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# City-Bike Maintenance and Availability

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# Abstract

This report analyzes the Copenhagen City-Bike Program and addresses the availability problems. We depict the inner workings of the program and its problems, focusing on possible causes. We include analyses of public bicycle systems throughout the world and the design rationale behind them. Our report also examines the technology underlying "smart-bike" systems, comparing the advantages and costs relative to coin deposit bikes. We conclude with recommendations on possible allocation of the City Bike Foundation's resources to increase the quality of service to the community, while improving the publicity received by the city of Copenhagen.

# Acknowledgements

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# Executive Summary

This project was completed in fulfillment of the Interactive Qualifying Project for Worcester Polytechnic Institute. It was sponsored by the Danish Cyclist Federation, the European Club for Cycling Friendly Cities, and the City of Copenhagen. Our goal was to document the political, financial, and physical aspects of the city-bike program; examine the real benefits of the system; and give recommendations which will increase the quality of the program to Copenhagen and its community. The solution should address the bike availability problems the program is currently experiencing.

Copenhagen is a city of 1.25 million people. The flat landscape and numerous bike lanes make the city ideal for cyclists. The Copenhagen City Bicycle Program (CBP) was founded in 1995 to help ease inner city traffic and pollution. Currently there are 1,200 bikes that can be released from one of the 115 racks with a coin deposit. The system is funded through the sale of small billboards near the rack locations throughout the city and by sponsors of individual bikes for advertising space on the bike's wheels.

With new administration and a new contract selling the use of the billboards near the bike racks, the coin-deposit bike program is currently expanding rapidly. The City Bike Foundation has just purchased over 1,000 new bikes. In 2003, with 2,500 bikes and 1,500 spaces across the 115 racks, there are two possible scenarios. Either there will continue to be great theft and misuse in the system, which will allow the 1,500 spaces to be sufficient even in off-peak hours, or the theft and misuse will decrease and the rack space will be insufficient for the number of bikes.

During use, the bikes are not allowed to be locked with a personal lock or ridden outside the designated downtown area. The city-bikes are made from non-standard parts

to discourage theft. To avoid potential maintenance problems the bikes have only one gear and solid rubber tires.

Maintenance is done by the Reva Center, an agency whose goal is to perform a social service to the community. They accomplish this by training the unemployed to fix bicycles and eventually re-introducing the workers into the workforce. They are not paid by the City Bike Foundation, making it valuable for the program.

Although the bikes are fairly durable and Reva is doing a fine job maintaining the bikes, the City Bike Foundation spends $75 per year on each bike for maintenance and collection. Considering each bike costs only $200, $75 is a considerable amount to be spent on maintenance each year. This high cost is almost entirely due to vandalism and abuse. The most common task Reva faces is repainting the bikes, ridding them of graffiti. Vandals also cause physical damage to the bikes and locks. Only about a third of all maintenance cost is spent fixing problems caused by normal use. Vandalism is not just a problem because it drains funds of the program, but because it defaces the system making it hard to sell sponsorships for bikes.

The city-bike rack lacks support for the bicycle, meaning the users are relied upon to use the kickstand when returning a bike. Frequently, bikes whose kickstands are not used fall over causing damage to the bikes. These fallen bicycles make the rack appear disorganized to the sponsors, residents, and visitors.

There are rarely more then 200 bikes in the maintenance center, leaving a minimum of 1,000 bikes on the streets. With 115 racks locations, 1,000 bikes seem adequate, yet bicycles are rarely available. This is because some users are abusing the sharing principles on which the system was built. Some will borrow a bike for a week or

longer, treating it as their own. Other people will not have the courtesy to return the bike to a rack when they are done using it, making fewer bikes available on the racks. Both of these problems are a result of a lack of incentive to return the bike in a timely manner. The bike is free regardless of the amount of time for which it was borrowed. Valued at about two and a half US Dollars, the coin deposit is not enough to stop people from abandoning the bike when it is convenient for them to do so. The program's rule of not allowing use of the bikes outside the inner city is not enforced effectively and the boundaries are often ignored.

Although many city-bike programs are started to reduce traffic congestion, this benefit is questionable. The bikes are most often used instead of walking or other forms of public transportation, neither of which significantly add to automobile congestion inside a city.

Public city-bikes serve two important purposes to a city and its community:

- Public transportation
- Good publicity

The city-bikes provide public transportation to the city's residents and visitors. The quality of this service is quantified by the amount of use each bike receives. Due to prolonged uses and unreturned bikes, a poor level of sharing occurs in Copenhagen. A lack of sharing leads to the unavailability of bicycles on bike racks. This greatly diminishes the system's value to the community. Just as a well working bus or subway system increases the quality of life in a city, a well working city-bike system could make life of the residents easier and more enjoyable.

City-bikes are used in promotional material describing and presenting the city. The Copenhagen system currently generates mixed publicity. Although it is an innovative idea, the system is plagued with problems. These problems result in negative publicity. Copenhagen could benefit greatly from the publicity generated by an impressive, successful city-bike program.

The smart-bike system is one where people insert a key card, similar to a library card, into a rack terminal to remove a bicycle. The key card exchanges information with the rack regarding the user and the bike being borrowed. This information is stored by the system, meaning that if the user does not return the bike the controlling organization will know and have the ability to penalize him with a fine. Also, because the smart-bike technology removes the anonymity of the system, it will deter theft and abuse. The data collected by the system allows the organizers to monitor the use and possible problems with the program; this usage data will also be valuable in selling bike sponsorships. To increase sharing the organizers can, for example, penalize users for trips over one hour, promoting timely returns and sharing of the bikes.

We considered a number of potential options for uses of the City Bike Foundation's funds over the next several years. We examined several scenarios and have a collection of recommendations:

- **Add support for the bikes on the city-bike racks**
- **Observe vacancy on bike racks in the coming years to see if more rack space is required to support the 2,500 bikes**
- **Start allocating resources for a smart-bike bike system**
- **Collaborate with foreign companies developing smart-bike systems**

- **When a smart-bike system is available that suites Copenhagen's needs, implement the system on a large scale, replacing the coin-deposit bikes**

The features Copenhagen should look for and implement in a smart-bike system are listed below.

1. **Dual locking system**
   Prevents theft

2. **Per-minute charge**
   Promotes quick return of the bikes, increasing sharing
   Provides revenue to the City Bike Fund

3. **Booking service**
   Reserves a rack space at destination, ensuring the bikes return

4. **Ability to accept bank cards or credit cards**
   Alleviates a setup procedure

5. **Comfortable bikes**
   Increases quality of service to the user

6. **Ability to personally lock bikes, other then at racks**
   Makes the system more convenient to user

7. **Durability: low maintenance physical bike design**
   Keeps more bikes available to the community and decreases costs

The adoption of a smart-bike system with these characteristics will increase the quality of the system to the users and the bike sponsors, while being impressive and creating good publicity for the city.

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# 1.0 Introduction

Many modern day cities are plagued with heavy traffic and pollution. As the population increases, it becomes more of a necessity to achieve a balance with the environment and our growing transportation needs. Convenient public transportation that meets these needs and growing health concerns is of great value for today's cities.

Modern cities commission subway and bus systems to alleviate automobile traffic. Taxi services have become big business in many cities by offering the great convenience of door-to-door service. None of these widely adopted transportation methods satisfy our needs without in some way harming the environment.

Bicycles emit no pollution and offer door-to-door service. In many European cities, bicycles are given a separate lane beside cars, making cycling a safe and practical method of daily transportation. A few cities have adopted a program called City-Bike.

Currently there is a City-Bike Program (CBP) providing bicycles to the public in the metropolitan area of Copenhagen. For twenty DKK ($2.40), an individual may take a bicycle from an automated rack. The deposit is refunded upon returning the bicycle to the rack at or near his destination. Currently the CBP employs several maintenance vans that collect city-bikes for repair. These vans and the bikes themselves are funded by the City of Copenhagen and by private sponsors who advertise on the bikes.

Although very successful, Copenhagen's CBP is not without its problems. There is a general shortage of bicycles available for use on the city's bike racks. Theft, extended borrowing periods, and unreturned bikes all contribute to this shortage. Corporate and municipal sponsors currently fund the upkeep and expansion of the program.

We mapped out the CBP from an organizational perspective to understand the responsibilities of each group involved with the program. We examined the bicycle maintenance and distribution within Copenhagen, with the aim to increase the number of bicycles available to the public. One method of increasing the number of bicycles available to the public is a smart-bike system using smart cards to track bikes and the user of each bike. With over 37% of the cost of each bike being spent on maintenance per bike each year, one goal was to lower maintenance costs. We addressed the cost incurred by normal use, misuse, and vandalism of the bikes and racks. We also examined the physical design of the city-bike, looking for ways to lower maintenance costs.

The following report gives an overview of the transportation options within modern cities and illustrates the need for public bicycles. Also enclosed in the report are several case studies of other city-bike programs around the world. We also describe the methods that we followed in Copenhagen that ultimately allowed us to give an intelligent recommendation to the CBP. Some of these methods included research, fieldwork, site inspections, and interviews. We conclude with our results and recommendations to our sponsors: the Danish Cyclist Federation (DCF), the City of Copenhagen, and the European Club for Cycling Friendly Cities (appendix A).

# 2.0 Background Information

This chapter documents our research relating to city-bike programs in and outside of Copenhagen and other relevant issues.

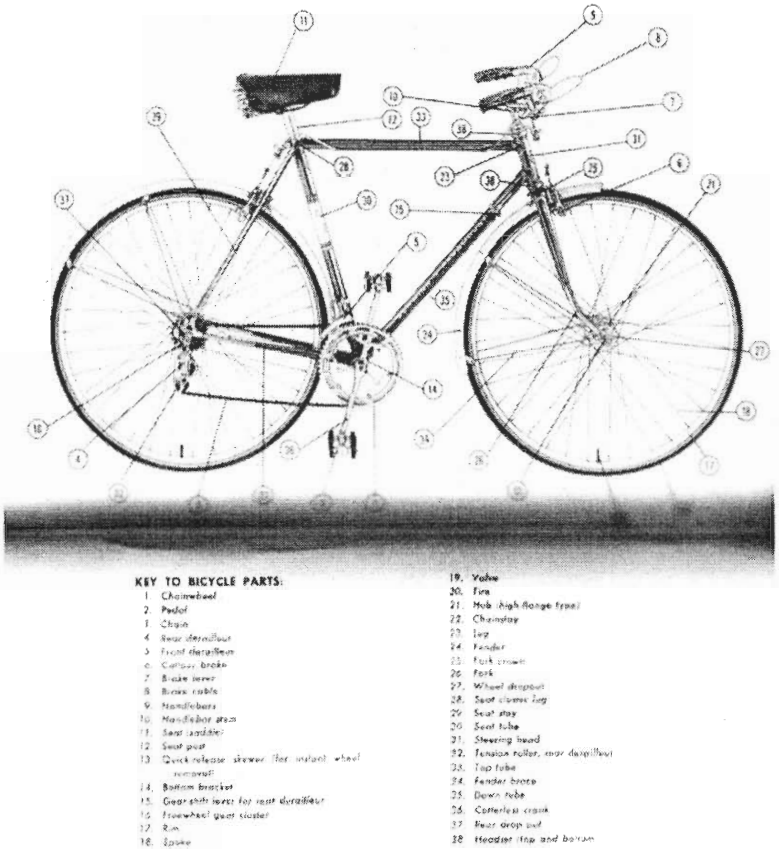


**Figure 1. Parts of a bicycle**

## 2.1 Transportation

While cities are overcrowded and roads are increasingly becoming congested, the public still demands convenience in its transportation. Also, air pollution is becoming a greater concern because it directly affects personal health. Cities want to treat

transportation as a right of the citizen and not a luxury; therefore affordable, environmentally friendly transportation should be available.

