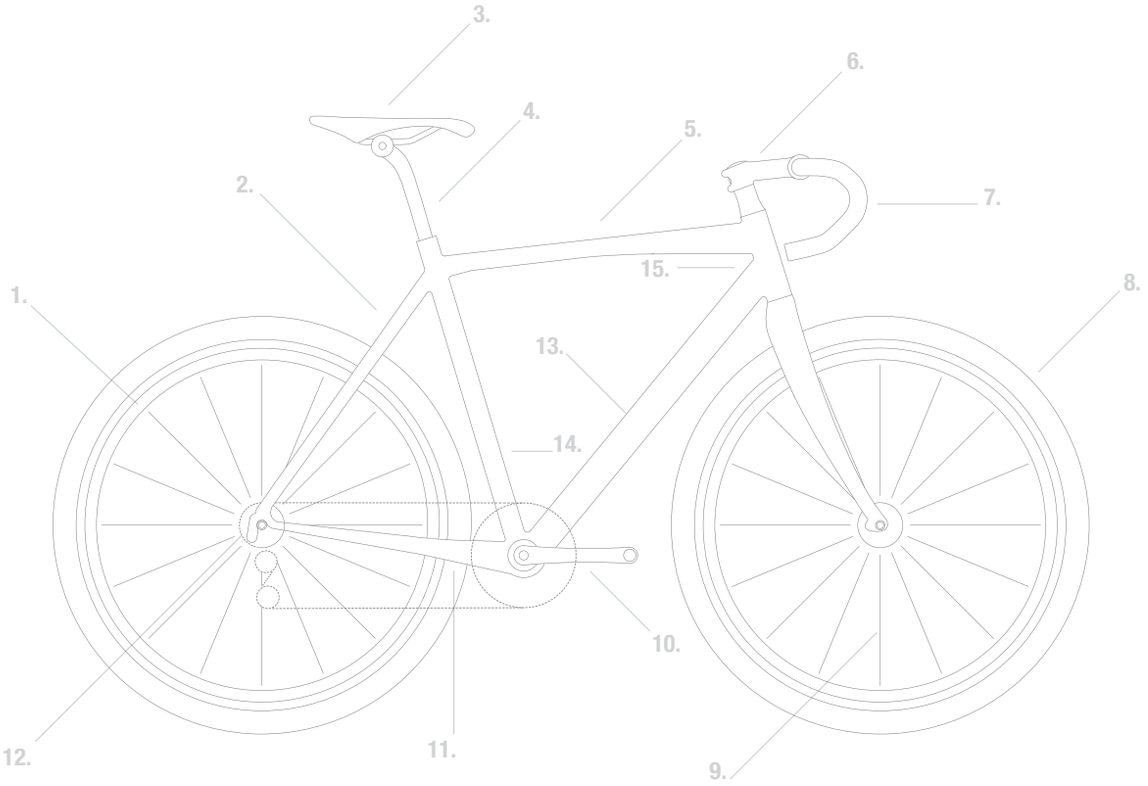
By the improvements in metallurgy it was now possible to make chain and sprockets which were light and strong enough for bicycles. The next step was to go back to the design with two same size wheels and now with the gear ratio you could achieve the same speed as the high wheel bicycles.

Bicycles still had full rubber tires and no shock-absorbing spokes and it was much more uncomfortable than many of the high wheel bicycles. Some of the eras bicycles had a front and/or rear suspension to achieve more comfort and safety. But it was pneumatic tires that finally killed the high wheel bicycle.

Pneumatic tires were first applied to the bicycle by Irish veteran called **Dunlop** who wanted his son to have a more comfortable ride on his tricycle. Pneumatic tires meant safety and comfort in the same package. Finally the manufacturing costs came down. Everybody was charmed by bicycles.

The bicycle had become a sensible investment for men but also for women who were now able to drive more versatile machines than just tricycles.
www.pedalinghistory.com/PHhistory.html

List of main parts in bicycle.

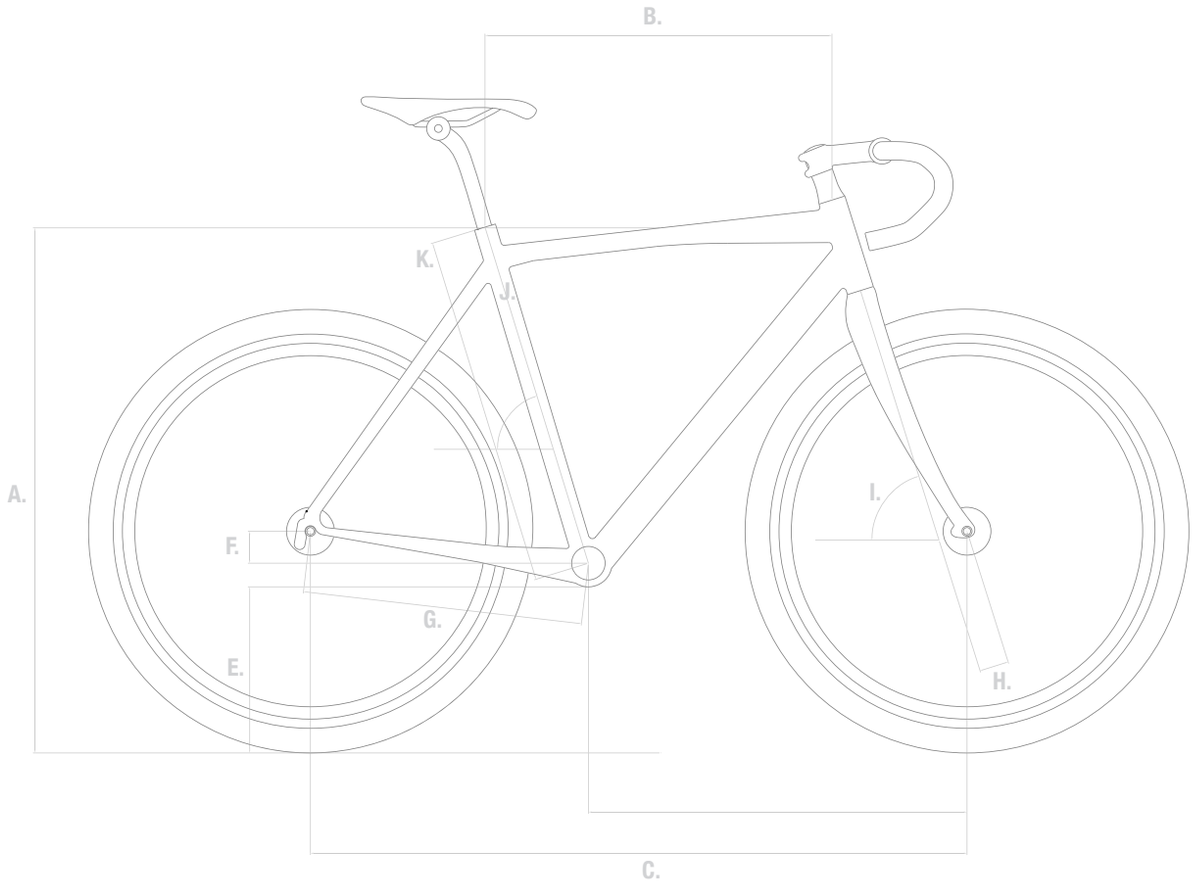


2.2

CONSTRUCTION

BICYCLE

1. Rim
2. Seat stays
3. Seat
4. Seat post
5. Top tube
6. Stem
7. Handlebars
8. Tire
9. Spoke
10. Pedal
11. Chain stays
12. Hub
13. Down tube
14. Seat tube
15. Head tube



A. Standover

B. Horizontal Top Tube Lenght

C. Wheelbase

E. Bottom Bracket Height

F. Bottom Bracket Drop

G. Chainstay Length

H. Fork Rake

I. Head tube Angle

J. Seat Tube Angle

K. Seat Tube Length

Geometry is a key element in every bicycle. It is, to put it roughly, about angels and dimensions of the frame and the forks. The frames geometry affects the efficiency of pedalling, handling and comfort. The choice of geometry will set some major features of the bicycle, though it is not the only thing influencing the ride experience. The quality of the ride can also be effected by the selection of materials used on the frame and the fork and also by the choice of components.

A determining factor for ride quality is the wheelbase. It is the distance between the centre of each of the two wheels. A long wheelbase makes a bike stable in high speed and in straight lines. It may also be more comfortable because of flex of the frame. A bicycle with shorter wheelbase is more nimble in turns. Other important factors are seat angle, head angle and trail. Head angle effects the steering and handling of the bicycle and the trail helps the bicycle to go straight and be more stable. Seat angle determines the riders position and the balance of the bicycle.

2.3

GEOMETRY

BICYCLE

2.4

STANDARD

BICYCLE

Bicycle components are mostly based on standards apart from few exceptions. This system makes spare parts easy to replace and also helps to control the product safety.

Some existing standards.

TC149 is a special technical committee set by the International Organization for Standardization, ISO, that has the following scope: “Standardization in the field of cycles, their components and accessories with particular reference to terminology, testing methods and requirements for performance and safety, and interchangeability

CEN, European Committee for Standardisation defines standards for bicycles. The standards are harmonized with ISO and it is mainly focused on minimum safety requirements.

en.wikipedia.org/wiki/Bicycle#Standards

3.1 Constraints

A city environment sets a variety of problems for cyclists. The main ones the cyclist faces in an urban environment are:

3.1

CONSTRAINS

ENVIRONMENT

Storage.

Space and facilities for storing bicycles is marginal in a city environment. Usually if you have an expensive bicycle you have to keep it inside your apartment to ensure safe keeping. This creates multiple problems such as getting the bicycle into the apartment, dirt from the bicycle and the space for the bicycle.

Theft/ Locking.

Locking is a problem for a lot of the existing bicycles. For a fast visit to the local store you will only need a temporary solution for locking your bike. It should be fast, easy and clean. For longer periods of time a safer system, that guarantees you have a usable bicycle afterwards, is required. It needs to be kept in mind that only parts of the bicycle may be stolen - not always the whole bicycle.

Maintenance.

One of the biggest problems in having a bicycle is that you need to have regular maintenance to keep it running nicely. Most people do not know how to take care of their bicycles and some only know the basics like changing a tire etc. Also the repairing is dirty and it takes space which you do not have much in an urban environment.

Traffic/other commuters.

Maybe the biggest safety issue while bicycling is other people/ traffic. City environment is hectic and there is not always special bicycle lanes. It is important to have good control of your bicycle. Good handling and good brakes can be lifesavers in traffic.

Other means of transportation.

Since bicycles are often used in an urban environment you should be able to take them with you on other forms of transportation such as trains, metros, trams and buses at least. This poses various problems such as carrying the bicycle inside the vehicle, the required space and weight- and dirt issues to name few.

Main problems

Storing

Locking

Traffic

Maintenance

Using other means of transportation

City environment

Obstacles
-Doors
-Escalators
-Stairs
-Lamp posts
-Fences
-Construction sites

Places to lock bicycle
-Fences
-Lamp post
-Bicycle stand
-Nowhere

Traffic
-Cars
-Public transportation
-Pedestrians
-Traffic lights
-Rush hour
-Bicycle lanes

Terrain
-Flat
-Tarmac
-Pavement

Defining

Storing
- home
- work
- street
- public transportation

Rush hour
- pedestrians
- cars
- public transportation

Locking
- secure
- place to lock
- long and short period of time
- process

Stairs
- carrying
- driving down the stairs

Tram
- getting in
- getting out
- other passengers

Bus
- getting in
- getting out
- other passengers

Train
- getting in
- getting out
- other passengers
- possibly storing

Subway
- getting in
- getting out
- escalator
- port
- stairs

Traffic
- cars
- public transportation
- pedestrian
- infrastructure

Possible features

Storing
- Compact size
- Clean

Locking
- Integrated lock
- Security bolts
- Hinges and multiple locking possibilities

Traffic
- Compact size
- Reliable
- Agile
- Fast acceleration

Maintenance
- Reliable
- Easy/fast to do
- Clean

Using other means of transportation
- Compact size
- Lightweight
- Clean

3.2

SCENARIO

ENVIRONMENT

I chose to design a main frame that is different from current bikes on the market from some features. The point in this approach is to study how changing some relatively small feature in the bicycle will affect the usability and the spirit of the product. Although this kind of thinking is not always the most economical approach, the idea of the concept is already used commercially in a smaller scale in Spezialized bicycles in Langster-series which has different themes for different cities. I try to take the next step in my concept by adding electric assistance for one concept and folding action for another if that kind of feature is needed.

