Electric Bicycle Design

Industrial Design
Final Project Work
Carlos Tovar
2008-09

Jönköping University
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Urban transport
Actual situation in the EU.

At present, the European cities are living each day an accumulation of excessive traffic and noise. Approximately one quarter of the population of the UE live within 500 m from a road with more than three million vehicles annually. Although the 50 % of the journeys by car doesn’t reach the 5 Km and the 30 % don’t even reach 3 Km, the 75% of the mobility in the European cities are done by car.

Other aspects that are being seriously harmed by the city traffic are the air quality and the health. The traffic is the main source of many air pollutants such as carbon monoxide and suspended particulates. In addition, the air pollution is the main cause of environmental disease in Europe. Because of this air pollution, the citizens have many possibilities to suffer some cardiovascular and respiratory problems.

The most important reasons of this air pollution are the traffic increase, also the increase of cars with diesel engines that are more pollutant than cars with gasoline engine. Another reason that explains the air pollution in the cities is the fact that vehicles pollute more in urban environments because of the traffic.

Adding to the list of problems suffered by the European cities and therefore by the citizens is the noise caused by the traffic. There are 210 million Europeans exposed to noise levels potentially hazardous to health. This problem is more and more increasing because of the traffic. According to a German study, 4000 heart attacks annually are due to traffic noise (UBA, 2006). Other possible consequences are the lack of sleep, discomfort, and mental effects.

Finally, and no less important, the climate change is quickly growing because of the air pollution in the cities. Urban traffic accounts for more than 40% of CO2 emissions generated by vehicles and 10% of total CO2 emissions in the EU.

To improve this situation, it is necessary to change the culture and the costumes for urban mobility. Institutions and citizens must make an effort and try to solve this problem as soon as possible. The following are some aims that would help to solve the problem:

- Reconciling the economic development in cities with the quality of life and environmental protection.
- Developing lifestyles less dependent on cars.
- Developing new clean and efficient ways of transport.
- Minimize the environmental and health damage.
- Reduce the energy use and the economic and social cost.
- Ensuring access for all the citizens.
The electric bicycle
The future of the urban transport.

The e-bike is a human electric hybrid vehicle. Basically, these bikes are for people who want an alternative to a car, get exercise, go fast without increased effort, and get you where you want to be. The e-bike is made not to leave the rider completely idle but to assist in the movement over hills as well as flat ground. Peddling on the part of the rider can be used both to move the bicycle and to recharge the batteries. It’s an amazing, fast and efficient vehicle that respects the environment. With this vehicle, it is possible to enjoy a leisurely and relaxing cruise and arrive at destinations (such as work) at the same time.

Amazingly, the price of a e-bike is the same as a standard one. This means that acquiring this vehicle, the purchaser get the regular bike functions plus the additional power from the battery to propel him faster than he could by himself for a longer period of time. The electricity of the bike is not to increase the speed or move without effort, it is to assist to the rider to ride at a regular safe speed on or off road.

In addition, this vehicle is regarded by the same as a traditional bicycle by the law. That is to say that riding an electric bicycle does not requires having a license to the user.

The e-bikes are becoming the best way of transport in urban environments. Bicycles are more agile and fast than cars because they are more maneuverable and can easily bypass obstacles that would greatly slow down cars. Bicycles are also easier to park because they are so portable. It is possible to park them almost anywhere. To top it all off, most electric bikes have sufficient range to handle day-to-day life in a city. Most traditional electric bikes still include the pedal assembly as well as the electrical one, so you can simply turn off your throttle if you want to ride for a while on your own power.
Can the electric bicycle solve the problem of the urban traffic?

In this page I will compare the aims proposed before to solve the problem with the features and benefits of the electric bicycle. These were the aims proposed:

1. Reconciling the economic development in cities with the quality of life and environmental protection.
2. Developing lifestyles less dependent on cars.
3. Developing new clean and efficient ways of transport.
4. Minimize the environmental and health damage.
5. Reduce the energy use and the economic and social cost.
6. Ensuring access for all the citizens.