### 2.1.1 Cars and Taxis

The two modes of door-to-door transportation that are most common in cities are personal cars and taxis. While cars are perfectly convenient, they are expensive, and parking is difficult or impossible to find. Taxis are also very convenient, but very expensive per kilometer. Both of these are very inefficient uses of raw materials and human resources. Personal cars are often one per party, while taxis facilitate many parties per vehicle. This allows cities to fulfill transportation needs without manufacturing or importing as many automobiles. Taxies, unlike cars, are "on" almost all of the time whether in use by a customer or not. This makes the pollution of a taxi solution worse than personal cars.

### 2.1.2 Buses and Subways

To alleviate traffic congestion cities deploy bus and subway systems. Although these systems do pollute, they are much friendlier to the environment than personal cars or taxis because each vehicle can host many parties at a time. They are, however, less convenient, because a user must know (or learn) the time schedule of the system, and then wait for the appropriate bus or subway car at a specific stop or station. While these solutions may pollute less than cars or taxis, they still add to the 25% of the carbon dioxide emissions into the atmosphere, for which the transit sector is responsible (Danish Government, 1 February 2002).

### 2.1.3 Bicycles

Initially thought of as a poor-man's-car, the personal bicycle has been growing in popularity in recent years for many reasons. A bicycle, unlike a car, is affordable to a vast number of people inside the city. Bikes do not require expensive fuel and maintenance is rare and inexpensive in comparison to an automobile. Instead of looking for a parking spot a cyclist may lock his bike to streetlight, bench, or bike rack. This allows a cyclist to use his bicycle as a door-to-door mode of transportation.

An important benefit to using a bicycle to travel is exercise. This is especially important today when many people are spending their free time and money exercising in a gym. Because of traffic congestion, the average speed of bicycles in a city may be higher than that of cars. In cycling-friendly cities, cyclists even have their own lanes to travel in safely.

Although much more affordable than cars, bikes can still cost several hundred dollars and some people may not be able to afford one, especially with the risk of theft. Even though most people invest in a lock for their bicycle, one and a half million bikes are stolen each year in the United States (National Bike Registry, 1 February 2002).

## 2.2 History of Bicycles

In 1791, the first bicycle was invented in the gardens of the Palais Royal in Paris, France (Oliver 1). The first bikes were made with wooden wheels. They could not be steered because of the way the wheels were designed; this prevented them from being turned. A revolutionary modification that occurred in 1817 was the addition of a steering

mechanism for the front wheel of the bike. Charles, Baron von Drais, of Sauerbrun devised a way to move the front wheel of the bike to change the direction of riding without having to lift, drag, or jump the front wheel. He also altered the saddle to make it padded and added an armrest to the front of the bike which exerted more force against the ground and increased its speed. Von Drais called his invention a *vélocifére* and patented it in 1818, but in about 1869 the term bicycle came into use.

In 1863, pedals were added to the front axle of the wheel. The credit for this important milestone goes to Pierre Michaux or his assistant Pierre Lallement; there is an uncertainty as to which one of them really deserves the credit. In 1868, the Hanlon Brothers of New York City suggested that rubber be used for the wheels. The rubber wheels made less noise and helped prevent slipping. Many developments have been added since then to improve bicycle performance and reliability (Oliver 5).

## 2.3 Public Use Bikes

To address some of the people who cannot or choose not to buy and use a bicycle, many cities have implemented some form of Public-Use Bicycles (PUBs.) The general idea is that, for little or no cost, a person can take a city-bike, use it to get to his destination, and drop it off for someone else to use. This combines the convenience of door-to-door travel and not having to wait for a bus, train, or taxi. Cyclists also benefit from PUBs by the exercise they do while transporting themselves. A user can also choose the path he will take, which may be scenic or a shortcut. City-bikes, like all bicycles, produce no environmental pollution other then the extra carbon dioxide exhaled by the cyclist during his travels, which he would have exerted anyway at a local gym.

Regardless of how the system is implemented, it is far less expensive, per person, then a metro, bus, or taxi service.

Inherent problems do exist with PUBs. Because of the nature of cycling, PUBs cannot be relied upon year-round in many cities. Snow or ice would make cycling very dangerous. One might argue that this limits the environmental benefit of cycling because the other forms of public transportation must still be large and vast enough to handle traveling needs without bikes. While people may use other forms of transportation less during cycling seasons, the other forms of transportation are still established to be able to handle many commuters. Some of these transportation systems might pollute the same amount whether people are using them or the bicycles. For example, the subway is always operating regularly, winter or summer, even if more people are taking bikes during the summer.

Another problem is that the PUBs can be abused for someone's personal convenience. Instead of leaving the bike for others to use, one might keep it in his flat, so it is convenient and available the next time he wants to use it.

Furthermore, bicycling is limited in many cities because of the terrain and geography of the region. Steep or unsafe paths make nearby destinations inaccessible to bicyclists.

Many different implementations of the idea of a bicycle as a free public transportation device have been tried. For the sake of organization, these implementations are generally categorized into four generations of PUBs (Commuter Choice/Bicycling Programs, 3 February 2002).

### 2.3.1 First Generation PUB

First generation programs are popular due to the low setup costs. Cities implementing this system simply collect bikes through donations, paint them, fix them, and put them out on the street. With no methods of preventing theft, many of these bikes that are distributed on the streets wind up stolen and are often taken apart for parts. Because these are donated bikes of various brands and quality the maintenance need is frequent and costly. Being regular bikes, they are not meant to be ridden constantly and may not be up to the challenge. Poor quality of the bikes, as they incur heavy use, may result in a safety hazard to the user of a bike that is partially broken or on the verge of problems.

### 2.3.2 Second Generation PUB

Second generation public use bicycles became popular after Copenhagen launched the first such a program in 1995. The implementation costs are much higher than first generation schemes because the bikes are not consumer level mass-produced bikes, but custom designed for extremely frequent use. These bikes are not light or fast, but are designed with equipment like extensive splashguards and tires that cannot be punctured. Lights, which go on when the bike is moved, appear on many of these bikes. Only one gear is used to prevent the frequent maintenance issues that arise in multi-speed bikes. This emphasis on durability makes it possible to administer several thousand bikes in a city with only a handful of maintenance personnel. This makes the program manageable and the total cost of administration very light compared to what it would be

with regular bicycles. Much of the cost is offset by hosting a program for corporations to sponsor bicycles, in return for which the bikes carry the sponsor's advertisements.

It is no wonder that the Copenhagen second-generation PUB implementation is the longest running PUB system in the world. These bikes are manufactured using nonstandard parts. Dismembering the bikes for parts is no longer an issue, as these are useless to someone missing a part on their regular bicycle. Located throughout the city are special bicycle racks from which people take the bikes and to which they are returned. The use of these bikes usually involves a small deposit satisfied by the nation's largest coin. There is a custom lock mechanism that will only release a bike when a coin is inserted, and releases a coin when a bike is returned. Although no one would steal these bikes for parts, an individual may steal one to use outside of the city as his personal bike. A thief could simply deposit a coin, and take the bike in his car and drive it to his home outside the city. No identification or information of any kind about the borrower is taken or recorded when the bike is borrowed. Usually the city administrating the system will give a large fine if a person is caught with a PUB outside of the city. Since the deposit is small and the system is entirely anonymous, some people can abuse or totally destroy a bicycle without any liability. People can also take a bike from a rack and keep it for weeks or months at a time, inside the city at their flat. This behavior cannot be easily solved in current second generation PUBs.

### 2.3.3 Third Generation PUB

Third generation PUBs, or smart-bike systems, build upon the good qualities of second-generation implementations but add some intelligence. This generation improves

upon the second mainly in theft deterrent technology. Depending on the particular system, a magnetic stripe card, instead of a coin, is inserted to release a bicycle. The card has personal information about the borrower, so that the city can track the use of the city-bikes. The city can send a bill if a bike is not returned or is borrowed for extended periods of time. This system is somewhat less convenient because the user is required to register for a card. The problem of theft is greatly diminished by this method of gathering personal information about the borrower at the time he borrows a bike. The same card is inserted when the bike is returned and the user's account is credited with the return and is again given the ability to borrow a bike. Because of the technology involved, the bicycle receptors are much more expensive to produce (Commuter Choice/Bicycling Programs, 3 February 2002).

Many of the third generation PUB solutions are done by the Clear Channel Adshel Corporation. They call their implementation SmartBike. This company also makes such contraptions as automatic toilets and bus shelters. What they call the SmartBike is a PUB with many physical features of a typical third generation PUB. A notable difference is that the bike has five speed gears and both front and rear brakes. The entire solution that they sell includes the docking console, control computer, card readers, and information panels (SmartBike, 20 January).

### 2.3.4 Fourth Generation PUB

Fourth generation PUBs are being developed. These are the same as third generation implementations, except that instead of magnetic stripe cards, the users' data are stored on a smart card. A smart card houses a chip that can store personal data or

other relevant information. This system is great for cities with a large distribution of smart cards established because of another system. In Washington D.C. over 175,000 people already have smart cards because they are used for the city Subway system (Commuter Choice/Bicycling Programs, 3 February).

## 2.4 City-Bike Programs in the United States

There are over fifty city-bike programs in the United States. Some states that have such programs include: California, Georgia, New York, Washington, and Wisconsin. There are more states than just the ones mentioned above that have community bike programs.

In Arcata, California, the Arcata Community Bike Program has two types of bikes: community bikes and library bikes. The community bikes are painted bright green to discourage theft and have a sign to indicate that they are community bikes. They can be picked up from any area in Arcata and left anywhere as long as they are visible to other users. There are no specific racks where the bikes are to be returned. The library bikes, on the other hand, are not as readily available. The Library bike deposit is $20. The deposit is returned when the bike is returned. The bike can be rented for up to six months at a time; after six months the bike must be returned or renewed (Arcata Community Bike Program, 5 February 2002). The main differences between these two types of bikes are that the library bikes can be rented out for longer periods of time, but for an initial deposit, whereas the community bikes are less restrictive.

In Dectaur, Georgia, the city calls its bike program Dectaur Yellow Bikes. The bikes are available for those who are older than sixteen years of age. The bikes must be

picked up and returned to the public rack areas. It is suggested that the user checks the bicycle to make sure that it is safe to use before actually renting it. The user should wear a helmet and follow the rules of the road that apply when using a bicycle (Decatur Yellow Bikes, 5 February 2002).

As bikes are becoming more popular as a form of transportation, cities are organizing programs to encourage people to use bikes within the city. Troy, New York will start its new CBP in August 2002. The mayor of Troy, Mark Pattison, has donated bikes to the Troy RiverSpark Visitor Center. The bikes were previously resting in a storage area as property of the city police department. It was thought that they serve the community better as a part of this program. The Visitor Center will use the bikes for historic, cultural, and self-guided tours. The bikes can be borrowed at the Visitor Center for $20; this deposit will be refunded when the bike is returned. Helmets, bells, and locks donated by a local bicycle store are provided with the bright orange bikes (Troy United Newsletter, 5 February 2002). Sightseers biking through the city will see a new perspective of the area.