I am designing the bicycle concepts to be used in Amsterdam - Netherlands, Paris - France and San Francisco - United states.

One of the reasons for these locations is the rich heritage of the cities and the positive attitudes towards bicycling.

Also all three of the cities are large metropolitan areas with their own special requirements that are significantly different from each other. This makes products differ from each other not only by the graphic design but also by the functional features.

Also the reason for choosing these specific cities is that I have personal experience from all of them so I have some kind of perspective for the local life and environment.

Paris

- Population 2006, 2,181,374
- Density 20,775 /km2
- Vast bicycle sharing program
- Small apartments
- Dry weather conditions

- Public transportation
    - Metro
    - Tram lines
    - Suburban train lines
    - Boat lines
    - Bus lines

- Average high temperature 16.1 C
- Average low temperature 9.4 C
- Average precipitation mm 642 in year

Conclusion

- Small size/folding design
- Lightweight
- Usage of public transportation

Amsterdam

- Population 2009, 762,057
- Density 4,459/km2
- Bicycle friendly environment
- Small apartments
- Moist weather conditions
- Flat pavement

- Public transportation
    - Tram
    - Bus
    - Ferry
    - Metro

- Average high temperature 12.3 C
- Average low temperature 6.1 C
- Average precipitation mm 779.5 C

Conclusion

- Weather protection
- Good bicycle lanes
- Hub gears

San Francisco

- Population 2008, 808,976
- Density 6,688.4/km2
- Bicycle friendly attitudes
- Average or large apartments
- A lot of high changes in contour

- Public transportation
    - Bus lines
    - Metro
    - Street car line (Tram)
    - Cable car line

- Average high temperature 18.4 C
- Average low temperature 10.8 C
- Average precipitation mm 565.9

Conclusion

- Massive contour changes
- Electric assistance
- Hub gears

Conclusions from the environment study

From every city there is information to take into consideration when designing the bicycle.

3.3

CONCLUSION

ENVIRONMENT

Possible solutions

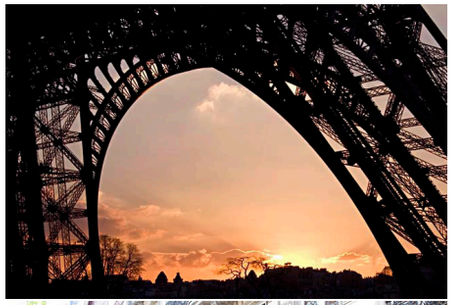
Storage
- Small wheel size (16”-20”)
- Folding mechanism

Locking
- Bolt on lock
- Integrated locking cable etc.
- Hinges
- Steering lock
- Security bolts

Traffic
- Small wheel size(16”-20”)
- Disc brakes
- Fast steering geometry
- Low gear ratio

Maintenance
- One sided forks for fast tire change
- More reliable drivetrain system than chain
- Liquid disc brakes
- Puncture protected tires
- Hub gearing
- Simple mechanics

Using other means of transportation
- Folding mechanism
- Lightweight structure and parts
- No chain to collect the dirt



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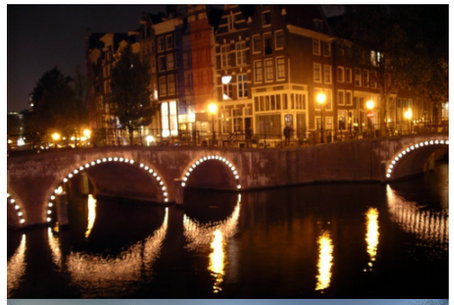
www.flickr.com/photos/wallyg/1405097244/

Paris

As a cycling environment Paris is already really friendly because of the vast bicycle sharing system. To make a successful bicycle in that kind of environment it needs to be robust and maintenance free to compete with the bicycle sharing system. Also the design of the bike should allow easy travelling in public transportation systems so folding mechanism is the key on that. It's also usable in storing the bicycle in apartments.



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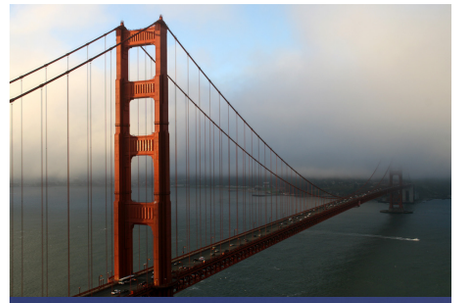
ohwhen.files.wordpress.com/2007/12/amsterdam.jpg

www.thetravelpeach.com/europe-vacations/the-netherlands/amsterdam-bicycles.jpg

Amsterdam

Amsterdam is famous for its bicycle friendliness. The inclusive bicycle road system makes public transportation almost needless for a commuter so no folding mechanism is needed in the Amsterdam concept. Because of good road for bicycles some gears are needed to get greater speeds. Also windy and moist environment speaks for more aerodynamic driving position and for some weather protection like mud flaps.



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www.flickr.com/photos/daveglass/2608991039/

San Francisco

The biggest issue when designing a bicycle for San Francisco is the massive changes in contour. For that reason I think electric assistance with gears is needed. Also wider handlebar could help to get more power when pedalling up the hills. Cable cars have no place for transporting a bicycle so folding action is not needed and the density of the population indicates that the people have enough space for storing the bicycle.

4.1 BENCHMARK COMPETITION

	Urban specific	BMX	Commuter bicycle
TYPES OF URBAN BICYCLES	Specially designed for urban environment. Usually small wheel size such as 20” or 26”. Different variations which usually base themselves from mountain or road cycles. Still there are also original models.	From the dirt tracks the bmx bikes have found their way to the city. From flatland tricks to everyday bicycle. Bmx bikes have 20” or 16” wheels making it nimble to manoeuvre in the city. BMX bikes usually have a really heavy frame because it is designed to take some abuse.	Commuter bicycles are designed for people who do their home to work journeys etc. with their bicycle. Usually 28” slim wheels to ensure speed and low resistance. Usually bikes borrow their geometry from a road- or a travel bicycle. Commuter bicycles usually have a lot of luggage possibilities.
ADVANTAGES & DISADVANTAGES	+ -Compact -Agile - -Versatility	+ - Compact - Agile - Durable - - Heavy - Unergonomic - Not for long distances	+ - Fast - Light - - Hard to store

Electric bicycle	Folding bicycle	Public use bicycle	Fixed gear	Standard bicycle
Normally targeted for elderly people to help on pedalling but also for all kinds of users. Electric bikes are made for cities and suburbs because of the limitations of battery charge(will change along development of batteries). The bike contains a battery- and an electric motor and the markets are full with various applications and solutions.	Folding bikes are designed for various needs. For city commuters, boat owners, travellers etc. The wheel sizes varie throughout the whole standard range. The mechanics varie also from simple to complex structures depending on the use of the bicycle	City funded projects to give bicycles for community and also for tourist. Durable and often quite heavy. User can pick up the bike from the special points which are distributed around the city. User must give some kind of deposit for the bike and return the bicycle from some of the returning points in the city.	The concept of a fixed gear bicycle is to take a track frame and use it in the street. The track frames do not have brakes and the drivetrain is fixed so the pedals are rotating all the time while bicycle is moving. Single speed bicycles relie in the same concept but because of the lack of fixed drivetrain they will need brakes to control speed.	Uses traditional diamond shape geometry or in female models low rise frame. The upright position helps with seeing the environment and it is also more comfortable to the user. Equipped with basket and/or carrier.
+ - Fast - Effortless - - Heavy - Complicated - Recharging	+ - Easy to store - Usability in public transportation - - Some are complicated - Hard maintenance - Expensive	+ - Cheap - Durable - Care free - - Heavy - Need of return points - Uncertain aviability	+ - Simple - Light - Maintenance free - - Unsafe for beginner(fixed gear) - Takes space	+ - Easy - Safe - Space for luggage - - Takes space - Heavy

4.1

BENCHMARK

COMPETITION

REFERENCE PICTURES

Urban specific	BMX	Commuter bicycle
		
www.cannondale.com/usa/usaeng/Products/Bikes/Recreation-Urban/Hooligan/Details/1316-0HL3-Hooligan-3	img.alibaba.com/photo/11675110/Dk_Dayton_2007_Bmx_Bike.jpg	www.fisherbikes.com/images/fisherbikes/bikes/2010/1600x1200/Lane.jpg
		
i.treehugger.com/images/2007/10/24/specialized-centrum.jpg	www.amazon.com/Mongoose-Spin-Freestyle-20-Inch-Wheels/dp/B001I90CFK	surlybikes.com/bikes/long_haul_trucker_complete/
		
www.ecoprofile.se/db/images/post4200.jpg	www.winstanleysbmx.com/product/25655/Eastern_Growler_Bike_2010	www.trekbikes.com/images/bikes/2010/xl/portland_darkmocha.jpg

Electric bicycle	Folding bicycle	Public use bicycle	Fixed gear	Standart bicycle
				
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www.smoove.fr/index.php?option=com_content&view=article&id=76&Itemid=76&lang=en	www.djmick.co.uk/images/2009/07/Brompton-Folding-Bike.jpg	www.bombayharbor.com/productImage/0477106001209710979/Electric_Bicycle.jpg	www.biketype.com/pics/5510/full/fixie_peacemaker.jpg	www.helkamavelox.fi/index2.phtml?page_id=1109&navi_id=1109&10012_iProductId=HMVO7NHR&10012_IPG:42_t=viewPublicProduct&

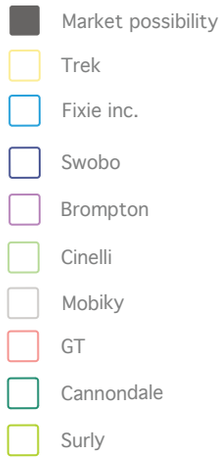
A diagram indicating the price of the bicycles and the specialization area of the company. The diagram roughly illustrates the markets where Surly, Cannondale, GT, Mobiky, Cinelli, Brompton, Swobo, Fixie inc.Target, Trek, Novelty value and Quality influence.

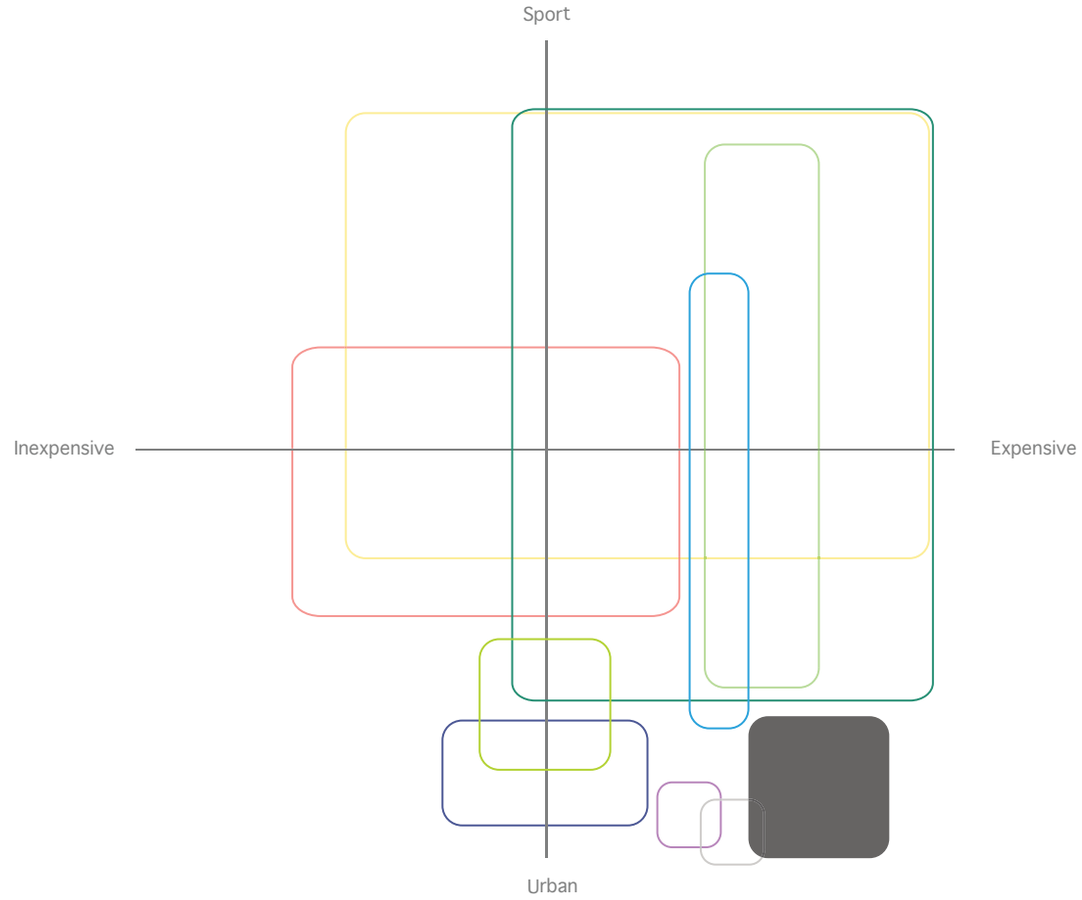
The market gap found in the bottom right of the diagram implies that there is not much competition in high priced urban bicycles.