We can see that introducing the use of the electric bike in the urban environment of the Swedish cities is possible to achieve all these aims. The electric bike does not harm the environment, minimize the energy usage because it is a human electric hybrid vehicle. Riding a bike is healthy and fun at the same time. Bikes are so much cheaper than cars, this means that is easier to purchase and maintain an electric bike than a car. Bicycles are more agile and fast than cars because they are more maneuverable and can easily bypass obstacles that would greatly slow down cars. Bicycles are also easier to park because they are so portable. It is possible to park them almost anywhere.

All of these features make the electric bicycle a very interesting vehicle that could become the most important way of transport in the Swedish cities in a few years, and later in all Europe.
The electric bike aspires to be the most seen vehicle in the Swedish cities, and later also in the European cities.

The main function of the electric bike is to reduce or even remove the fatigue from riding a conventional bike. This objective must be met without changing the concept and the message that the bike transmits to the people.

These are the features that the electric bike should have:

- The e-bike must have a Swedish look.
- The main target of this bike are workers. It is necessary to think about the profile and the habits of this group of people.
- The electric bike is an eco-product and this feature should be visible to purchasers and users.
- The maintenance and the starting of the electric bike should be fast and easy, reducing the necessity of tools. The insertion and removing of the battery must be easy and fast. One of the key considerations during the design of the bike will be the study of the possible places to keep the battery and how to insert and extract the battery in the bike as well.
- The electric bike must have lights to see and to be seen in the darkness.
- The bike will contain as much standard parts as possible.
- The price of the e-bike should be between a bike and a motorcycle price.
- The autonomy of the battery should be between 30 and 50 Km.
- The time necessary to charge the battery shouldn’t be more than 5 or 6 hours.
- The electric engine must work only if the user is pedaling.
- The e-bike should give to the user the possibility to choose the engine help level.
- The effort realized when riding the bike shouldn’t depend on the inclination of the ground.
- The e-bike should be produced in Sweden.
The Swedish design

1. Functionalism
2. Simplicity
3. Beauty as a function
4. Search for ergonomics
5. Noble and technological materials use
6. Rational conception of the daily life
7. Nordic light
8. Pop culture and art
9. Rustic objects
10. Natural Shapes
11. Pale colors
12. Plain textures
Bikes Research in Jönköping (Sweden)

With this research we discovered which kind of bicycle is the most used in Jönköping and so in the Swedish cities. With this information we will be able to know what does the Swedish population want in a bicycle.

These are all the kind of bikes used in Jönköping:

<table>
<thead>
<tr>
<th>1 – Classic lady bike</th>
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<tr>
<td><img src="image1.png" alt="Classic lady bike" /></td>
<td><img src="image2.png" alt="Beach cruiser bike" /></td>
<td><img src="image3.png" alt="Racing bike" /></td>
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<td>4 – Utility bike</td>
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<td>7 – Mountain bike</td>
<td>8 – Lady mountain bike</td>
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<td><img src="image7.png" alt="Mountain bike" /></td>
<td><img src="image8.png" alt="Lady mountain bike" /></td>
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Bikes Research in Jönköping (Sweden)
Place: Small groups

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Bikes Research in Jönköping (Sweden)
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Place: Juneporten

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Bikes Research in Jönköping (Sweden)
Place: Cinema

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### Bikes Research in Jönköping (Sweden)

**Place:** Small groups

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Bikes Research in Jönköping (Sweden)
Place: Small groups

Conclusion

Between all the kind of bicycles, the most popular are the city bikes because the majority of the displacements occur within the cities. The lady city bike (kind of bike 1,2,3) is the most popular bike in the Swedish cities. Studying the features of all these kind of bicycles we realized that this three bikes are the best prepared for this kind of displacement. This means that our bike should have similar technical and ergonomic benefits to make it appropriate for the urban displacement.
Target: the Swedish working population

Swedish citizen profile:
• Age and gender: The average city worker is 35 years old.
• Marital status: About the 45% (women and men) are married.
• Hour of working: 8 hours a day
• Education: They are educated people with a career or some other professional degree.
• Occupation: business, education, engineering, ...
• Income: around 28000 SEK per month
• Way of transport: At the moment, the 90% of the population use the car to go to work. The rest of the people use the public transport, the bike or walk.