The city of Madison, Wisconsin has two CBPs: the Red Bike Program and the Yellow Bike Program. The color distinguishes the benefits and restrictions of the bike. The red bikes are distributed for free without any pickup or return area, whereas the yellow bikes have to be checked out with a $75 deposit. The benefits of the yellow bike are that the lock and helmet are provided for the user. The deposit is refunded when the bike is returned (City of Madison Pedestrian-Bicycle Program, 6 February 2002). Having two types of bike programs is useful because the user gets to choose which is more convenient.

## 2.5 Maintenance

Before improvements can be made on the mechanics of a bicycle, it is important to understand its working parts. Also important are the applicable technologies that are available in today's market.

Each genre of cycling hosts its own unique bicycle, catering to the specific needs of the user and the bike's terrain. For example: mountain bikes frequently have shock absorbers on the front fork, and a wide tire base for dirt, mud, and gravel riding. Racing bikes are often made with carbon fiber frames, with extremely light tires, and no extra features that will weigh down the rider.

There are five distinct parts of a bicycle: the frame, wheels, gears, operator devices, and brakes. Each part is dependent on the others, as they all function together to keep the bike moving.

### 2.5.1 The Frame

The frame is the backbone of the bicycle. Usually made of aluminum or steel, the frame consists of the following parts: the top tube, seat tube, down tube, forks, and lugged fittings (Safeco, 4 February 2002). The tubes are the actual beams of metal that make up the frame and the forks extend away from the tubes to hold the wheels in place. The lugged fittings are an extra feature on some bicycles that support the joints between the tubes.

One of the most important parts of the frame lies on the inside of the tube. The best bicycle frames are thicker at the joining ends and thinner within the middle. This

technique, called *double butting,* adds extra support in the joints of the bike where stresses are the highest (Whitt 251).

Lugged fittings perform a similar task. These metal supports at the joints of the frame aid in structural support. They also allow the tubes of the frame to be connected without heavy electric welding. Electric welding increases the temperatures of the metals within the tube, and can often cause tiny fractures or imperfections within the metal (Sloane 45). These imperfections cause further thermal stresses on the joints of the bicycle. For this reason, heat treated aluminums, which can resist some thermal stresses, are a better choice for frames.

### 2.5.2 The Wheel

The wheels of the bicycle are a key contributor to the efficiency and effectiveness of the bike's motion. Since the wheel is the only part of the bicycle touching the ground, the slightest change of texture, air pressure, or size will make a significant impact on riding. The wheel consists of the following parts: the tube, spokes, rim, hubs, and valves (Ewers 19).

There are three main types of tires: clincher, tubular, and solid. Clincher tires are best characterized by the "U" shape of its tube, while their tubular counterparts are typically "O" shaped (The Skinny on Tires, 6 February 2002). Tubular tires are lighter and of slightly higher grade than the clincher tires, however clinchers have a distinct advantage in that they are much easier to replace. A tube within the clincher tire extends between the surface and the rail and is easily removable and replaceable. Until recently tubular tires were considered considerably better then clincher tires. Today, after heavy

development, the clincher tires are now comparable with tubular tires on the road as well as in the shop.

The solid tire is an entirely different type. Typically seen as tires of the past, solid tires make cycling uncomfortable and are often looked down upon by the bicycling community. There are, however, definite advantages to solid tires. While they might provide a less comfortable ride and decrease the efficiency of bicycle, these tires require little maintenance and are puncture proof. While solid rubber tires are most common, there are other alternatives available. Cyclo manufacturing claims to have developed a puncture proof tire using lightweight polymers (Cyclo Manufacturing Company, 6 February 2002). Although these lightweight solid tires may not be considered mainstream yet, the introduction of modern materials into cycling will provide constant advancements in bicycling dynamics.

The size of the wheel is an important characteristic for all types of tires. The larger the diameter of the tire, the easier it is for the cyclist to travel. With larger tires, however, some maneuverability is lost (Henkel 33).

### 2.5.3 The Brakes

Brakes are an intricate part of the bicycle. There are many different kinds of brakes, including: caliper, cantilever, center-pull, coaster, disk, double pivot, drum, roller, side-pull, single pivot and spoon brakes (Sheldon Brown's Bicycle Glossary, 7 February 2002). Brakes on modern cycles are most likely a version of the side-pull caliper, or center-pull caliper brake mechanism.

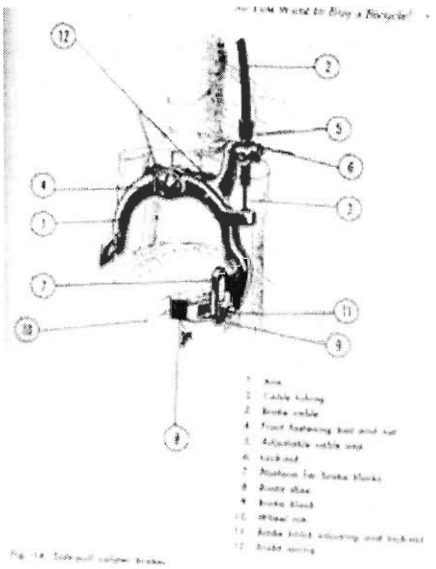

**Figure 2. Brake Parts**

The side-pull brake apparatus uses the brake cable to squeeze two metal arms together that are attached to the brake shoes (see figure). These shoes press against the rim of the wheel and will stop the bike. It is called a side pull because it comes from one side of the wheel. On the contrary, the center-pull brake cable comes down from directly above the wheel. It connects to two other cables, usually at a yoke, and then connects to the arms and stops the wheels (Henkel 32). Because of the importance of brakes, these devices should be checked regularly for flaws.

### 2.5.4 The Gears

The most complicated and most important parts of the bicycle, with respect to producing motion, are the gears. The gears translate the power from the cyclist's legs, into the movement of the tires. The parts of the gears are: pedals, chain, front and rear chain wheels, front and rear derailleur, and derailleur rollers (Henkel 29).

When the cyclist pedals, the front chain wheel turns. This turning process pulls the chain, which then turns the back chain wheel, and the bike will begin to move forward. This alone is a simple process. Complication arises, however, when the gears are changed.

The derailleur is a complex device that will move the chain between different sized chain wheels. The differences in sizes allow different amounts of force to go to the wheels at the same pedaling speed.

### 2.5.5 The Operator Devices

While riding, a cyclist certainly should not have to think about the functionality of the derailleur. In fact, the only things that should concern the operator are those devices, with which he has direct contact. These include the handlebars, break levers, seat, and any accessories (bells, water bottles, etc...). These devices pertain to operation and comfort.

The handlebars have two purposes. They allow the operator to steer the bicycle. They also must give some amount of comfort to the cyclist. The handlebars should be easily adjustable for any angle between 10 and 70 degrees (Sloan 93). The greater the angle, the more upright the handlebars rest. Also included in the handlebar package are break levers, handgrips, and occasionally a light or bell. Depending on available funds, the quality of these devices can be improved; however, these basic devices will not influence the efficiency or performance of the bicycle.

The bicycle seat is a crucial part of cycling enjoyment. Often even the most halfhearted bike rider will spend extra money to add comfort to the seat. Over long

periods of time, the biker can experience great pains from an uncomfortable seat. Recent advancements in technologies for bike seats and the seat post have improved comfort significantly over older models. It is not uncommon to find seat posts with shock absorbers, or high quality carbon and steel tubes (Ultimate Support Systems, 31 January 2002).

### 2.5.6 Tools and Upkeep

Even with extensive knowledge, without the proper tools, repairing a bicycle would be very difficult. Many different tools are required when a large amount of maintenance is needed. Each part of a bicycle requires different tools to repair, but there are certain instruments that will facilitate the maintenance for most bike problems.

The Allen wrench is the first and foremost tool for bicycle repair. Most joints of moving parts are held together with a hex bolt. A six-millimeter Allen wrench will assist in most simple tightening problems (brakes, gear cables, derailleurs). More specific problems will require more specific tools.

Maintenance is a very important part of bicycle upkeep. One of every five bicycle accidents that occur is caused by some sort of mechanical failure. With proper upkeep and maintenance, many bicycling accidents can be avoided.

## 2.6 Copenhagen City-Bike Description

The city-bike is made to endure heavy usage. Solid tires are used to hold up against punctures. The seats of the bike can be adjusted easily in height to accommodate

different sized users. The parts used to make the city-bikes are not the same as the ones used to build standard bikes.

Since many of the city-bikes are sponsored, they host many advertisements. Experiments were done to see how effective these advertisements really are. One such experiment has shown that advertisements on wheels going up to fourteen km per hour are still legible. Another such experiment shows that sponsoring twenty-five bikes is less expensive than printing out a full-page advertisement for up to eight months. The bike sponsor can put an advertisement on the wheel of the bike or on the bike racks.

## 2.7 Bicycle Racks

Rack design is one part of the Copenhagen program that needs attention. Currently, the Copenhagen city bicycle program uses a simple bike rack that consists of a long cylindrical tube with two ground supports and five chains, each of which can be connected to a bicycle. Alex Sully, a Senior Bicycle Planner for WS Atkins South West in the UK, designed a series of criteria which defines a good bicycle rack. Some of these criteria are:

1. Visible
2. Accessible
3. Secure
4. Covered
5. Affordable
6. Easy to use
7. Location
8. Attractive
9. Coherent
10. Able to maximise the involvement of other 'partners' and funding sources
11. Linked to other needs of cyclists.
12. Part of a 'Cycling Culture'

These criteria however, apply most accurately to a standard bike rack, one to be used with privately owned bicycles. City-bike racks do not need quite as many options available because they can focus on one specific type of bicycle, with one specific purpose. For example, one might expect a public bike stand to be versatile and able to be used with all bicycles. This would not be necessary for a standardized bicycle unit, like a city-bike.

While some options may be less important, others carry more weight, such as visibility, accessibility, location, and attraction. Because the CBP depends on advertising, potential sponsors must see the program as a worthwhile, important system.

One important aspect of rack development that is not included in Sully's list of rack criteria is support. The entire principle behind a bicycle rack is to provide support for bicycles. Without proper bracing, the bicycle rack will become disorganized and could result in damage to any parked bicycles.

Bicycle racks can be organized into two types: horizontal and vertical racks. Most racks to be found in cities are horizontal, as these types are easier for the user and cheap to produce. These bike racks typically consist of a bracket that will hold the front wheel of the bicycle between two pieces of metal tubing. This provides support for the front of the bicycle and ease of use for the public.

The front bracket comes in a variety of shapes and sizes. Typically, these racks are designed to accommodate many different types of bikes. The city-bike racks, however, do not need this versatility.

## 2.8 Original City-Bike Program in Copenhagen

Two men, Ole Wessung and Morten Sadolin, started the Copenhagen city-bike program. One night, their bikes were stolen so they had to walk home from the bar late at night. They were very angry at the disrespect so they sat down and formulated the idea of free bicycles.

The project was started in 1989. Its purpose was to reduce the number of bicycle thefts in Copenhagen. The underlying idea was that the insurance companies would sponsor the city-bikes in order to reduce the amount of compensation for personal bikes being stolen. The plan was that the insurance company would spend the same amount of money or less on the free bikes as they did for the compensations. Wessung and Sadolin carried out this plan by having bikes made at a closed-down Danish shipyard. However, this project went bankrupt after only two years in 1991 (History of Copenhagen, 28 January 2002).

## 2.9 Technology

Many technologies available in some form today may be applicable to solving some of the maintenance, repair, and availability problems that plague the program.