4.2

PRICE/FOCUS DIAGRAMS

COMPETITION



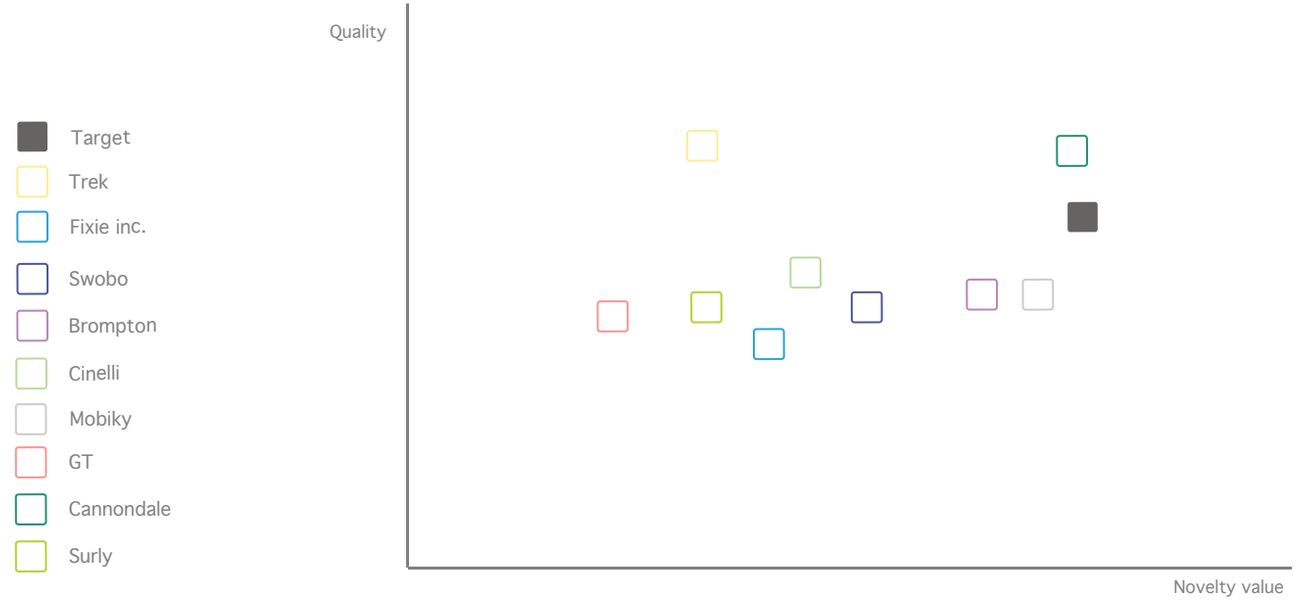


A diagram illustrating the relationship between quality and novelty value. The level of originality and innovations is compared to the brands image.

When designing an expensive urban bicycle the quality and the level of innovation should both be quite high. In reality it may not be possible to get the highest level of quality because the product is not manufactured by a major company. At least the level of innovation can be high.

4.3 QUALITY/NOVELTY VALUE DIAGRAM

COMPETITION



A diagram illustrating the relationship between style and technological innovations. The diagram shows that the industry is set to be stylish but conventional. This can be explained by the high price of research and development and the small margin of profits in bicycles.

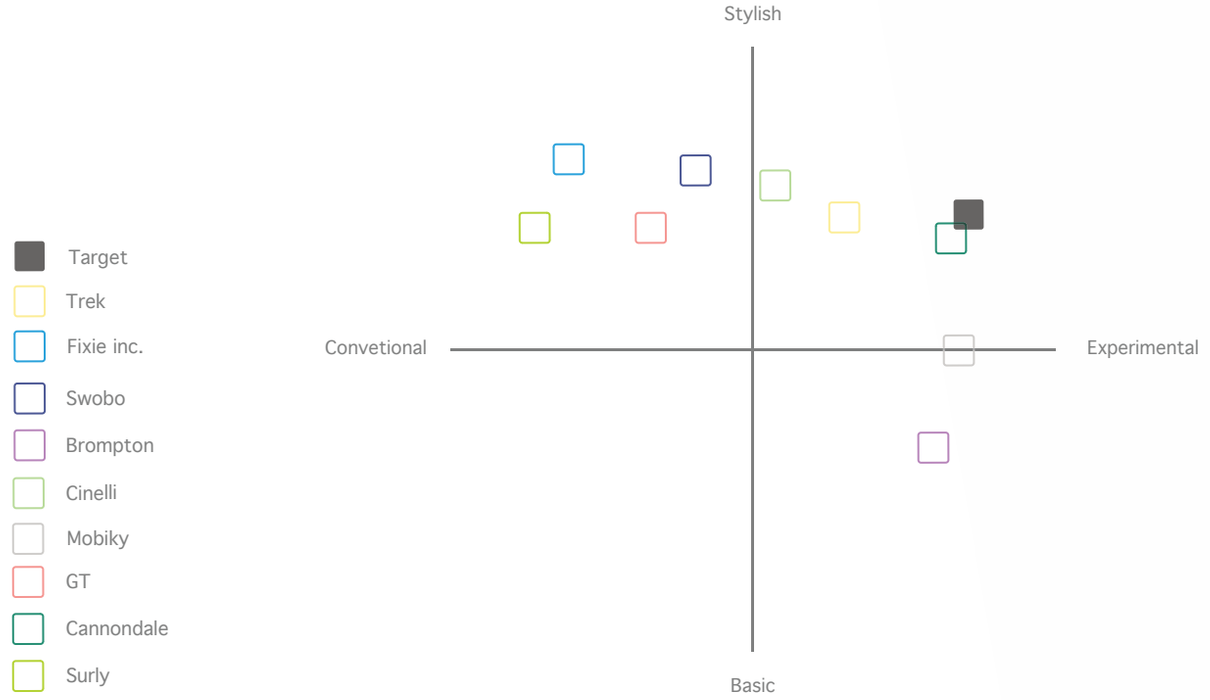
My conclusion of the diagram is that I do not have the choice to make a conventional bicycle especially in the price range I am heading for with my design. And to really set out from the mass I need to be really experimental also

4.4

MARKET SECTIONS

DIAGRAMS

COMPETITION



Some of the features of existing bikes would be useful to use in design.

The bicycle concept will be relatively high priced but it should also be highly innovative.

To stand out from the vast competition the bicycle should have a unique look that is recognizable even from a distance.

The bicycle concept should be unique and innovative. Already these factors guide towards quite individual customers. Manufacturing volumes of the bicycle are not so great and the price is high so possible new ways to increase sales would be needed to be successful.

4.5

CONCLUSION

COMPETITION

Defining the target group for the bicycle I used a tool that uses five steps for determining the target group for the product.

Step 1. Define the market or the needs that have to be fulfilled.

Step 2. Segmentation is where you cover as much as possible about the end user. In this project I describe different kinds of bicycle users.

Step 3. Customer profile. This is where you combine the users you believe would be perfect for your definition of needs and describe them as detailed as possible.

Step 4. Fully identify your markets. Study the competitors and study if there are markets for the concept. This step is covered in chapter 4.

5. Determine the markets and market shares. Where is the bicycle going to be sold and how many competitors there are in those areas. Step 5 is covered in chapters 3 and 4.

5

DEFINING TARGET GROUP

1. Target market and need to be fulfilled

Bicycle for people living in urban environment. Goal is to create bicycle that will give alternative for commuting in a city. Easy to maintenance and use.

2. Segmentation

Segmentation of different types of bicycle users.

Enthusiast/lifestyle
-Bicycle messengers
-Bmx

Commuters
-Commuting to work, about 10 km to one direction???

Leisure
-Free time usage

Fitness and sport
- Exercise
- Competition

Random user
- Occassional usage of bicycle
- Bicycle is for fast an short commuting

Compulsory users
- Under aged kids
- No other mean of transportation

3. Customer profile

A mix between a random user and
a commuter.
Most likely the commuting is quite short, maybe about 5 kilometer journeys and the life circles in quite small territories.
The target user uses a bike occasionally among other means of transportation.

Sex
- Male

Age
25-35

Career
- Graduated
- Well educated
- Office worker

Family
- No children

Values
- Somewhat green
- Trendy
- Technology fan
- Non sporty
- Practical

Environment
- Amsterdam, Paris, San Francisco
- Good infrastructure
- Central areas of the city

Social environment
- 9-5 work
- 5 days a week
- Busy schedule
- Outgoing

Commuting
- Bike
- Metro
- Tram
- Train
- Bus

4. Identifying market

To survive competition bicycle must be unique by the design and the price is not competition advantage on this product.

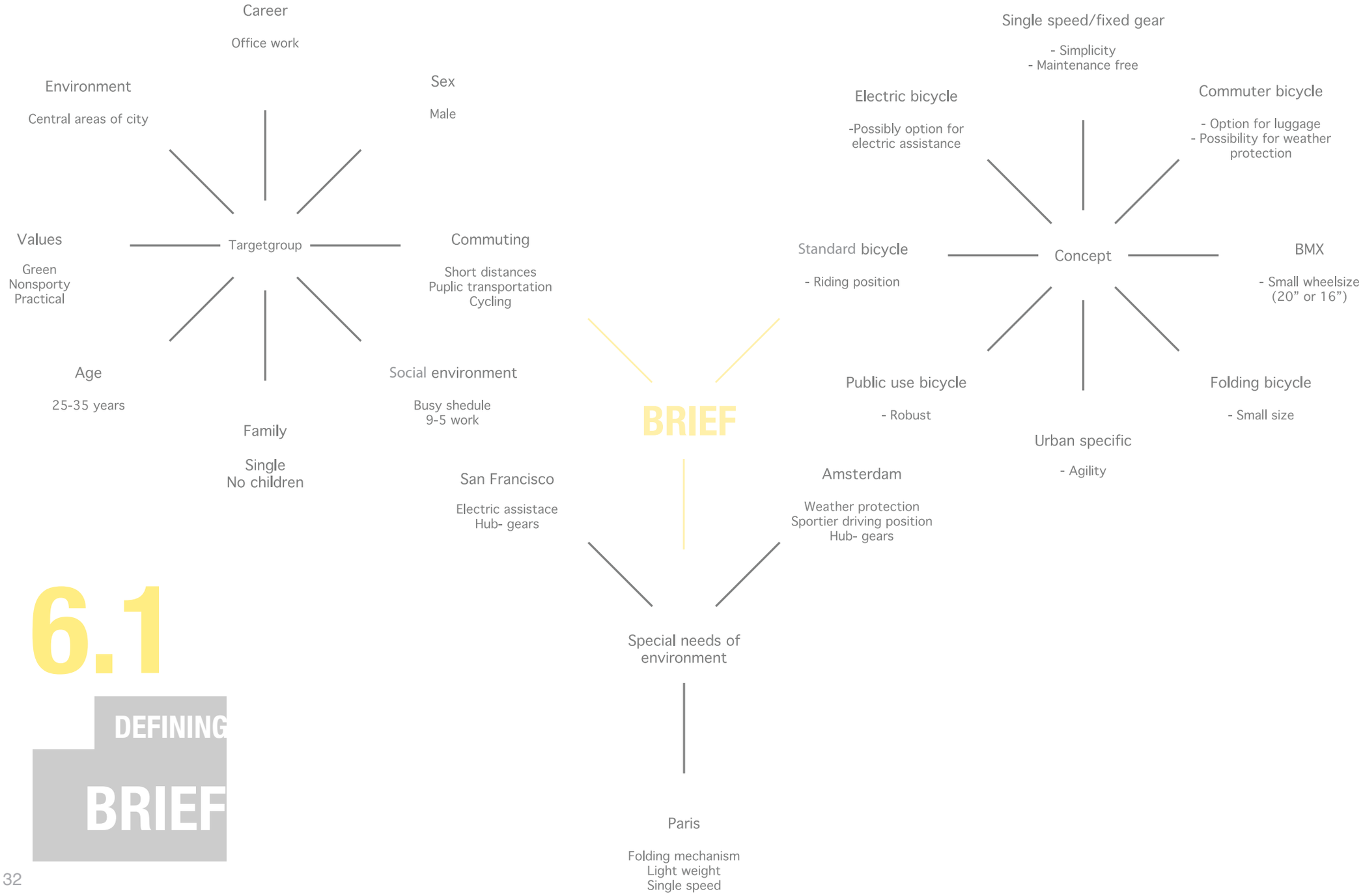
5. Determine the markets

Bicycle is to be designed for urban section. The aim of the product is in large metro-politan areas. Due the price markets will be marginal .

www.flickr.com/photos/reidrolls/3370010441/sizes/o/

6.1

DEFINING BRIEF



The goal is to design a concept bicycle for the urban environment. The concept should solve or minimise problems of owning a bicycle in a metropolis area. Problems such as bicycle theft, maintenance, storage, traffic, dirt etc. The concept also features a new drivetrain concept. All the materials and technologies should be existing ones and already on the market or ones that are possible to make in current technology.