Conclusions: For this group of people, the electric bike is the best way of transport. With this vehicle they will be able to go faster and moreover, they will do some exercise that will improve their health. Using the electric bike they won’t have to do any extra effort and they will get to arrive at their jobs in a shorter period of time. Moreover, they will spend less money and they will help to save the environment. We are convinced that they will love this fantastic vehicle.
Creative session
Concept 1
Concept 1

More Relaxed Posture
"Cruising"

Adjustable Seat

Safer Stop
"Two Feet"
Concept 1
Concept 2
Concept 2
Concept 3
Concept 3
Second creative session
Concept 4

This model is basically the initial idea that was developed in the first creative session. In this design, the battery is located inside two special profiles that join the front and the back part of the bicycle.

It is characterized by the use of the straight line. Its esthetic and style is totally functional.
Second creative session
Concept 4

The top and the bottom face of these special profiles are hidden with four embellisher components that make the bike more esthetic.

In this picture we can see how is the inside of the special profiles.
Second creative session
Concept 5

This concept is quite similar to the first one, but we have changed the style of the top stay of the frame and the special profiles. Now, the top stay is completely curved and is joined to the seat tube in the same point as the top special profile. The special profiles have changed from a continuous and smooth shape to a new shape with more stress and personality.
Second creative session
Concept 6 (Selected)

The third concept is the most innovative one. Its aerodynamic shape make it more modern and elegant. All the joins between the different elements of the frame are smoothed and rounded so all the frame is continuous and uniform.

Now, the place for the battery is done by a cut in the frame.
Second creative session
Concept 6 (Selected)

Now the battery is placed inside a plastic box assembled directly to the frame.
Product Development
Component description

Frame

The frame is the most important component in our electric bicycle. Its innovative geometry is different from the actual bicycle frames because we locate the battery inside it, just between the seat and the fork tube, thus avoiding the need for extra support to accommodate the battery, such as e-bicycles today do.

The hole which houses the battery is formed by a cross cut that passes through the Top and Down Tubes. During the development of the frame, we realized that this hole could make the frame weaker. To solve this strength problem, we designed a special profile (number of the picture) reinforced with two walls that divided it into three sections. This special profile allow us to make the hole of the battery assuring the strength of the bike.

To develop this frame we also considered the question of style. We wanted this bike to be Swedish-styled, innovate and unique. This aim was achieved with the combination of two kind of profiles (circular and elliptic), that makes the frame more aerodynamic and esthetic. Also a noteworthy point is the special use of the curve that makes the frame more continuous and uniform.
Component description

Frame
Component description

**Frame**

- Material: Aluminum profile
- Colors:
  - Pantone Black
  - Pantone Cool Gray 3
- Surface finish: Anodizing

![Seat and Fork Tube profile](image1)

![Top and Down Tube profile](image2)
Component description

Fork

The fork is the component that joins the front wheel and the handlebar with the rest of the bicycle. For the design of this component the aim was to maintain the main character and aesthetics achieved with the frame. We want to emphasize the use of the curve and the combination of circular and elliptical profiles as we did before with the frame.

Putting the fork and the frame together, it can be seen that the two form a uniform set, with the same esthetic design and style.

Technically, as the frame, the fork is manufactured with aluminum profile, colored with Pantone Black and finished by anodizing.
Component description

Battery

The kind of battery selected for this bike is a lithium-ion battery. We changed the dimensions and shape of the original one to make it easier to carry, insert/extract and recharge.

This battery has a saddle that can be hidden inside it to make the bicycle more esthetic.

Because it is not a standard battery, it is necessary to find a Li-ion Battery manufacturer that help us to find the way to be able to manufacture this battery design.

The next pictures show the main dimensions and the appearance of our battery.

The handle makes the battery easier to carry

In this side of the battery are placed all connectors and the indicator Led
Component description

**Battery Support**

This component serves to attach the battery to the bike and to connect the battery to the electrical circuit.

With this battery support, the process of connecting the battery to the bike is considerably reduced because the user doesn’t have to connect cables. All the connectors between the battery and the bike are located in this component. As the pictures below show, the battery support is assembled to the bike just with two screws.
Component description

**Handlebar**

The handlebar is made by steel circular profile with a 18 mm diameter. To make it more ergonomic and to continue with the style and appearance of the bicycle we decided to bend the extremes like the pictures below show.

The innovative support of the handlebar has been also bent in such a way to give the bicycle a more unique look.
Component description

**Fenders**

Back wheel fender
Material: Chrome plated steel.
Installation:
1. Screw the fender to the hub of the Frame (2).
2. Screw the fender to the Frame (3).