### 2.9.1 Electric Devices

The 'electric fence' is commonly used for pets and shopping carts. Pets are zapped with an electric collar if they go outside boundaries set by a wire placed underneath an owner's yard. A wheel of a shopping cart at your local supermarket might have a device that locks the wheel when it leaves a designated area. Many safety issues

arise when talking about using this technology for bikes, but an alternative might be something that locks the wheels any time the bike is at a stop outside the usage limits. Another might be an alarm that goes off alerting the user and possible police officers that the bike is outside the city limits.

### 2.9.2 Beacons

A beacon system might be another possibility. City officials could home in on stolen or forgotten bikes, tracking a signal from some sort of electronic beacon. This tracking progress would require many officials and city dollars to accomplish. This also offers no compensation to the city or the program if someone destroys a bike, or simply leaves it somewhere without returning it to its rack.

### 2.9.3 Timed Devices

Timed devices that can be made to activate or trigger after a specified length of time could be useful for bicycling. A timed device might be used to make the bike unusable after twenty-four hours away from a city-bike rack. This would ensure a user does not store the bike in his flat for an extended period of time.

### 2.9.4 Smart Cards

Using a smart card or simple magnetic stripe readers, one could swipe or insert a card when he takes a bike. The user's identification information is electronically checked and stored, if the card is approved, a bike will be released. When the user returns the bike, the system will calculate any late fees that would be applicable. If the bike is not

returned at all, the city officials know to whom to charge. This would not only give motivation to return the bikes in a timely fashion, but would also serve as a record keeper to see what routes are used often and where bikes are at any time. This would require purchasing or designing a new bike receptor that accepts smart or magnetic stripe cards.

One issue that arises with all of these potential solutions is cost. A district for an electric fence the size of the city might be very expensive to implement. Along the same lines, the beacon requires enormous resources to track down these bikes, and if a bike is found damaged and abandoned, it is nearly impossible to know who to hold responsible. The smart card or identification readers would require adapting all 115 racks with the new technology. The costs of the information technology may outweigh the benefits.

# 3.0 Methodology

The project was carried out by doing a series of interviews, fieldwork, research, and site inspections. The data collected through these different methods was carefully evaluated to provide recommendations to the sponsors.

## 3.1 Interviews

In Copenhagen, we conducted numerous interviews. The goal of these interviews was to help us understand the CBP politically, financially, and physically. They also gave us insight into the problems of the system and how it can be improved.

To accomplish our first goal, we primarily spoke to the secretary of a mayor, the directing manager of the City Bike Foundation, and the manager of Reva, the city-bike maintenance organization. By getting the thoughts and opinions of these three separate organizations we were able to piece together the methods of operation by which the CBP runs.

Our first interview, with Christian Christiansen, was conducted in a semi-formal, un-standardized structure. As a secretary for the mayor of transportation and parks, Mr. Christiansen provided us with an important perspective on the operation of the CBP, and gave us insight into the political backing behind it.

Secondly, we interviewed Klaus Hildebrandt, the directing manager at the Copenhagen City Bike Foundation. Because he works directly with the advertising agencies, Mr. Hildebrandt was able to answer many of our questions regarding the sources of income for the program and how the funds are spent. We inquired about the history of the fund, the maintenance costs, and the responsibility of the involved

organizations. We also learned about the City Bike Foundation's plans for the bike program, their thoughts on the feasibility of smart-bike technology, and the role they play in gathering funds which pay for the program.

To learn more about the physical nature of city-bikes, we interviewed Kim Madsen. Mr. Madsen is the manager of the maintenance division of the CBP. This interview was also conducted with an un-standardized structure. During this meeting our questions focused more closely on the bikes themselves, their repair, and the methods of gathering and redistribution.

Within each of our first three interviews a few questions were standard. By keeping some of the questions the same, we were able to analyze any differences in responses to better understand each department's views on similar issues. Some of the common questions included:

- What is your responsibility with the CBP?
- Are you pleased with the current program?
- Who are the targeted users of the bike program?
- Who currently uses the city-bikes?
- Do you have any plans to change the program or your relationship with the program in the near future?
- Do you have any suggestions on ways in which this program could be improved?

As we conducted interviews, we began to learn which topics have greater importance to the inner workings of the city-bike system. Some of these topics included: location of the bike racks, vandalism, smart-bike possibilities, and the general Danish mentality towards the program as a whole.

Also, in an effort to dig deeper into the financial workings of the CBP, we decided to interview a member of the advertising agency: AFA JCDecaux. This company is in charge of the signs and billboards located around the racks and are an important part of the system. This phone interview was also conducted with an un-standardized structure. We were interested in the agreement between AFA JCDecaux and the city-bike fund and what responsibilities it assigned to the company. We also gained a lot of information regarding their general satisfaction with the agreement, and their thoughts on expansion of the program. We asked many questions regarding a consolidation of the advertisements on the bikes and the racks, and their interest in such a consolidation. The conversation gave us a feel for their general thoughts and concerns about the CBP, which is a welcome new perspective to examine.

We also interviewed a number of other individuals. We interviewed Søren B. Jensen, the original manager of the CBP, over the phone to get more information regarding the history of the CBP. Also, we talked to a number of other individuals, directly involved in CBPs in other cities, which gave us a better understanding of how to adapt Copenhagen's system.

Accumulating and evaluating the results from all our interviews, we were able to find key problem areas on which to focus our research and field work.

## 3.2 Research

Since many of the topics that we learned about in interviews were not part of our original plan, we found it necessary to do some extra research in these specific areas.

Some of these areas included research into vandalism, research into the campaign process, and a thorough analysis of the city-bike financial status.

After identifying vandalism as one of the main reasons bikes are brought in for maintenance, we decided to look more closely at the causes of vandalism and ways to prevent it. Also, we researched methods of removing graffiti and techniques to increase public awareness of the current defacement problems.

After deciding that some sort of campaign may be the best method of improving public awareness of vandalism, we decided to investigate the possibilities of having such a promotion. We talked directly to a member of the DCF to inquire about their current 'bike to work' campaign, what kind of work and planning is necessary to run a program like this, and what kind of success they are achieving.

Finally, we financially analyzed the CBP. By comparing the costs of the current program with other systems, our team was able to suggest the most practical ideas for improvement to the program. We also considered the cost of upgrading to a smart-bike system versus the cost of replacing the stolen bikes each year.

## 3.3 Other cities

The idea of providing public bicycles to the population of a large city has only in recent years become popular. To put a perspective on Copenhagen's unique system and situation, we looked at other cities currently planning or running a CBP.

We constructed a database, appendix H, of CBPs in various cities by research conducted on the internet. In this database we listed the applicable information for these cities and their bikes. Copenhagen has the largest program, but we wanted to gain some

perspective, so we listed the number of bikes used in each of these other city's programs. City population was very important to get an idea of the number of bikes compared to people and the total bicycle demand.

We also contacted a number of these municipalities and organizations involved to aid us in filling in our database of CBPs. These conversations focused on more specific topics. Very crucial in Copenhagen's case is the amount spent on maintenance and vandalism, so we noted if these other organizations were having similar problems with their systems. The cost of the various parts of each city's system was also noted. We also listed the structure of funding for the program in each city; while it might be very specific to the type of local government, an understanding of the structure was very valuable. The targeted users were also very important and often linked to how the system was funded.

We spoke with Mangor Eikeland, of the Sandnes CBP in Norway. He was very helpful with our inquiries and was willing to meet with us during our visit to his city. Upon our visit he gave us a tour of the premises, speaking of the technology involved in his system and its financial structure. We also learned about subtle problems with the system, which may concern Copenhagen if it adopted a smart-bike system. Our conversations often focused on the vandalism and maintenance cost that plague Copenhagen's city-bike system.

We also spoke with Luud Schimmelpennink from Amsterdam. As the manager of this city's highly technological CBP, we felt he would be able to give us important information on costs, problems, and benefits of a smart-bike system. We tried the bikes as well, so that a physical comparison could be made with Copenhagen's bicycles. By

testing other cities programs in this way, we were able to better understand CBP's in general, thus bringing us closer to possible recommendations.

# 4.0 Results

The following section includes results from the research involving Copenhagen's CBP. Information about quality, vandalism, and bike racks is also included, as well as any information obtained about CBPs from other cities.

## 4.1 Quality

The definition of quality varies between different parties. Below we have included a series of statements of quality for different groups involved with CBPs.

### 4.1.1 Statement of Quality to Billboard Sponsors

The quality of the system does not interest the billboard advertiser. The sponsor feels advertisements on the racks are unrelated and therefore unaffected by the city-bikes. Although the billboards are placed next to the racks, the advertisement is not directly linked to the city bicycles.

### 4.1.2 Statement of Quality to User

- Easy and inexpensive setup and registration
- When and where needed, a bike is available
- Hassle free and inexpensive borrowing and unlocking procedure
- Bikes must be comfortable, safe, and well maintained
- Simple locking and returning procedure
- Assurance that a bike will be available when needed again
- Vacancy at rack and simple returning process

These are the user's concerns with regards to the system. By addressing these concerns, the program will gain more respect from the users.

### 4.1.3 Statement of Quality to the Bike Sponsors

- Clean and graffiti-free bikes and racks
- Bikes properly positioned on the racks
- The bikes and system must be respected by the people viewing the advertisement

A bike sponsor has slightly different concerns. The sponsor is mainly concerned with the aesthetic nature of the system and the bikes they sponsor. They are also interested in public and user opinion of the bikes because high public opinion will make the bikes a more valuable asset.

### 4.1.4 Statement of Quality of a City-Bike Program to the City

- High number of trips each day per bike
- Low cost per bike
- Physically attractive system
- Good public image
- No competition with private businesses

The CBP influences the city and taxpayers on two accounts. First, it is a form of transportation, measured mainly in the amount of travel per dollar spent on the system. Secondly, it is used in promotional literature and presentations, thus attracting tourism. The publicity and knowledge of a system will influence the quality of the city. While

these benefits are hard to quantify, they are important to consider when determining the true value of a CBP.

Although many CBPs are started to reduce traffic congestion, we feel this benefit is questionable. These are three general types of people in the downtown area of a city: residents, commuting workers, and visitors.

A resident of a cycling friendly city like Copenhagen, who wants to cycle, will typically own their own bike. With the choice between a personal bike and a city-bike, the resident will chose his personal bike for convenience, assured availability, and comfort. For this reason, most residents would not use city-bikes regularly.

Many individuals drive to the city on a daily basis. This trip is usually from a location outside the city-bike limits and could not be alleviated with city-bikes. Commuters coming by train might use a city-bike to go to work from the station, but this would be in place of a bus ride or a walk, not an automobile. This use of city-bikes would not lower traffic congestion inside a city.

Visitors are probably the prime users of the city-bikes. These people usually do not bring their own bike nor do they have a car or any other form of transportation. Visitors would benefit greatly from city-bikes, but these users are not using city-bikes in a way that would lower traffic congestion as they would have otherwise walked or purchased a bus pass.

This analysis leads us to believe, while it may happen, city-bikes are rarely used instead of personal cars. Programs such as the Danish Cyclist Federation's Cycle to Work campaign have a greater influence on decreasing car usage within the city.

Campaigns like these are successful because they target specific users and can achieve results through a simple rewards system.

## 4.2 Copenhagen

The Copenhagen program is the largest city bicycle program in the world. It has been operational for seven years. In this section we will briefly describe the history, the present program, and its advantages and disadvantages of the CBP.