The target group of the bicycle concept is a 25-35-year-old male. He is an occasional bicycle user who is living in a central area of a city.

The environment which the bicycle is designed for is in the central parts of three large cities Amsterdam, Paris & San Francisco. The design and solutions are aimed for those climates and environments individually.

Level of execution

The graduation project should meet the requirements and needs of Lahti University of Applied Sciences, Institute of design.

3D-models and renderings of the bicycle and of the drivetrain concept.

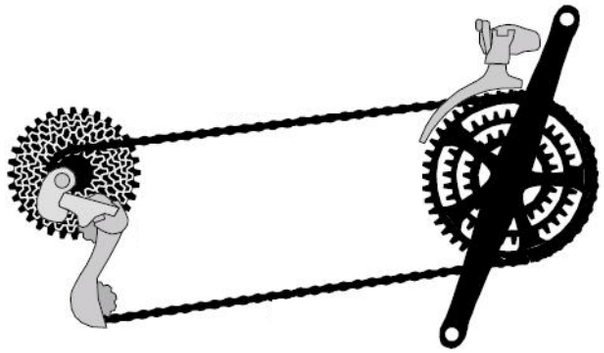
6.2 BRIEF

7.1

CURRENT SOLUTIONS

DRIVETRAIN

A traditional solution for a bicycle drivetrain is a chain. A chain has many good characteristics such as low resistance and the possibility for external gearing. On the other hand it collects dirt because of the oiling and it tends to stretch over the time. It needs to be maintained regularly.



bikincyprus.com/wp-content/uploads/2009/07/drivetrain.JPG

Nowadays more and more belt driven bicycles merge to the market. Advantages of belt drive is its long life and since it does not need any oiling it wont collect so much dirt. On the other hand, to have gears you need internal hub gears and the frame has to be specially fabricated to belt drive system. A belt drive has a bit greater friction than a chain-one.

www.trekbikes.com/images/bikes/2010/large/district_vintagegray.jpg

A rather rare solution for drivetrain in bicycle industry is a driveshaft. Driveshafts usually need a special frame or at least some fitting parts to fit to the frame. On the other hand it provides dirt- and maintenance free drivetrain for a bicycle. Shaft drive has the biggest friction of all the mentioned drivetrains.

www.dynamicbicycles.com/images/parts/shaft-drive-gear.jpg

One of the growing trends nowadays is electric powered bicycles. These hybrids use both pedal force and electric assistance to propel the bicycle forward. The problem in electric powered bicycles is the weight of the battery and also its' using range. Batteries are improving and in near future they can be very competitive.

www.belizebike.com/images/KIT%20Clean.jpg

For an urban bicycle a drivetrain should be maintenance free, dirt free and quite low in friction. I wanted to search for an alternative solution for the problems in current drivetrains.

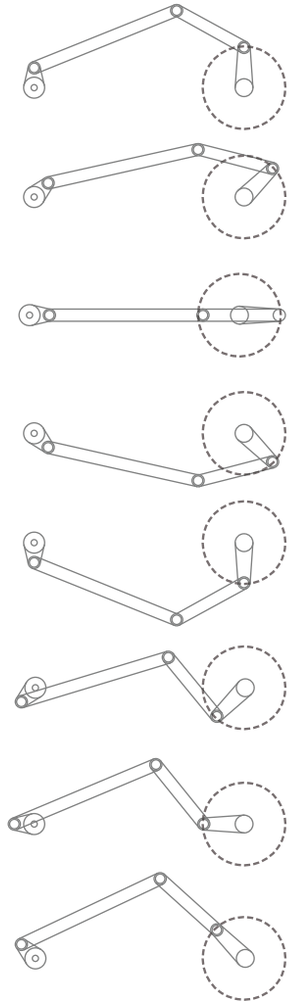
For a drivetrain concept I got inspired from an old locomotives drivetrain. The concept on locomotive is that the piston pushes a rod which is connected to the wheel in an eccentric way. The rod has bearings in both ends and the force of the engine is delivered trough wheels in other rods. The problem in transferring that design to a bicycle drivetrain is that the ratio in locomotive is 1:1 which wont work with bicycles. The rod-drives advantages in bicycles are that it's maintenance free, dirt free and low friction. The disadvantages are the weight, cost and need of special a frame. After various concepts and prototypes and after consulting mechanical engineer **Jussi Rosenström** I found a possible solution for the problem.

The methods used were sketching, 3D-modelling and prototyping with both a mockup model and with computer simulations.

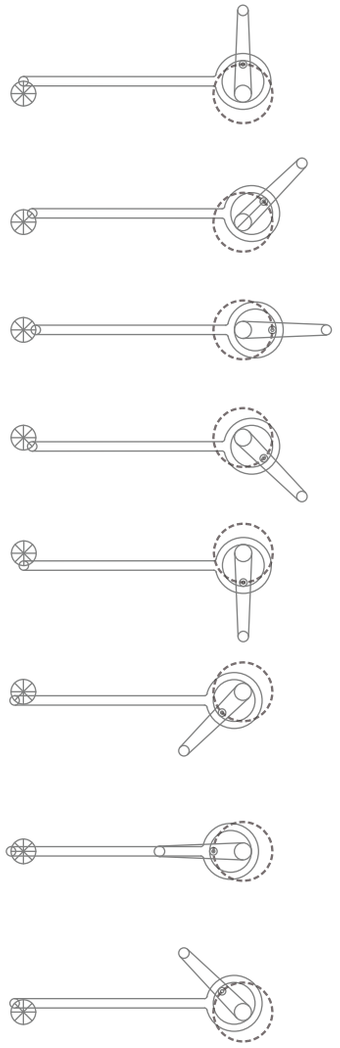
7.2

CONCEPT DRIVETRAIN

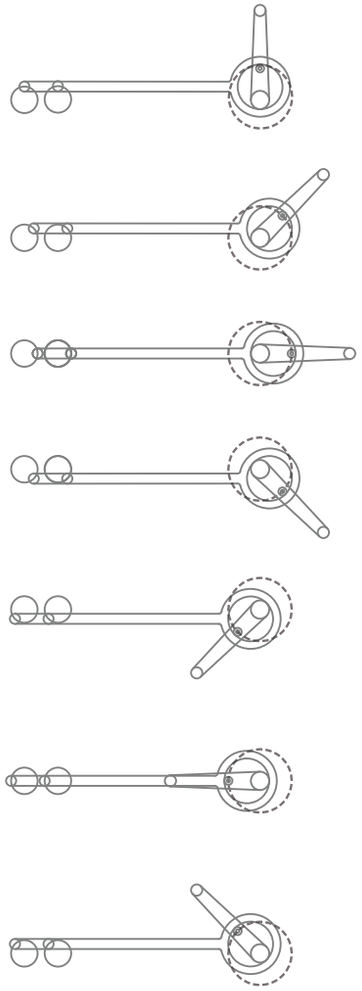
This solution worked in theory but in simulations and in a prototype the lever construction proved to be unreliable and eager to change direction.

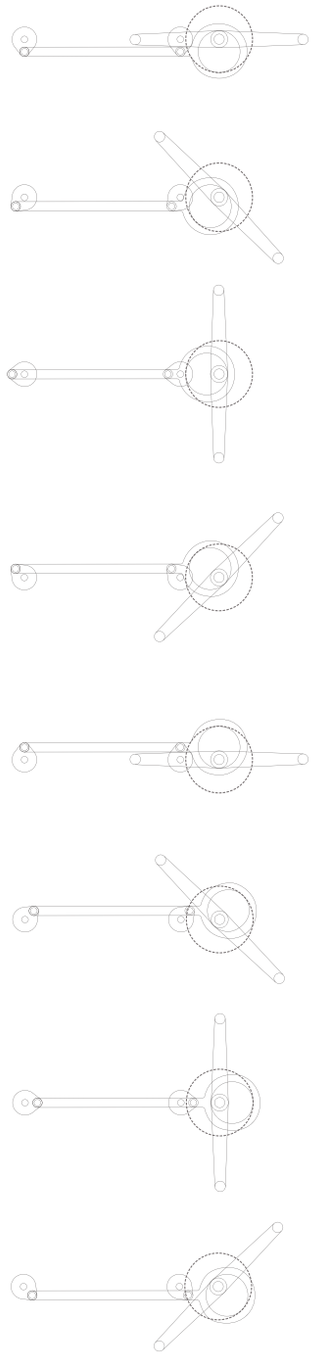


The second concept proved to be more reliable and the prototype did not show the feared backspin. But it occurred in the computer simulation.



An improved design from concept 2. Adding one more freewheel to the shaft eliminates the possibility of the backspin and the distortion in rotation. This, in theory should prevent backspin

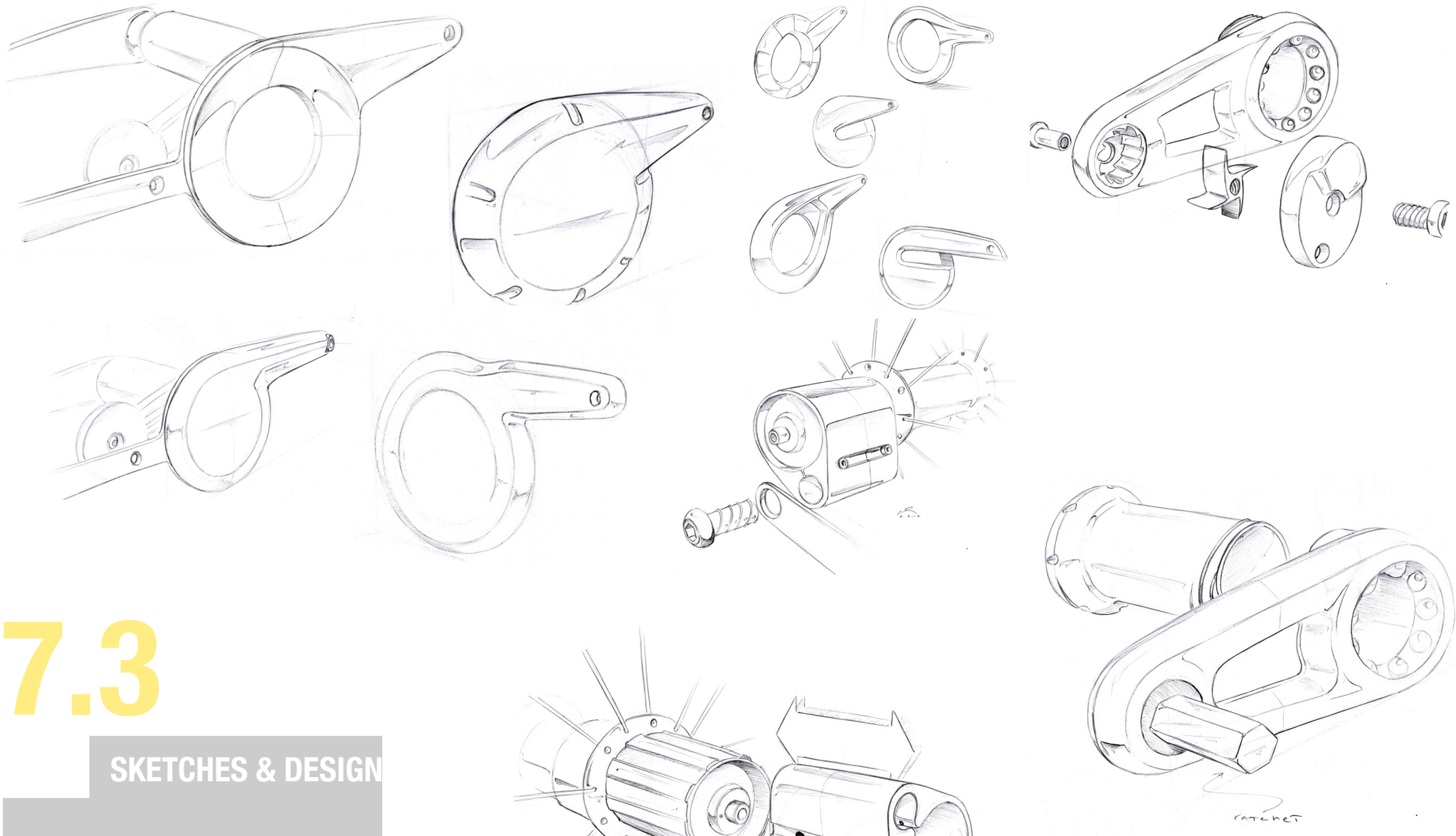




The mechanical engineer **Jussi Rosenström** told me that the problem was when the greatest force from the cyclist is applied, the lever in the back freewheel is in a wrong position to deliver the best performance possible.