Front wheel fender
Material: Chrome plated steel.
Installation:
1. Assemble the fender to the hub of the fork. (5).
2. Screw the fender to the Fork (6).
Cables distribution

Thank to the new location of the battery, all the connections between the battery and the rest of the electric circuit are placed inside the frame. The only cable that will be seen is the one that goes from the engine to the battery support. As the picture bellow shows, this cable goes out from the fork and gets into the frame through the extreme of the Down Tube.

With regards to the mechanical cables, there are only two cables that will be seen. One of these cables belong to the gear control and the other one belongs to the front brake. As the picture below shows, the cable of the gear control goes into the frame through the extreme of the Down Tube, and the cable of the front brake goes out from the fork and is connected directly to the brake lever.
Standard Components

- Wheels: 47-622 black aluminum

- Tires: Schwalbe
  Basic-Road cruiser: The new profile offers good grip and quiet running. 700x40 (mm)

- Seat: Selle Royal Look-in
  Code: 5236HEC
  Line: LOOKIN
  Style: Relaxed
  Price: 98 SEK
  Length: 270
  Width: 199
  Structure: Elastomers
  Weight: 755

- Rear Hub: 7 Speed SRAM® Spectro S7 with drum brake
  Optimal gear ratio for equalized steps between gears, smaller first gear for climbing steeper hills with increased range (303%), better shifting performance into first gear.

  Price: 600 SEK
Standard Components

- Motor 36 V 10 A
  EBM03 (non-brush and non-gear)
  Mini Motor Feature: Small, light, maintenance free.
  Performance:
  Voltage: 36V  Rated Power: 150-500W
  Rated Efficiency: ≥65%
  Load Speed: 15-35km/h

- Front Wheel Brake lever: Shimano BL-IM45 Brake Lever
  Price: 200 SEK
Using the battery

Inserting

1. Transport the battery to the bike, handing it by its handle.

2. Position the battery perpendicularly to the Top tube of the frame

3. Start inserting the battery maintaining the perpendicular position to the frame

4. Continue inserting until the battery touches the battery support.

5. Press until you hear a click. That means that the battery is connected.

6. Hide the handle inside the battery.
Using the battery
Extracting

1. Press in the handle to extract it.

2. Grab the battery by the handle.

3. Start extracting the battery.

4. Extract the battery perpendicularly to the frame.

5. Transport the battery handing it by the handle.
Using the battery
Recharging

1. Place the battery on a stable surface near an outlet.
2. Connect the cable provided to the battery as shown in the image.
3. Connect the cable to the outlet. After that, a red light will indicate that the battery is charging. When the battery is full, the light will turn off. If the battery is totally empty, the recharge of it will take around 5 hours.
Looking for a manufacturer

Taking a look at the brief (page 3) and analyzing the situation of the market, we conclude that VOLVO would be interested in making our bike. These are some of the reasons that make us to conclude this:

• VOLVO is a Swedish brand that manufactures vehicles.
• As we said in the brief, our bike must have a Swedish style and philosophy, like the VOLVO’s products have.
• This brand could easily manufacture the bike because they have the technology and resources to make it possible.
• VOLVO is a brand interested in eco friendly vehicles and they are already manufacturing some eco friendly cars, so producing this bike they will be seen as a brand that respect the environment, improving their projected image to the customers.

The brand will be shown in the front of the bicycle as the picture below shows.
Volvo has recently developed eco friendly car models supported by the logo “Drive”. These cars achieve emissions figures as low as 104g/km and 72mpg.

We have redesigned this logotype (“Drive”) that are used with the eco-friendly cars to be used on our electric bicycle. The new logo uses the same typography and colors as the original, but uses the word “Ride” instead of the word “Drive”. This logo will be seen in the front face of the battery as the picture below shows.
Different versions

To expand the market of our e-bike, four different versions of the e-bike have been developed. In this manner, potential customers may choose their favorite one.
Different versions

Frame
Pantone 185

Saddle Support
Pantone Black

Direction Hub and Fork
Pantone Black

Fenders
Pantone Cool Gray 3

Frame
Pantone 165

Saddle Support
Pantone Black

Direction Hub and Fork
Pantone Black

Fenders
Pantone Cool Gray 3