### 4.2.1 History of the CBP

Copenhagen's CBP began in May of 1995 with a total of one thousand bikes. Eight hundred of these bikes were sponsored. An independent foundation, Fonden Bycyklen i København (City Bike Foundation in Copenhagen), run by Søren B. Jensen (appendix D), was established to oversee the CBP and the City Bike Fund. The municipality donated two million DKK ($240,000) and the Green Foundation donated a half million DKK ($60,000) to help the City Bike Foundation purchase the first bikes. Other sponsors included Netto, the supermarket chain; and Politiken, the National newspaper. Each of these companies sponsored three hundred bicycles for the next three years.

The city-bikes are mainly operated in the center of the city, where the parking fines are highest, to discourage car usage. Half the users of the bikes were commuters going to and from work or school. The map below shows the area where the city-bikes are supposed to be ridden.

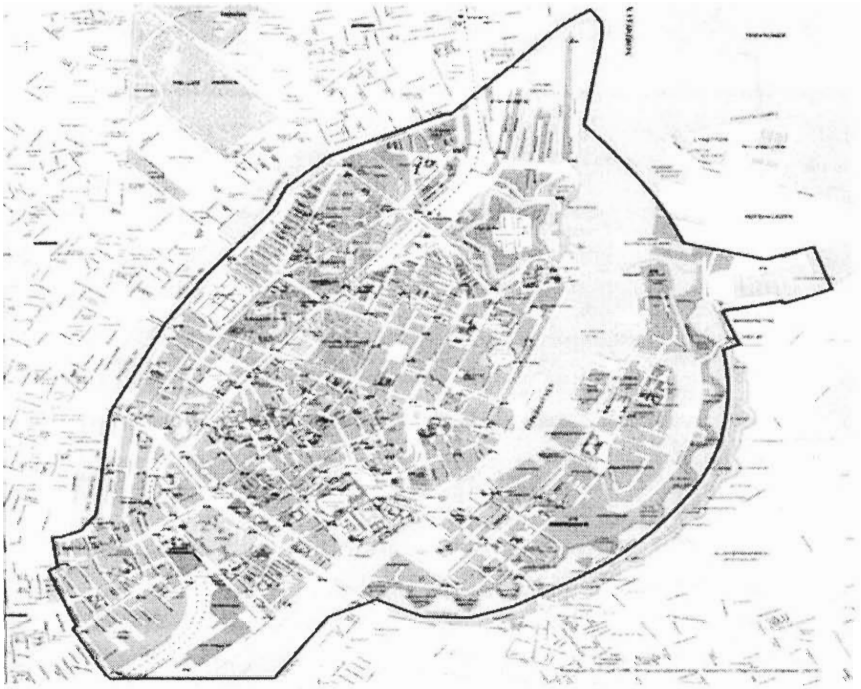

**Figure 3. Area where the city-bikes can be used**

A city-bike is rented out by inserting a twenty Kroner coin into the bike. The deposit is refunded when the city-bike is returned to any city-bike rack. There are roughly 115 bike racks throughout central Copenhagen. The city-bikes are seasonal from May to December. During the off-season they are taken in for storage and repair. The design of the bike was adequate, but too weak for heavy usage.

In 1996, one thousand more bikes were bought with funds from ten new sponsors, including Coca-Cola and the Girls Guides Association. This resulted in a total of two thousand bikes for that year. Then the quantity of bikes decreased as they were worn out and taken out of the system; about ten to fifteen percent would be missing each year.

Danish State Railway and the Employment Service of the City of Copenhagen became sponsors of the CBP in 1997. That year three hundred bikes were missing or worn beyond repair. This number included the fifteen percent bike loss the City Bike

Foundation predicted. Since 1997, the sponsors have changed numerous times and the quantity of bicycles has fluctuated.

### 4.2.2 Current CBP

The City Bike Fund is currently controlled by the City Bike Foundation. The Foundation is directed by three individuals on the City Bike Board. Christian Christiansen and Jens Jacobsen from the municipality have chairs on the board, while Ian Elmelund of the City Bike Foundation is the foreman. The City Bike Foundation is an organization run by Ian Elmelund and Klaus Hildebrandt.

The city of Copenhagen is lending the City Bike Foundation 115 spots of land for bicycle racks and rights to have a billboard at each of these spots (appendix B). The Copenhagen CBP currently consists of 1,200 bikes across these racks. Starting in 2002, AFA JCDecaux will pay a fixed fee of ~2,000,000 DKK ($240,720) per year to the City Bike Foundation, which is responsible for maintaining the bike racks and the area around the racks. The company bid this amount to win the contract giving them rights to the billboards throughout downtown Copenhagen. It is enough money to fund the expansion of the CBP over the next several years. The advertising company does not want any advertising on the bikes themselves, because they feel it is ineffective and unattractive. AFA JCDecaux arranged their ten year contract with the City Bike Foundation to be sufficient without income from individual bicycle sponsors.

The City Bike Foundation wants to buy as many bicycles as possible for the city. Klaus Hildebrandt of the City Bike Foundation recruits bike sponsorships from local and national corporations individually (appendix C). The majority of the bikes are currently

sponsored by government or former government companies, partially as an act of goodwill. The interest in bike sponsorship has fluctuated through the history of the CBP, but there is currently very little interest due to the program's bad public appearance.

Last year the City Bike Foundation paid one and a half million DKK ($181,022) to Reva: a facility which trains unemployed individuals to fix, paint, collect, and distribute city-bikes. Reva's goal is to re-introduce these people to the work force. Generally these employees leave for other work within nine months. Although these temporary employees may not be as effective as permanent ones, they are not paid for their work; therefore the overall benefit to the City Bike Foundation is more than the amount of cost it inflicts on the Foundation. The bikes themselves cost around $200 for the parts which are manufactured by a firm in Taiwan, per specifications given by Reva.

### 4.2.3 Copenhagen City-Bike Program Critique

In order to properly critique the Copenhagen CBP we first had to understand the objectives of the program. Copenhagen originally designed the CBP to relieve automobile traffic in the city. This objective developed over time into a more complex goal.

As mentioned in our quality section, the city receives two major benefits from hosting a CBP. One benefit is public transportation and the other, good publicity. The following critique examines how successful the program is as a form of transportation and as a way to generate good publicity for the city of Copenhagen

With an unreliable public bike system, many of the CBP goals cannot be achieved. The city-bikes do not constitute a heavy percentage of bicycle traffic

throughout the city. Those users who were originally targeted, people coming into the city on trains and commuting, will not use the unreliable system.

Currently there are not enough bicycles available because many are left unused away from the city racks. Furthermore, when the city bicycles are used as personal bikes, they will not be available on the racks thus making fewer trips per day. This limits the total amount of sharing that occurs. Also, there are occasional problems with disrespect to the program. Bicycles are stolen, thrown in canals, and found far from the city-bike boundaries.

Tourists use the system frequently. Though this does support the tourist industry, it does not directly aid the Copenhagen tax payers. Tourists, who might regularly rent bicycles from shops, may use city-bikes instead. This pulls more revenue from the city. In addition, tourists using the bicycles make the system even more unreliable for the resident public.

The bicycle racks are of poor design. The existing racks rely on the bicycle's kickstand to keep the bike standing. As is shown in the picture below (figure 4), the city-bike racks do not provide any support for the bicycle. If a rushed user were to put a bike back on the rack without using the kickstand, that bike might tumble over, potentially taking two or three more bikes with it.

**Figure 4. City-bike rack in Copenhagen**

Being one of the most visible aspects of a CBP, the racks are essential for publicity to a city and should be designed accordingly.

Other problems are also inherent in the rack design. Many of the locking chains and keys are missing from the racks and the bike racks are not designed specifically for the city-bikes so members of the public will often place their personal bicycles at one of the racks. This decreases the quality of the program for the sponsors, users, and city.

In regards to bicycle design, the Copenhagen system could use some improvements. Currently the bicycles are very uncomfortable and have no space for personal belongings. Also, an individual must insert a 20 Kroner coin into the lock on the bike to take that bicycle. Though this deposit may seem nominal it requires that users carry this particular coin.

Next year, in 2003 after more bikes are added, there will be a total of 2,500 bikes in circulation. The total number of bicycles that the 115 racks can accommodate is about 1,500. It is questionable if the 2,500 bike system will function with only 1,500 parking spots available. The City Bike Foundation does not feel that this will be a problem because in past years the ratio of bikes on the racks to the total bikes of the system was very low. This low ratio even occurred during the middle of the night when the amount of usage was thought to be low. This low ratio is most probably caused by unreturned and stolen bikes. The Foundation also believes that this increase in bikes will greatly improve the reliability and eventual respect of the system. They feel this will decrease theft and misuse of the bikes significantly. If the misuse and theft does significantly decrease, then the ratio of bikes on racks during off-peak hours will be very high, and the rack space will be insufficient. In 2003, with 2,500 bikes and 1,500 spaces either there will continue to be great theft and misuse in the system, which will allow the 1,500 spaces to be sufficient even in off-peak hours, or the theft and misuse will decrease and the rack space will be insufficient for the number of bikes.

The CBP does contribute heavily to Copenhagen's public image. Currently, due to the bikes poorly providing transportation, the image of the system is poor, which reflects poorly upon Copenhagen. Having a better bicycle program, in both appearances and operation, will improve the public image Copenhagen maintains.

## 4.3 Vandalism

An important component of the bike program is the protection of bikes from theft and vandalism. Vandalism, a problem found across the world, is defined as willful or malicious destruction of public or private property.

Communities are working hard to repair the damage caused by vandalism and prevent future damage. It is not only a maintenance problem but also a social one. This is because vandalized areas invite more vandalism and cause the public to feel insecure.

Depending on the vandalized surface, there are a number of different ways to remove graffiti. Some devices, such as sandblasters, remove painted graffiti off stone, cement, and other mineral surfaces by using ordinary food-grade baking soda under high water pressure. These machines do not damage the surfaces and are environmentally safe. Paint thinner is another substance used to remove paint. There are many different solvents, therefore choosing the correct one is important. Appendix J shows graffiti removal techniques for different surfaces; it also lists products that can be used to coat surfaces to help remove paint more easily.

Danish Rail, operator of the railway traffic of Copenhagen, had seen an increase of vandalism and graffiti at the railway stations for a number of years. The personnel at the railway stations felt insecure when the vandalism was increasing. In order to reduce the vandalism and improve the environment at the railway stations, Danish Rail used a video surveillance system to monitor the stations 24 hours a day. Since then, Danish Rail has seen a reduction in vandalism and has made it safer for its personnel.

Another method of discouraging vandalism is by improving the lighting. Motion detectors are a good solution in that they turn on when there is movement in the vicinity.

The average operating cost for a commuter bicycle is 230 DKK ($28.14) varying on the amount of vandalism and maintenance. Some ways that bikes are vandalized are by graffiti, tire punctures, scratching the frame, or destroying the parts of the bike such as the chain or gears.

The city-bikes can be further vandalized by breaking the locks or inserting items other then coins into the locking device. Using the bikes to carry people other then the rider can damage it. The bikes racks are vandalized in that they have missing or bent keys and the chains are broken or missing. Vandalism has been seen on some of the poster boards next to the racks as well. Spray paint and broken glass occasionally litter the areas around the bicycle racks.

All of these vandalism problems have a devastating effect on the CBP. Currently, two thirds of all maintenance funds go towards removing vandalism (appendix E). If vandalism could be decreased, more funds could be invested in other aspects of the program.

## 4.4 Other Cities

Three cities were analyzed in detail: Rennes, France; Sandnes, Norway; and Amsterdam, Netherlands. Each of these cities has a unique CBP, each with its own strengths and weaknesses.