For a solution **Rosenström** offered to rotate the right side crank 90° from its' current position. This design would allow more force to drivetrain while pedalling.

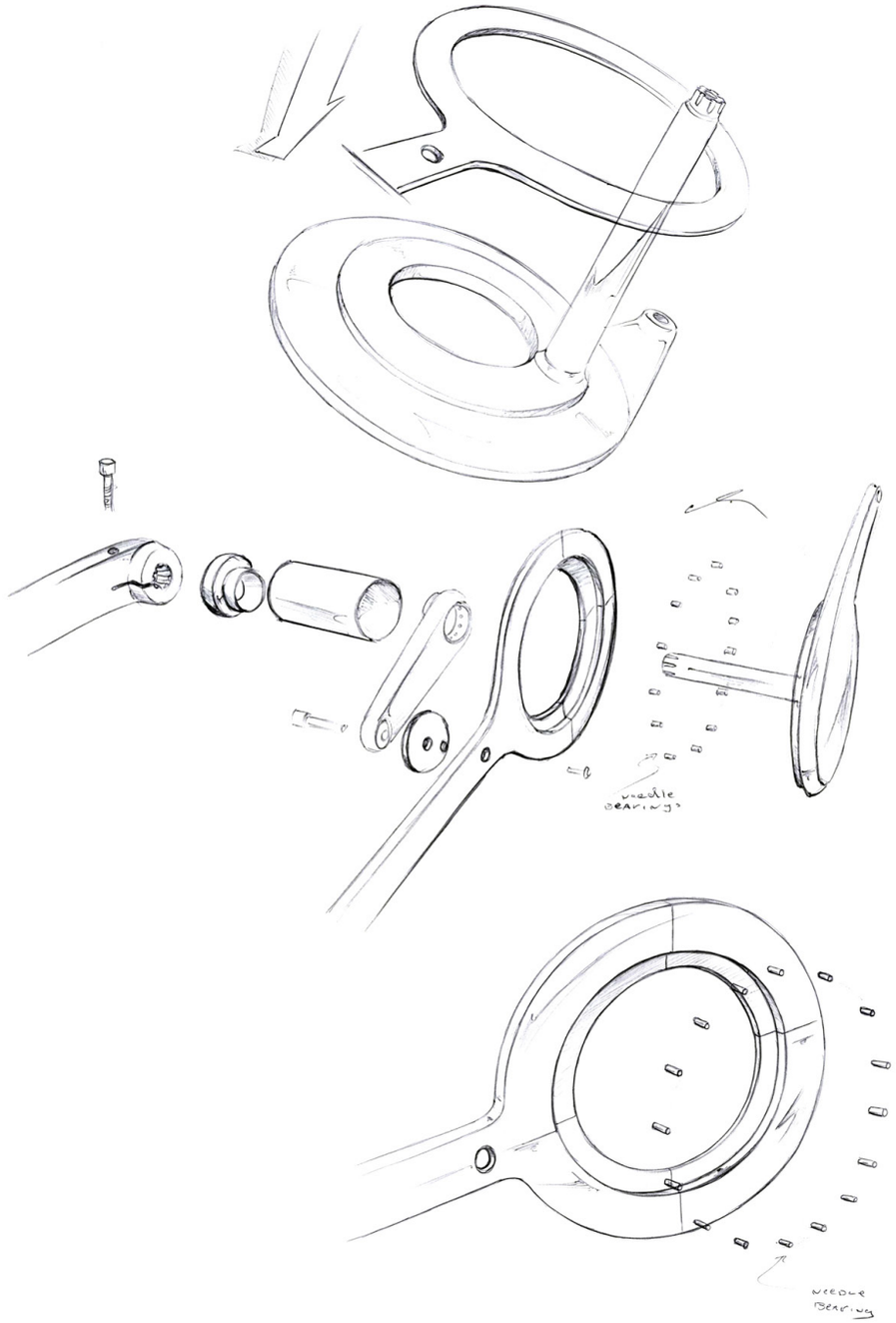
Also the ratchet mechanism has to be moved next to the pedals because the one sided rear-fork-design (which is needed for this kind of drivetrain) does not have any space for a ratchet in the back section of the bicycle.



7.3

SKETCHES & DESIGN

DRIVETRAIN



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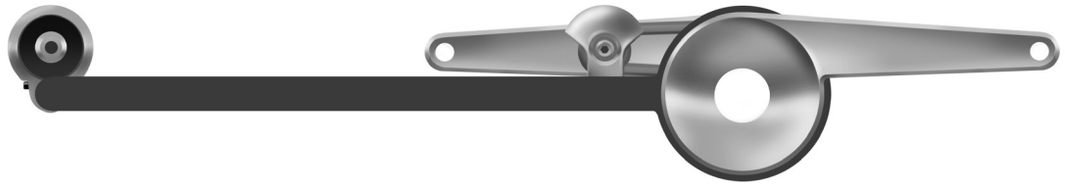

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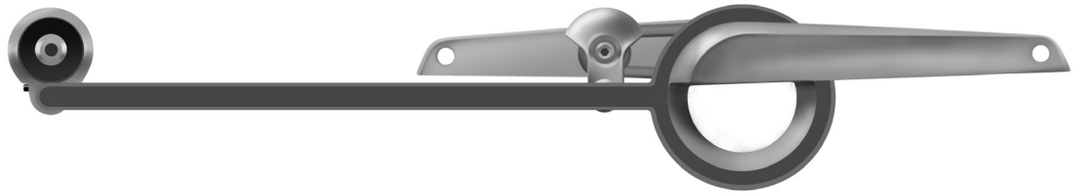

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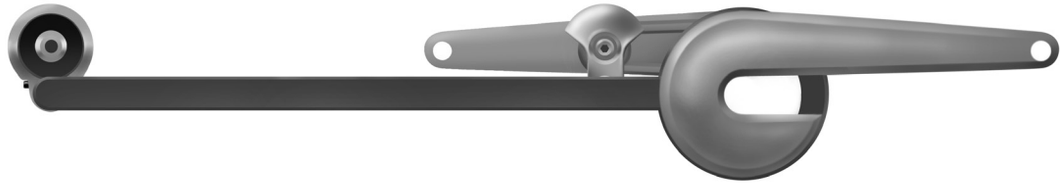
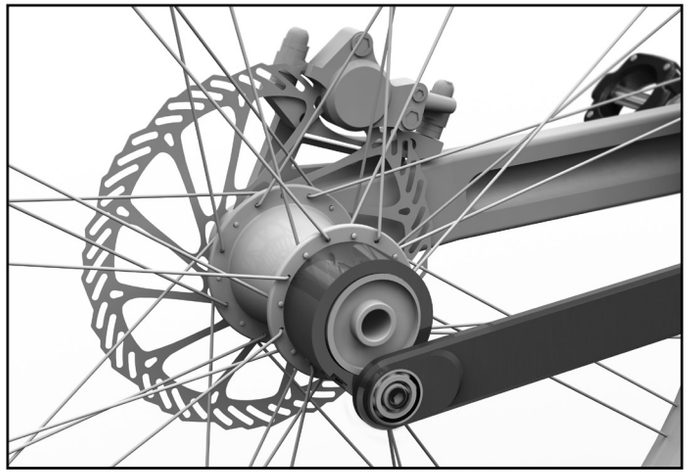
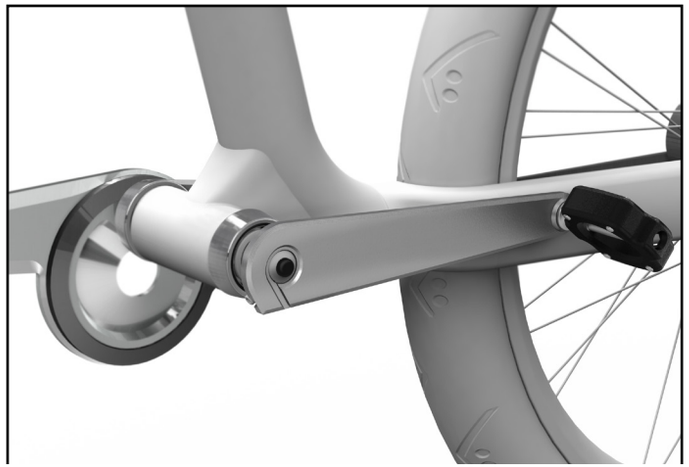


After I had selected the method of power transfer from pedal to the wheels I had a lot of details to solve. Most of the details I was able to solve by sketching by hand but smaller details and tolerances I left for computer aided design stage.

From sketches I selected three different concept to think a bit further. To my opinion the concept number 2 looked the best but for urban environment I think it was a bit too much. Concept number 1 was the best solution, not too bold but still remarkable different from existing design on crank arms on the markets.





For the final design I selected simple and clean form. I did not want to overdo the design and emphase the technical innovations.

The look is clean and relatively timeless and in my mind it appears to be durable and functional.

The design is not meant to be wild and bold even if the concept behind may be. The effect and interest will be caught by other means like the eccentric rotation of right crank arm and rod will definitely catch some attention.

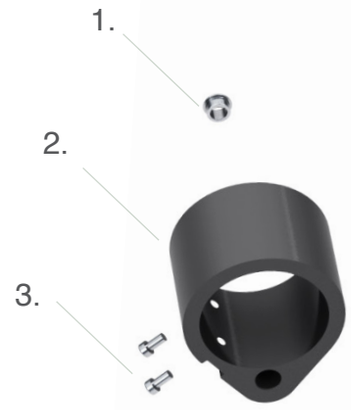
The drivetrain is build from five main pieces. Crank arms, pushing rod, adapter for cassette body, ratchet mechanism including counterweight wheel and bottom bracket which is integrated with ratchet mechanism.