### 4.4.1 Rennes

Rennes, France also has a third generation CBP called SmartBike. The CBP was initially developed as a solution for the growing traffic problems in the city because it

helps relieve overcrowding of streets and reduce pollution. The system was started in 1998 by Clear Channel Adshel. Clear Channel has an agreement with Rennes to keep the system running smoothly. The agreement states that Clear Channel is in charge of installation and maintenance of the system and bikes for the duration of the contract.

Smart cards are issued to the users allowing them access to the bikes in the city. Information on the user, bike, and rack are sent to Clear Channel every time a bike is removed or returned to a rack. These data act as a deterrent against theft because the user knows that his information is recorded and he will be responsible if the bike is not returned. Clear Channel controls many dispatch vehicles that act on these data and redistribute the bikes throughout the city.

A total of two thousand smart cards have been issued. The smart cards were divided into three categories: 1,320 cards are distributed among the residents of Rennes, 280 to the residents of the District of Rennes, which includes thirty-two neighboring villages and towns, and 400 are reserved for the students enrolled in universities in Rennes.

The smart cards are given for free on a first-come, first-serve basis. The user must present two forms of identification and is required to sign a contract which states the terms and conditions for using the system. A maximum of one smart card is issued per household. A user may only use the bike for two hours per loan; but the bikes can be taken out multiple times throughout the day.

Today the system consists of two hundred smart-bikes. The bikes are a unisex custom-design, made for outdoor conditions, comprised of parts that are not compatible

with other bikes. Each bike also has a separate lock and cable so that it can be secured temporarily.

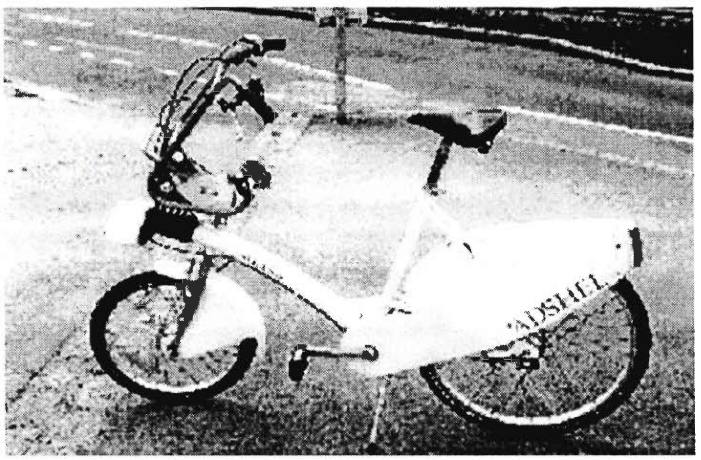

**Figure 5. Smart-bike used in Rennes, France**

There are a total of twenty five docking stations. Rennes is divided into twelve sections; each section has a docking station and is directed by a member of the municipal council. The other thirteen stations are installed next to train stations, bus terminals, university grounds, shopping centers, parks, and major administrative buildings.

The bike rack holds the front wheel off the ground to accommodate uneven terrain. A power source must be nearby to operate the racks and the station must have a good GSM (Global System for Mobil communication) signal of 900 MHz frequency. The controller and docking rail are the only hardware requirements for the docking station.

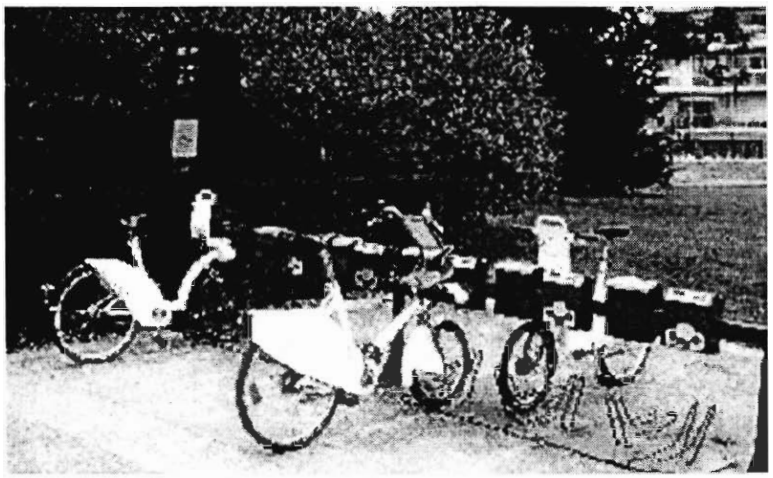

**Figure 6. Docking station and smart-bikes**

The controller is a local computer that controls all the functions of the station. It consists of a GSM modem, CPU (Central Processing Unit), and a power supply unit. The controller enables the communication between the individual docking points in each station and the card reader located on the bike. The card reader batteries are charged by the power supply.

Each docking point on the rail has a radio frequency coil which transfers power and data to the card reader. The docking rails can hold combinations of three and five docking points. There are two designs of docking rails available, straight and curved. The structure is composed of zinc treated steel using stainless steel for the critical parts.

Dispatch vehicles are used to transport bikes from full racks to ones that are empty. The vans are linked to the stations through SMS (Short Message System) communication that can notify the status of a bike at any given location. It is also used for on-site repairs and transporting bikes to the repair center.

**Figure 7. Dispatch vehicle in action**

The central computer is the most important component of the smart-bike system. It automatically downloads information stored in each docking station. All the communication done by the central computer is through GSM. The central computer authenticates users' smart cards and compiles user and rack usage data.

The SmartBike system in Rennes is successful in a number of ways. Only four bikes have been stolen since the system started. The CBP also provides people with an alternative means of transport that is free. Appendix G shows the uses and the user statistics of the bikes. It also has the results of two separate studies of the SmartBike System.

### 4.4.2 Sandnes

Sandnes, Norway has an operating third generation city bicycle program. This program has developed significantly since it was first started in 1991. The two main goals of the original bicycle system were: "to make the town more friendly for cyclists" and "to make more people use the bicycle" (Eikeland 2). These two goals successfully divided the Sandnes workload into a construction part and a campaign part. The

construction included the building of bicycle lanes within the city. The campaigns consisted of introducing bikes to the public and supporting their use.

The first bike system that Sandnes used was very similar to the current program used in Copenhagen. A number of ordinary bicycles could be taken by members of the community for a small deposit. The bikes were locked with the same chain and lock system as that in Copenhagen. However, numerous problems arose with this system. The most prominent problems were theft and that the bicycles were too weak. The bikes were even stripped for parts.

Sandnes then moved to a new system. The bike foundation believed that by starting a program with more defined rules the community would respect the program and use it wisely. For this reason, the bicycles of the second system remained unlocked in the bike stands. The problems, however, did not dissipate.

Sandnes then adopted a third system, the one in use today. This system had a stronger, more unique physical design. Suggested by the City Bike Foundation and built by DBS, Den Beste Sykkel, the new bicycle design won an award. They had a stronger frame, smaller front wheel, and an electronic locking device.

Under this new system, a subscriber would go to a number of locations to register for a smart card key. This key allows a user to unlock a bike from any of the racks. In order to register, the user must give his name, sex, and address. Once registered, that user can take a bicycle from any of the rack in Sandnes. Unlike the Copenhagen city-bikes, the subscriber can use the locking device on the bicycle to secure his rented bicycle at any location, not just at a rack. When secured at a non-rack location, the bicycle can only be unlocked by the person who locked it. Furthermore, because the system stores

information about the current user, that user has more liability and responsibility for that bicycle. Once returned to the rack, the bike will reset and unlock for any subscriber.

The City Bike Foundation of Sandnes has two agreements with the municipality. Both twenty year contracts, these agreements create a financial foundation for the program. The first agreement states that there will be twenty boards for advertising located throughout the city, and that these boards will be used to help bring advertising income into the program. The second agreement is with a private company that operates the advertising and dictates the financial income earned through the ads.

Physically the bicycles of Sandnes are maintained and supported by a group of handicapped persons. The labor, like that of Copenhagen, is a social service to the community. The handicapped are hired to make repairs, just as in Copenhagen the unemployed are brought in to fix the bicycles. The bicycles, as stated earlier, are designed to withstand heavy use. They use Kevlar tires, which are filled with air and resist puncture, and frames which are simple and strong in design.

Currently a board of six individuals has jurisdiction over the program. This committee represents the municipality, the shop owners, the DBS factory, the handicapped, and the bicycle industry.

The CBP of Sandnes gets funds through two different means. Advertising is the main source, bringing in 95% of income. The other 5% comes from proceeds gathered by selling the individual smart keys for the bikes. Each key requires a fifty Norwegian Kroner ($6) deposit. Each year, users must also pay one hundred Norwegian Kroner ($12) to keep their key activated. For that cost, each user gets unlimited usage of any of the city's smart-bikes.

The technology for the Sandnes bike system was designed by Infotronics A/S. This local company designed the electronics in the bikes, as well as those in the racks. No central computer is used in this particular program; any updates to the racks must be completed by on-site trips syncing a laptop to each rack. This distributes the user data throughout the racks, and gathers it into a central database where the organizers analyze it.

Because of impressive technology and strong build quality, the Sandnes City-bikes are expensive to purchase and implement. The cost break down for the individual bikes is as follows:

| | |
|---|---|
| One Bicycle: | 4,000 Nkr ($468) |
| One Unit Stand with Electronic device: | 2,000 Nkr ($234) |
| One Bicycle Lock: | 1,500 Nkr ($175) |
| Other costs: | 1,500 Nkr ($175) |
| Total | 9,000 Nkr ($1,055) |

In Sandnes, there are currently ninety bicycles in use. Four hundred individuals subscribe to the program. The future plans are to have 2,000 members, and 150 bicycles. Included in the appendix I are data regarding usage of the present bicycle system.

While this city had much to offer, we felt the small size and scale of the CBP makes it difficult to compare to the Copenhagen CBP.

### 4.4.3 Amsterdam

In 1966, Luud Schimmelpennink and others helped organize a city bicycle program. The city of Amsterdam collected donated and unclaimed bikes, painted them white, and unleashed them to the cities inhabitants. While the idea was utopian in nature,

thieves and vandals robbed the city of its free public use bicycles. In the nineties, technology existed making effective theft-deterrent bicycles feasible. After many iterations of design, Luud believes he is very close to the ideal theft and vandal proof PUB program.

Amsterdam's bike system uses a regular bank-issued smart card to control the release of bicycles. The user proposes his destination at the rack location. Then the Depo bike pole, which communicates directly with the central computer, authenticates the user with the bank and checks the destination rack for a vacant space. If one exists, a bike will be released for the journey. The user will be charged about 3 cents per minute for use of the bike.


**Figure 8. Amsterdam's smart-bikes and rack**

During the trip, the bicyclist may want to stop at a cafe. He simply gets off the bike and inserts his smart card into the bike, locking the wheels. When he is ready to leave, he inserts his card to unlock the wheels, allowing him to travel to his destination.

The bikes themselves are very durable, using a rugged metal frame to protect the internal electronics. A battery powers the various electronics inside the frame of the bike and is recharged when the bike rests on the rack. Wireless communication using Bluetooth technology transfers information from the bike to the pole, making the racks themselves somewhat cheap compared to the bikes, because they are not used to facilitate communication.

The bikes are heavy and durable. They have a comfortable seat, special air tires that have a lifetime puncture free guarantee, and well placed pedals and handlebars. These features make riding the bicycle comfortable, despite a smaller front tire and single gear.

Depo is a corporation that proposes innovative designs involving the public sector and transportation for municipalities. When an idea is completely developed, the city then purchases the product and Depo can sell the finished product to other cities interested in a similar solution. The Amsterdam office space where the system is developed, is a design lab, a place for Luud and company to work with new technology and apply it to the bikes.

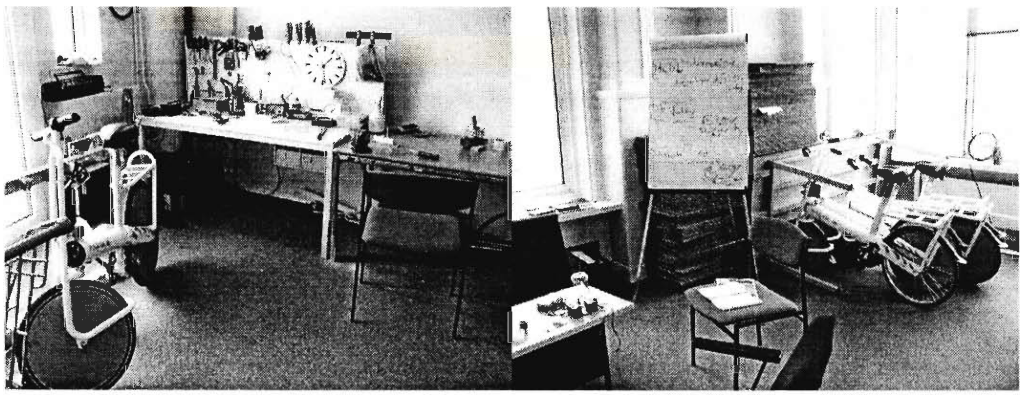

**Figure 9. Y-tech Industries (Depo)**

As these pictures indicate, the new smart-bike system described above is still incomplete. The project is at somewhat of a standstill until funds are secured for the completion of development. Once complete, the system has a lot of potential.

The system has a double lock solution. The bikes are secured to the racks with a very sturdy clamp; if a bike was to be successfully removed, the wheels would be locked because the bike was not properly checked out. The only way a bicycle could be stolen would be by overcoming both locking devices. While the clamp discourages regular theft, the wheel locking device makes a stolen bicycle useless for transportation, thus making theft futile.

The system has a fairly low per-bike cost.

- $500 per bike
- $5,000 per booking pole (includes 2 public payphones)
- $100,000 per central computer

Most smart-bikes communicate with the rack card reader through the rack itself. The technology needed at each bike space to facilitate communication makes the racks very expensive. Amsterdam bikes wirelessly communicate with the booking pole with

Bluetooth wireless technology. This removes much of the required technology on the rack, lowering its cost. For this reason, rack expenses are minimal.

| Bikes | Booking Poles | Total Cost (USD) | Cost per Bike (USD) |
|---|---|---|---|
| 50 | 5 | $152,500 | $3,050 |
| 500 | 50 | $600,000 | $1,200 |
| 3000 | 100 | $2,100,000 | $700 |

**Table 1. Cost analysis of Depo Smart-bikes**

The high central computer cost means the system is financially attractive only when there are a large number of bicycles. As shown above the cost of the system with 3,000 bikes is very reasonable.

Although not required, the system is capable of booking. When a user chooses a destination, the system will only release a bicycle if there is an empty bike slot at the specified rack. If there is an empty spot, it will be reserved and a bike will be released. This may limit usage because during travel bicycle parking may become available at a previously full rack. If this were to happen, a trip that would have worked flawlessly would be denied. This is a negative aspect of the booking system, but such circumstances could not be accurately predicted. The booking system does, however, give a sense of assurance to the user that a return space will be available. This is especially important in a system which the user is paying per minute. On racks that are overcrowded with bikes, the host of the program can simply lower the price per minute of bikes taken from that rack at times when it is full. This increases demand and will create vacant slots for bikes whose users want to travel to those racks which otherwise might be full. There appears to be no way, without booking, to guarantee a bicyclist the ability to return the bike at his destination.

The system runs on common bank issued smart cards. The registration for a bike card is nonexistent, because most people already have a bank card. Without the possibility for coin deposit, tourists may be alienated by the system. For a city that relies on income from tourists, this may be a good system because it requires them to rent a bicycle from a local bike shop. Using a bank card also gives the governing organization the valid background information of a user, allowing the parent organization to follow through on fines if someone does not return a bike.

With the use of the per-minute charge, an organization may not confine the area of use for the city-bikes, allowing the user to go anywhere around the city. This geographical freedom removes the need for enforcement of boundaries.

# 5.0 Scenarios

In an effort to suggest the best possible recommendation for Copenhagen, we have organized several potential scenarios in this section of the report. These scenarios include: remaining with coin-deposit bikes, changing to a dual coin-deposit and smart-bikes system, completely switching to smart-bikes, and waiting for an ideal system to be developed.

## 5.1 Coin-Deposit Bikes

The simplest solution to the CBP's availability problems is to continue purchasing more of the currently used coin-deposit bikes. Increasing the total number of bikes may result in an increase in availability. The City Bike Foundation in Copenhagen is currently attempting to purchase bikes until the demand for available bikes is satisfied.

The main benefits of this system are that many bicycles can be purchased and the system can be built upon the existing bicycle program. Costing only $200, these bicycles are less than a quarter of the price of the smart-bikes, ultimately allowing the city to have an excessive number of bikes. Also, because of the special design, the bikes are not often stolen for parts or sale, as they are heavy, uncomfortable, and comprised of custom parts.

With more bikes it is hoped the system will be better-treated by its users. Because of the vast number of bikes, people may not question their likelihood of getting a bike the next time they need one; therefore users will not hesitate to return a bike. As bikes are returned, the availability increases, resulting in more use. This increase in sharing will improve the dependability of the system, directly influencing quality to the user and the city.

As dependability of the system increases, respect for the program will grow. With more respect comes less vandalism; this belief is held by many involved with public systems. Less vandalism will decrease maintenance costs and make the system more appealing to sponsors.

There are many problems that remain, regardless of the expansion of the CBP. People can borrow bikes for extended periods of time without consequence, so it is likely that many people will. The quality of the system's transportation depends on the amount of transportation accomplished for a given cost. Prolonged bicycle use decreases the amount of sharing of the system, decreasing the amount of transportation it satisfies. Other problems include the high cost associated with maintenance due to vandalism, which may still plague the system regardless of the number of bikes.

## 5.2 Dual System

Another possible solution for Copenhagen's CBP would be to adopt a dual system. This means that Copenhagen would have two bike programs in operation at all times. A coin-deposit system for individuals wanting quick service without much responsibility, and a smart system for the user requiring a bit more quality.

The benefits of this scenario are clear. Copenhagen could achieve the best of both worlds: providing for the tourist, child, and casual user, as well as the businessmen, commuter, and frequent user. The coin-deposit bikes require no registration and are free to use, making them ideal for a child or visitor to the city. A smart system would achieve a higher level of bike availability, and would be more desirable to those willing to pay or register for the service.

As with any solution, the dual program does have potential problem areas. Maintaining two systems could be very complex and expensive. Reva would have to develop methods of repairing two different types of bikes. This is especially problematic because the average stay of a worker at Reva is only six months. Having enough racks in a variety of locations for each system may require more land then the program currently has. Getting more land from the city may be difficult. Initial setup and equipment costs of smart-bike systems are very high, meaning a smaller implementation would have very high costs per bike. All of the problems associated with the coin-deposit bike still remain.

## 5.3 Switch to Smart-bikes now

Another option for Copenhagen's bike system is an immediate and total switch to smart-bikes. The most certain way for Copenhagen to get a smart-bike system which suits its needs is to abandon the current coin-deposit system and forward all resources to developing a new smart-bike system. Engineers would develop and test the system over the next few years to assure its functionality. Dismissal of the current program ensures that a maximum amount of resources will be focused on the developing smart-bike program.

The main argument for this solution is that it guarantees a working system eventually. In addition, it removes any reliance in other companies to further develop their systems in a timely manner. Because the system would be built and developed in Copenhagen, it will add to the community's pride and to the city's image.

Problems lie in the costs. With each iteration of development there is wasted materials and development costs. The involved organizations of the Copenhagen CBP

are not capable of developing the needed technologies for smart-bikes. For this reason, engineers must be hired or the City Bike Foundation must contract an outside firm to develop a smart system. In addition, the community will be robbed of any city-bike system during the development process.

## 5.4 Wait for Satisfactory Smart System to be Completely Developed

One option for the City Bike Foundation is to wait. Amsterdam has arguably the most desirable system, with dual solutions against theft and booking technology. However, the system is not ready. Other programs like the one they are using in Sandnes, Norway are also improving each year. Rather then picking up a work-in-progress, the City Bike Foundation could wait until a few of these bike systems are satisfactory, then choose the one that best fits Copenhagen's needs and the City Bike Foundation's budget.

This option seems sensible because of the high cost of the components of the system. Buying a system of this cost now, only to replace it with a better one a year or two later is not sensible financially. Also, with several companies so far in development, starting development of a system in Copenhagen is probably not very cost or time efficient. The City Bike Foundation could wait a short amount of time for a foreign system that would take far longer to develop from scratch.

The CBP in Copenhagen is the largest in the world. With such a grand scale issues arise that may not in very small implementations such as Sandnes. Although we may never know when a system is perfect, the current systems available for purchasing all have noticeable flaws. For example, the Sandnes smart-bikes have some easily

damaged plastic parts. If the technological head-start that foreign city-bike programs have is to be taken advantage of, Copenhagen should wait a few years to allow the systems to be improved or completed.

Waiting can be problematic. As many cities are continuously developing new and improved bicycle programs, there may never be a final result. Essentially, Copenhagen could be waiting forever.

## 5.5 Expansion of Bicycle Boundaries

With any of these scenarios it will be important to investigate area expansion. Currently the Copenhagen CBP fills the inner city (appendix F). With natural boundaries on all sides and 115 bike racks throughout the city, the CBP area is well defined and is covered comprehensively. However, once the desired amount of inner-city transportation is achieved, Copenhagen must decide if the controlled area should increase.

The positive features of an expanded area include: a wider user base, a broader advertising audience, and a greater coverage of the city region. With such a system, more trips would be possible because fewer destinations and departing points are outside the limits of the system. Ideally the entire country would be within the city-bike limits with bike racks on every street corner. This abundance of locations would ensure the bikes successful adoption in a wide variety of trips.

Unfortunately a wider cycling region also means more maintenance, greater up-keep costs, and the need for artificial boundaries. Without a natural boundary, it would be easier to take bicycles beyond the city-bike limits. Also advertising is less attractive to sponsors if their bikes are out in the suburbs rather then downtown. Because population

is less dense, it may be easier to vandalize the system; in addition, it is harder and more expensive to check up and maintain the system in these less dense areas of the city.

Expansion would also require a gift of more public land from the municipality which may not be possible. Expansion would require the installation of more bicycle racks as well as the purchase of more bicycles. The benefit of a greater area, however, might outweigh the costs of increasing the boundaries.

# 6.0 Recommendations

Next year the CBP will be running with a total of 2,500 bicycles. After examining a number of options and scenarios our team has decided that it would be best for Copenhagen if the city were to adopt a smart-bike system.