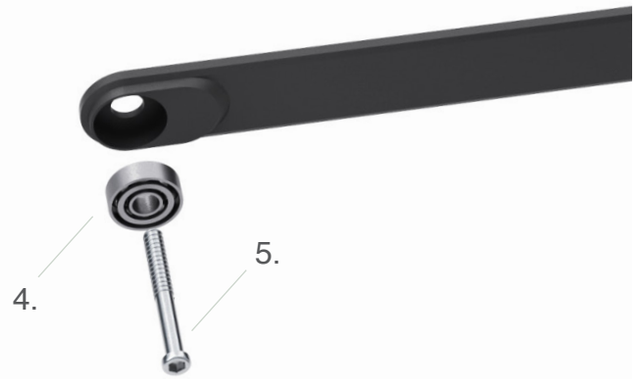
7.4

FINAL DESIGN

DRIVETRAIN

1. Nut
2. Free wheel adapter
3. Adapter locking bolt
4. Ball bearing, 8mm x 22mm x 7mm
5. Bolt
6. Crank arm tightening bolt
7. Crank arm locking bolt
8. Left crank arm
9. Crankset ball bearing 18mm x 32 mm x 9mm
10. Left bottom bracket ball bearing cup
11. Left bottom bracket ball bearing cup with ratchet arm.
12. Bolt
13. Ball bearing, 8mm x 22mm x 7mm
14. Counterweight wheel
15. Counterweight locking bolt
16. Ball bearing 18mm x 32mm x 9mm
17. Needle bearing
18. Pushing rod
19. Right crank arm

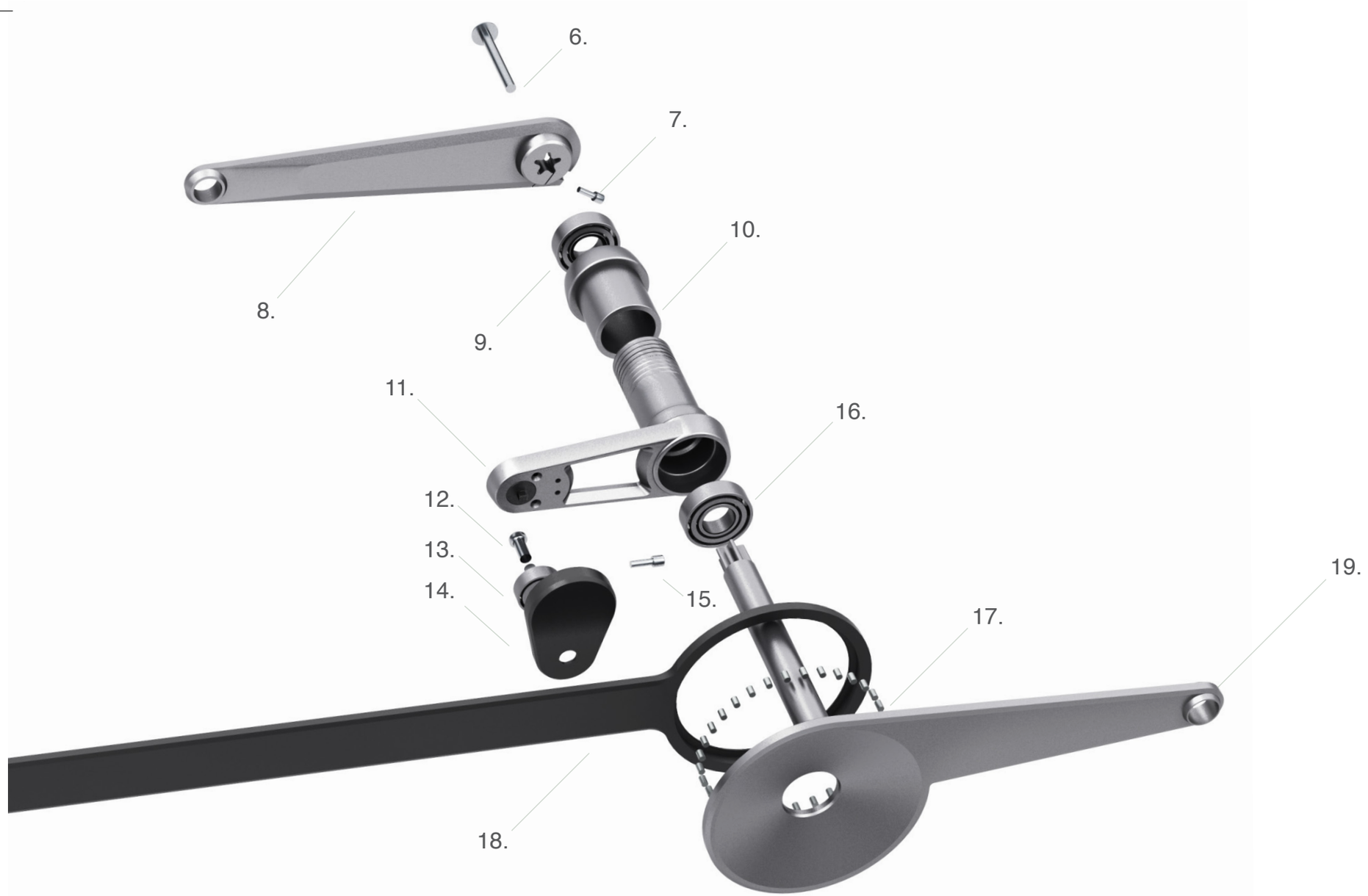




7.5

PART LIST

DRIVETRAIN


6.
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18.

As the base for geometry I chose Cannondale Hooligan. It is already designed for an urban environment, but it is not aimed, in my opinion, for an extra urban environment.

To meet the needs of central urban areas I wanted to get a shorter wheelbase for more compact size. At the same time I wanted to keep the length of the horizontal top tube the same as in the reference bike so the wheelbase had to be shortened at the rear fork. This effects the bikes balance and the frame will get too rear ended. To get the frame back to balance I lowered the handlebar to move the riders weight to front and even out the features of the frame.

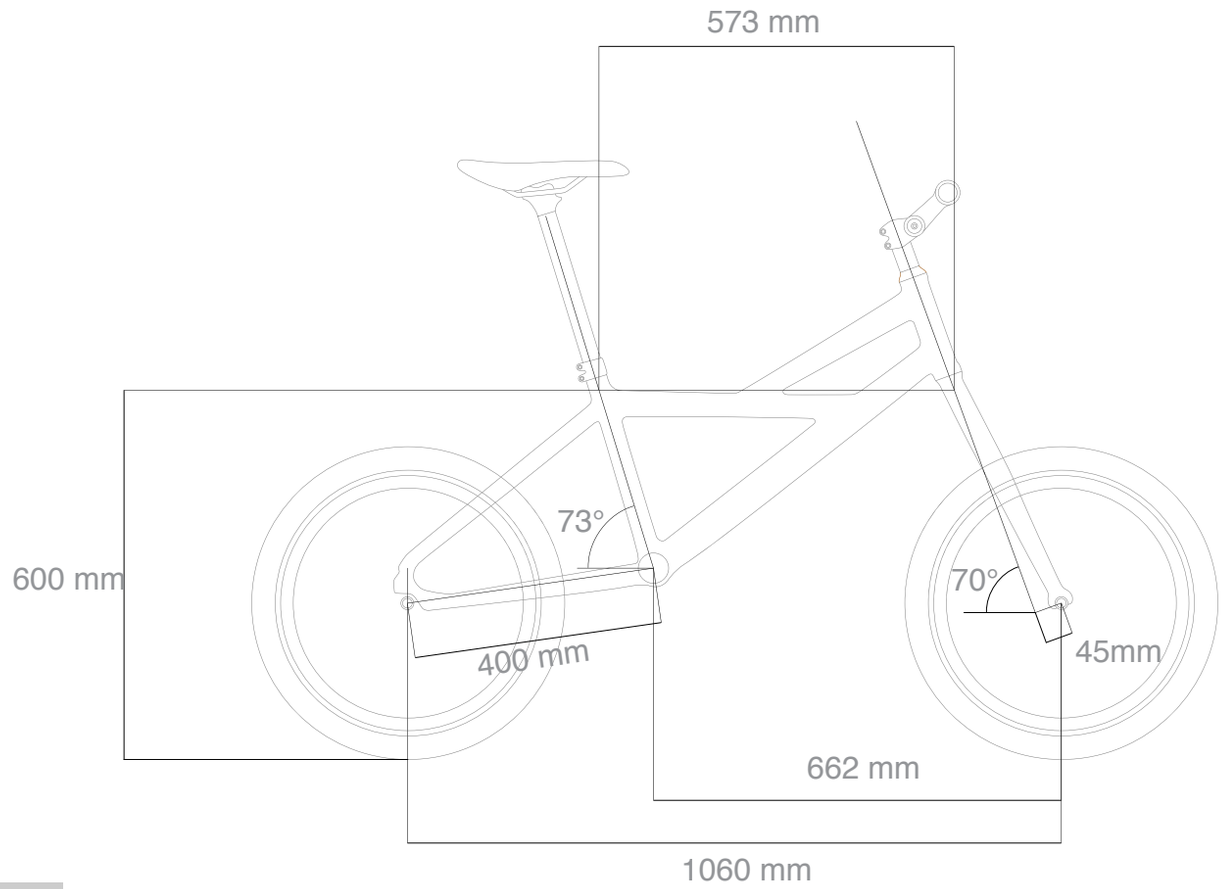
The modifications for the frame will give the rider a more aerodynamic driving position, which is not needed in a city environment but it will make steering feel more precise. This calls for a shorter frame as it turns more easily than the longer ones.

8.1

GEOMETRY

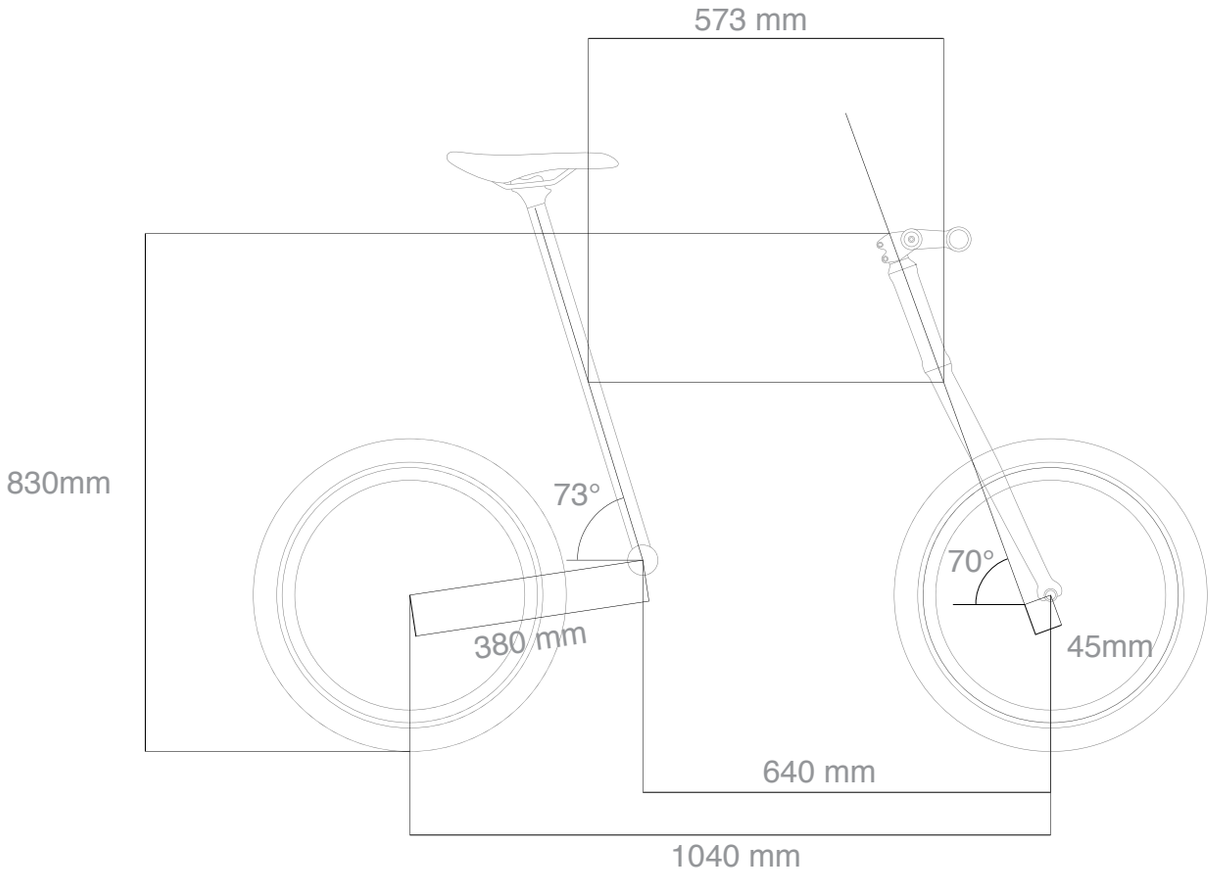
URBAN BICYCLE

Cannondale Hooligan



www.cannondale.com/usa/usaeng/Products/Bikes/Recreation-Urban/Hooligan/Details/1316-0HL3-Hooligan-3

Gnome



1.

2.

3.

4.

5.

6.

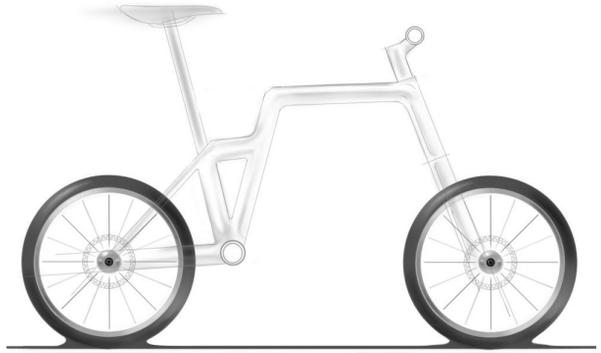
8.2

SKETCHES

URBAN BICYCLE

Designing the frame started from deciding the main measurements of the frame. The geometry gave me the constrains and from that I started sketching over the geometry picture. To work this way is vital when designing bicycle because of the tight constrains of the measurements on bicycle.

7.



8.

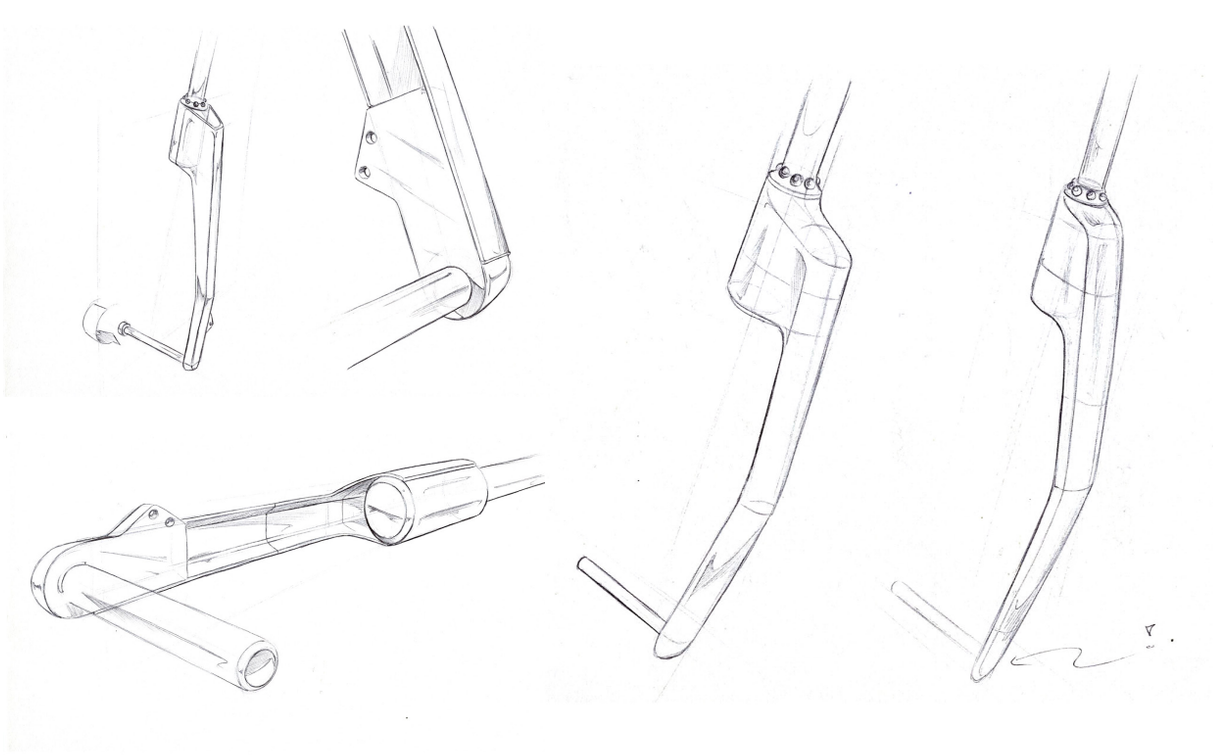
9.

10.

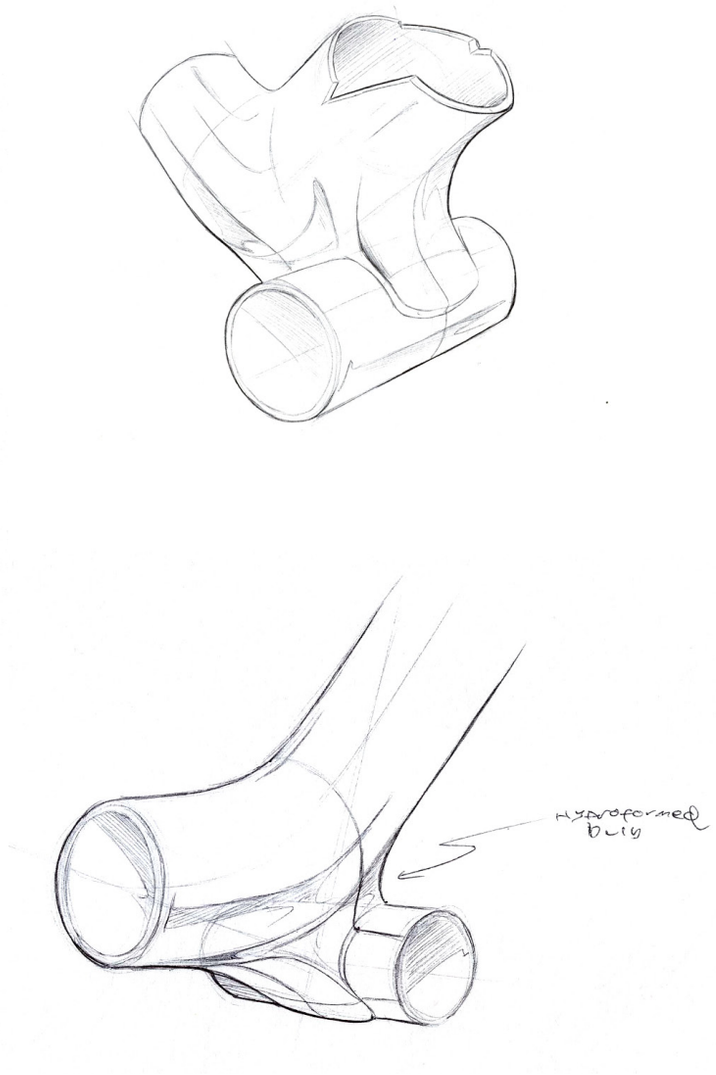
11.

12.

I wanted to design something different but still something quite simple. This prove to be problematic since the basic diamond shaped bicycle is really functional and well proportioned. When trying to do something new the most of the designs went too far and afterwards there was only concept 1,5,6,10 and 12. To my taste the concept 10 and 12 looked best and still really close alike. After some careful thinking I decided to go on with concept 12 because of the fact it was possible to use more standard parts like seat post and normal stem configuration.



Different variations and studies of steering fork



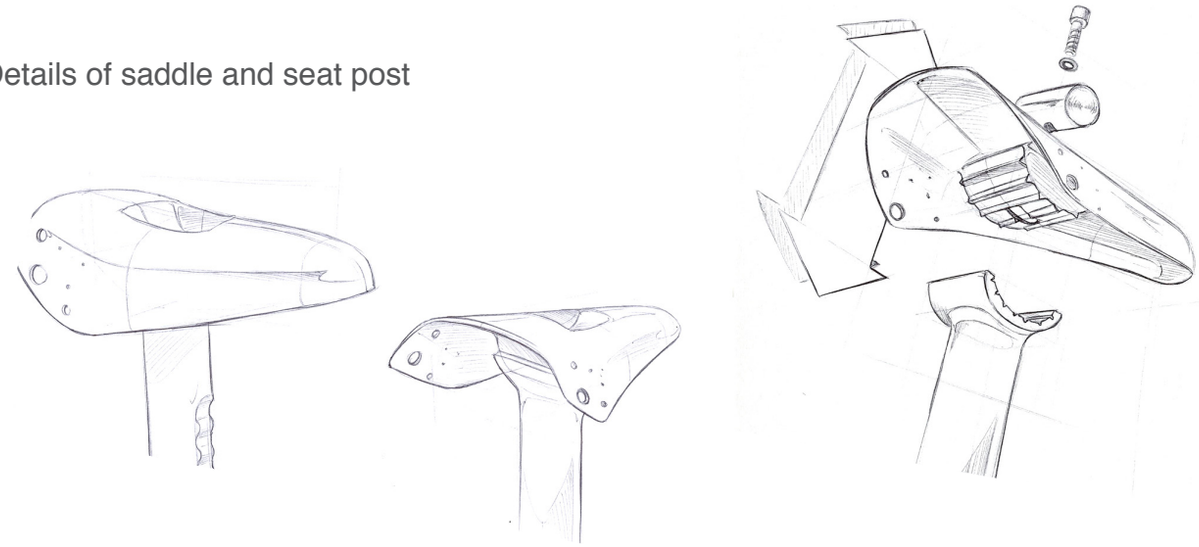
Details of hydroforming the housing for the bottom bracket. The problem with this detail was to create smooth change from frame to bottom bracket and still give enough surface to weld the bottom bracket to the frame.

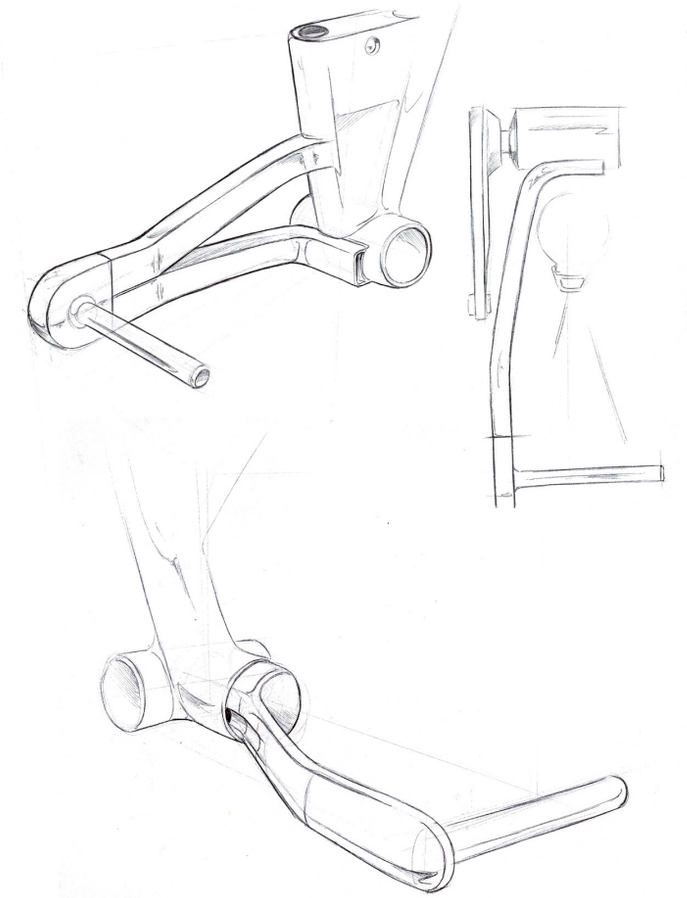
8.3

DETAIL DESIGN

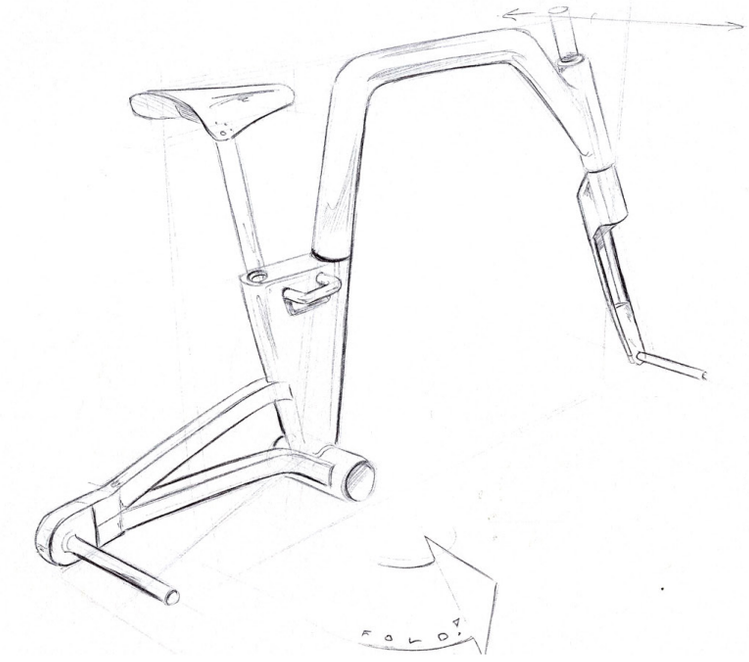
URBAN BICYCLE

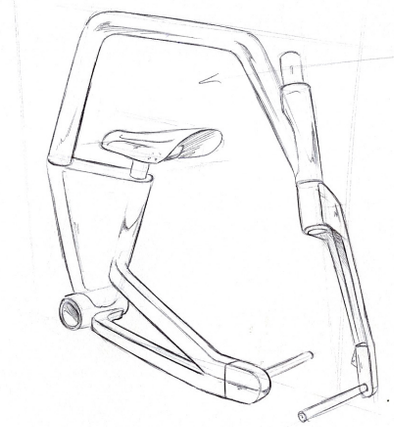
Details of saddle and seat post





Chainstay design. I selected for final design simple one armed design. The brake cables are run trough the frame. The detail that allows the cable to exit the frame works also as a reinforcement for the chainstay.





Details for Paris concept

Basic model

San Francisco concept

8.4

DESIGN FREEZE

URBAN BICYCLE

Photoshop illustrations of final design. These picture works as a final guide to 3D modeling along with detail sketches.

The process of modeling was done in two three separate parts. First I designed the drivetrain completely based on standard measurements of bottom bracket, hub and wheel width. That because I would not face any problems later on when designing the actual frame of the bicycle.

After modelling the drivetrain I started making all the standard part of the bicycle such as wheels, hubs, disc brakes, stem, saddle and so on. Designing all parts mentioned earlier I kept the standard measures in mind so all these components are easily changed or replaces if needed.

Amsterdam concept

Paris concept

When I had finished all the components needed I started designing the frame of the bicycle. As the first reference I used geometry designed earlier on the project. The geometry gave me rough outlines of the bicycle and after importing all the standard parts to Rhinoceros 3d modeling program I had all the constrains needed to design the frame.

9.1

DESIGN CONCLUSION

The frame of the bicycle is made from aluminium. The main frame is 45 mm diameter tube bend from one piece. The tube goes trough hydroforming process to even out the distortions of the tube bending machine and also to make place to weld the bottom bracket on the frame. the seat tube box and head tube is welded on the frame and the welding seams are sanded down for smooth appearance.

The final design feature one sided steering fork and chainstay. This features was chosen to the front wheel for easier maintence. For example there is no need to take off the wheel for tire chance. For chainstay the one sided for was essential feature to make room for drivetrain concept. The chainstay and steering fork is made out from carbon fibre to stand out the forces of cyclist and environment. Carbon fibre chainstay is clued to the aluminium frame.

The bicycle is equipped with drivetrain concept, hydraulic disc brakes and puncture protected tires for the durability.

All the upcoming concepts are based on this basic model with some modifications and different graphic design.

9.2

DETAILS

CONCLUSION

9.3

ERGONOMY

CONCLUSION

The geometry chosen for the bicycle has advantages but also some disadvantages. The high standover of the bicycle limits the rider height in about 180 cm. The top tube is on 83 cm off the ground which is a little bit lower than the average 180 cm male inseam measurement (85 cm). But this feature do not limit shorter person than 180 cm to ride this bicycle.

Leaving out the down tube from design makes frame flexible which increase comfort but on the downside the flexibility is not always wanted like when pedalling with force. Also the design without the down tube makes bicycle ideal to carry around on the shoulder. Feature which is useful when using public transportation or carrying bicycle up to the apartment. Also with the drivetrain concept user does not mess up his/hers clothes.

www.sxc.hu/browse.

www.flickr.com/photos/nuzz/3377973099/sizes/o/

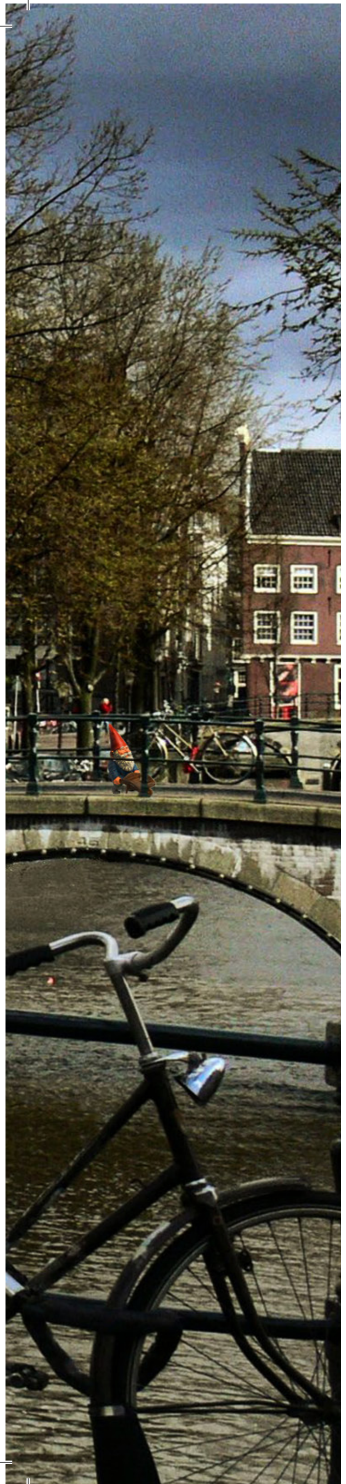
9.4

AMSTERDAM

The Amsterdam concept.

The Amsterdam concept is modified to accommodate need of Dutch urban cyclist.

The fender are essential need for the country which have large humidity levels. Also the drop handlebars give some aerodynamic advantages for the windy environment. Since the bicycle have drop bars and Netherlands have long heritage of road racing with bicycles I decided to give it sporty graphic outlook.



www.flickr.com/photos/piet_musterd/4255997786/sizes/l/

AMSTERDAM

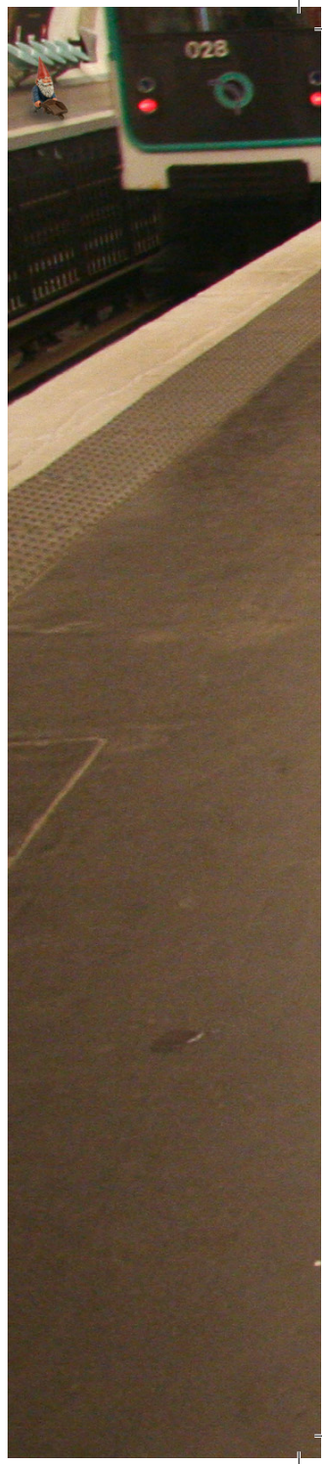
9.5

PARIS

The Paris concept

The lack of living space and vast public transportation system need a bicycle that is small as possible. For Paris concept the main frame of the bicycle is cut in to two pieces and connected again with simple hinge mechanism.

PARIS



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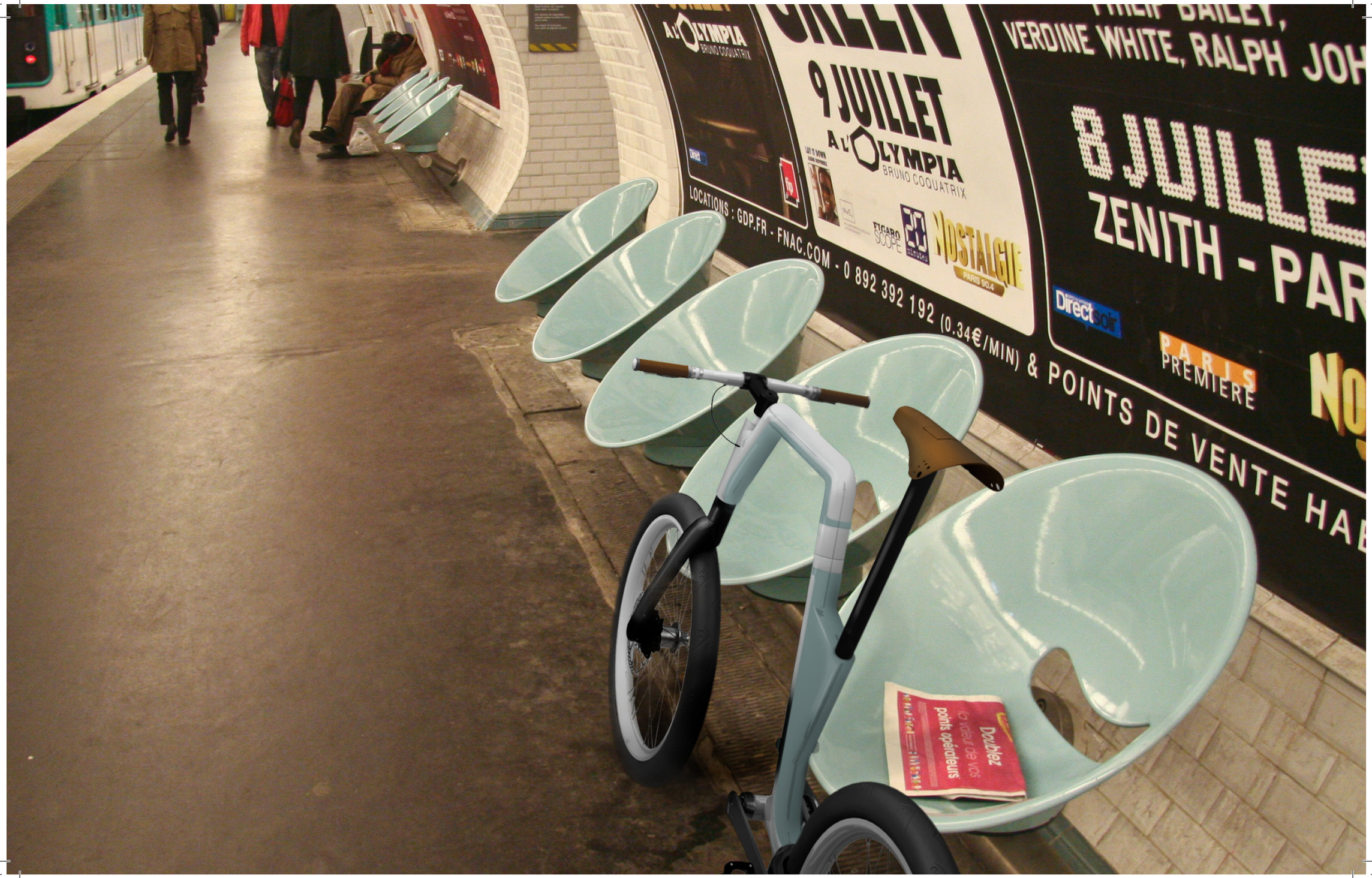
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NOSTALGIE
PARIS 90.4
Direct Soir
PARIS PREMIERE
VERDINE WHITE, RALPH JOH
8 JUILLE
ZENITH - PAR
Doublez
points opérateurs

9.6

SAN FRANCISCO

The San Francisco concept.

The San Francisco is well known for it is massive contour changes. The concept is equipped with electric motor in the front hub of the bicycle. Batteries are located under the top tube in to detachable package. Since the electric motor is located to the front hub of the bicycle there is no problem to install hub gear to the rear wheel.


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10

FURTHER DEVELOPING

The drivetrain concept will be taken further in development. The aim is to create working prototype to test the concept and possibly to develop it further if needed. The prototype will be produced with rapid prototyping machine in Lahti University of Applied Sciences.

The frame of the bicycle is already in quite complete stage and not much testing is needed for prove it usability and strength. Possible computer aided calculation will provide enough data to demonstrate frames strength. The prototype is not in consideration at the moment.

11

CRITICISM

Process

To achieve the goal of the project prove to be more difficult and labour intensive than I thought.

The background study and determine the target group and environment of usage took a lot of resources and time but prove to be really helpful later on design process.

Designing the drivetrain was really hard but rewarding experience. Designing mechanics took almost 3 weeks which is a lot of time from graduation project and there was times when I was almost giving up with the concept but in the end the visual appearance and the mechanics were much better than I earlier imagined. I noticed that consulting a different professionals and colleagues was really helpful and essential to get the final result.

Designing the frame of the bicycle was a much easier task. The final form was found quite easily and effortless. The alterations for basic frame for different environment were found easily because of the study and research I made earlier.

The time the project took was overwhelming but I am really pleased for the results although there is always room for improvement.

Achieving the goals

The project goals I set to achieve was in most parts answered. I did not find better solutions for some problems like bicycle antitheft. But all in all I am really satiated for the outcome and also the path I took to get there.

I also learned new computer program for the project. I made all the 3d rendering with Luxology Modo 401. The learning the program took a lot of time and consulting. I could have done some similar pictures with other programs I already know but still I think the learning process was worth the effort.