We have developed three main recommendations for the Copenhagen CBP. These recommendations are listed below:

- **Upgrade the rack design immediately to remove reliance upon kickstands**
- **Observe vacancy on the bike racks in the coming years to see if more rack space is required to support the 2,500 bikes**
- **Observe foreign smart bicycle developments and collaborate with the smart bicycle developers, noting when a system is satisfactory for Copenhagen's needs**
- **Start a full smart-bike program when enough resources are available**

The City Bike Foundation should upgrade the bike racks immediately by adding a structure which will keep the bikes standing. A modestly priced supporting bracket to brace the front wheel should be added to the current racks. This is needed because currently the bicycles rely on their kickstands to remain standing. If the kickstand is not used the bike will fall, knocking over nearby bikes, and causing damage to the locks, chains, and bikes themselves. Not only does this problem cause damage, it makes the bikes in the racks look undesirable and in disarray. Improving the appearance of the bikes in the racks will increase the quality of the city-bikes to the sponsors (section 4.1.3). Increasing advertising demand leads to more revenue for the City Bike Fund.

Copenhagen should not begin a smart-bike program immediately. While keeping a close eye on the progress of foreign programs like Sandnes and Amsterdam,

Copenhagen should start allocating resources towards a smart-bike system. Once the city bike board agrees that a foreign smart-bike program is satisfactory for Copenhagen's particular needs, the allocated resources should be used to start a full smart-bike program, replacing the current system entirely.

## 6.1 Characteristics of Copenhagen's Ideal Smart-bike System

Listed below are the features Copenhagen should look for and implement in a smart-bike system.

1. Dual locking system
2. Per-minute charge
3. Booking service
4. Ability to accept bank cards or credit cards
5. Comfort
6. Ability to personally lock bikes, other then at racks
7. Durability: low maintenance physical bike design

### 6.1.1 Dual Locking System

City-bikes are usually stolen for use, not for parts or sales. The new Depo Smart-bikes' wheels will not move unless electronically authorized, making it undesirable to steal and almost impossible for a thief to ride off with a bike. This wheel lock technique, along with a more traditional lock should be sufficient to keep theft at a minimum in Copenhagen.

### 6.1.2 Per-minute Charge

As discussed earlier, smart-bikes are very expensive (section 4.1.4). City-bikes are a form of public transportation. To improve the quality of this service, the city-bikes must provide a large amount of transportation per dollar. To achieve this, the expense of the bikes must be offset by a great deal of sharing. A charge of three cents per minute would be sufficient motivation for a user to return the bike when he is not using it.

| Per-minute | Hours/Day | Annual Income Per-bike |
|---|---|---|
| $0.01 | 1 | $219 |
| $0.01 | 4 | $876 |
| $0.01 | 8 | $1,752 |
| $0.01 | 16 | $3,504 |
| $0.01 | 24 | $5,256 |
| $0.03 | 1 | $657 |
| $0.03 | 4 | $2,628 |
| $0.03 | 8 | $5,256 |
| $0.03 | 16 | $10,512 |
| $0.03 | 24 | $15,768 |
| $0.05 | 1 | $1,095 |
| $0.05 | 4 | $4,380 |
| $0.05 | 8 | $8,760 |
| $0.05 | 16 | $17,520 |
| $0.05 | 24 | $26,280 |

**Table 2**

| Per-minute | Length of Trip (minutes) | Cost of Trip |
|---|---|---|
| $0.01 | 5 | $0.05 |
| $0.01 | 15 | $0.15 |
| $0.01 | 30 | $0.30 |
| $0.01 | 45 | $0.45 |
| $0.03 | 5 | $0.15 |
| $0.03 | 15 | $0.45 |
| $0.03 | 30 | $0.90 |
| $0.03 | 45 | $1.35 |
| $0.05 | 5 | $0.25 |
| $0.05 | 15 | $0.75 |
| $0.05 | 30 | $1.50 |
| $0.05 | 45 | $2.25 |

**Table 3**

The tables above give examples of how a per-minute charge can be valuable to the user and provide substantial revenue to the City Bike Fund.

| Bikes | Booking Poles | Total Cost (USD) | Cost per Bike (USD) |
|---|---|---|---|
| 50 | 5 | $150,000 | $3,000 |
| 500 | 50 | $600,000 | $1,200 |
| 3000 | 100 | $2,100,000 | $700 |

**Table 4: Price chart for Depo Smart-bikes**

Given a large implementation, if each bike was used on average for four hours per day at a rate of one cent per minute, the smart-bikes would pay for themselves in less then one year.

If the system manages to pay for itself, the city would benefit by removing the billboards throughout the city, which currently pay for most of the CBP. Removal of the billboards will improve the city's appearance.

The flow of the system could also be improved by a per-minute charge. Currently there is a large concern with distribution of the bikes throughout the day; some cities have re-distribution vans traveling to and from racks to maintain a good distribution of the bikes. A better solution for reducing the number of bicycles on overcrowded racks would be to increase the demand of bikes on these racks by implementing a dynamic per-minute charge. For example, per-minute charge of bikes at a full rack could be cut in half to increase demand when the rack is full. This will result in more bicycles being taken from that rack and extra parking spots becoming available. This may be too complex for many users, but it is worth consideration, as it could be an easy way to keep the bikes well distributed throughout the city.

### 6.1.3 Booking Service

To increase the quality of the system to the user, a booking system should be adopted. This reserves a spot on a rack at the user's destination. This is required to ensure the user will not be waiting or traveling to a different rack in search of a vacant spot for his city-bike. This is especially important because the bikes are paid for per-minute. Some users may be unsure of their destination. These users should still be

allowed to use a bike, but they should be warned that they are not guaranteed a vacant spot when they conclude their journey.

### 6.1.4 Ability to Use Bank Cards or Credit Cards

To ensure a system's success, it should be simple and hassle free for first time users. Many smart-bike systems require registration and approval of a special smart card. We strongly recommend the adoption of bank cards or credit cards as the method of identification and payment for the bikes. This is easy for the user because there is no registration procedure, as they can simply use a bank card or credit card that they already own. It is also good for the organizer because the bank card or credit card will simply be charged for the amount of use that is accrued. This alleviates potential billing problems and hassles that might arise with a special city-bike smart card.

### 6.1.5 Comfortable Bike

Although a comfortable bike may not be the most important characteristic of the system, comfort does influence perceived quality to the user. This influences the number of users the system has and the amount of transportation the system will satisfy. Air-filled puncture proof tires, comfortable handlebars, and seats can all be added to a bike without significantly degrading durability or increasing maintenance costs. Another feature that will add to the level of comfort during a ride would be a basket or another system of storage for the cyclist's belongings. These improvements will greatly increase the quality of the riding experience.

### 6.1.6 Ability to Personally Lock Bikes

A common complaint with Copenhagen's city-bikes is that they cannot be locked outside of the racks. This can be addressed by allowing the user to lock the bike to a tree or bench with a locking mechanism stored on the bike. This will allow the user to stop at a café or a store during his trip, without worrying about theft of the bike. While this might promote prolonged uses, it is still benefiting the system because of increased income from per-minute charges of longer journeys. This ability will also increase the quality of the system to the user and demand of the bikes.

### 6.1.7 Durable Low Maintenance Bike

The number of bikes that are undergoing maintenance decreases the amount of bikes available to the public and the amount of transportation the system can satisfy. Making bikes durable and easy to maintain will lead to a high quality of service of public transportation. This is fairly well accomplished by the current Copenhagen City-bikes, but should not be forgotten when moving to a smart-bike system.

The adoption of a smart system with these characteristics will increase the quality of the system to the users and the bike sponsors, while being impressive and creating good publicity for the city. Just as museums, Tivoli, and the well working bus system are respected by the community and seen as attractions to the Copenhagen lifestyle, so too would a high-quality city bicycle program be appreciated.

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# Appendices

# Appendix A

The City of Copenhagen is sponsoring this project because Copenhagen is known as a City of Cyclists and it wants to remain that way. In order to be called the city of Cyclists it must improve cycling conditions. It also needs to keep the cyclists satisfied and promote bicycle usage to those who are not using them. The City of Copenhagen has to keep working hard to make bicycling easy and convenient. They have a plan from 2000 to 2005 to work on improving bicycle traffic. They have repaved a lot of the worst bicycling paths; this is a two-year plan that is currently in progress to improve bicycling conditions. The City of Copenhagen often works in collaboration with the Danish Cyclist Federation and other organizations to improve the Copenhagen city policy.

The DCF (Danish Cyclist Federation) represents the interests of everyday bicyclists, and has done so since they were established in 1905. They put their efforts into establishing cycling as a serious transportation method, and everything that goes along with that. One of their objectives is to make all destinations reachable via bicycle without the need for side-tracking. They very actively promote things like the "Cycling to Work" campaign they launched in 1999, promoting just that, in everyday life. The federation boasts a membership of around 26,000 Danes, from 41 branch associations across Denmark. They accomplish bicycling beneficial policies by political lobbying and communication with the appropriate government official.

The European Club of Cycling Friendly Cities is a non-profit organization that is striving to spread cycling as a mode of transportation throughout Europe. The official Goal of the club is to "promote and encourage bicycling in the countries of Europe as an economic, efficient, healthy, and environmentally friendly means of transportation and

recreation." Currently there are twenty three full members of the club including Denmark.

# Appendix B

Interview with Christian Christiansen, Secretary to the Mayor of Transportation
Thursday, 21 March 2002

Interviewer: What is your responsibility with the city-bike program?
Christian Christiansen: Recently I became a member of the board of the City Bike Foundation. I am representing the administration of the city.

I: Does the city help the CBP in regards to money?
CC: You could say it that way, first of all, the city-bikes have racks placed in public soil. Normally if somebody wants to use public land, they have to pay a fee. But this Foundation doesn't, it's for free. Another thing is that, I don't know if it will happen in this season, but in other seasons, different parts of the city administration have been sponsoring the city-bikes. And then they have advertisements on the wheels.

I: For other government programs?
CC: No, for instance the Energy Provider, they have been paying for having their logo on the wheels. In this part of the administration we have, a so called business publications who are engineering and architectural works, and they too have been sponsoring wheels, so to say.

I: Is that partially because you are trying to help the program? You would not have done it otherwise if it was a third party?
CC: The optimal situation is that it is wholly privately financed. Some years ago are good, some are not... in that respect.

I: The city itself is financing it themselves, in exchange for advertising.
CC: Yeah. I have to stress, this is not a public program. But we are intermingled with it.

I: Will you continue to fund it this year?
CC: Yes. At the moment the program looks okay, because the economy is more stable. There's an agreement with a sponsor for the next ten years. That gives us a foundation for developing the program.

I: There are no plans to change the funding structure?
CC: It's hard to say, because we have some ideas on how to develop it. And now we have some money to do it. Not in the short term, more in the long term.

I: Are you pleased with the CBP so far?
CC: At the moment, last year and the year before, we lacked bicycles. And when you lack bicycles, it's difficult to get sponsors, and when you lack sponsors, it's

difficult to buy bicycles. So it was an evil circle. But with this agreement, I think it will be improved a little bit into a better situation; for my personal joy as well.

I: Are there any plans yet for the program, in terms of significant changes? Maybe not financially but, for example, technologically? Right now you use a coin to get the bike, while other cities use smart-bikes and things like that?

CC: We are thinking about it, yes. It's not planned... just ideas. One of the things that we can see now, something that doesn't please anyone, is the system of racks, with the chains hanging down. And some kind of disorganization of the bikes within the rack, gives the impression of disorder. And, that's not so good. We have to develop that part of the system.

I: From what we've gathered so far, tourists and kids are the main users of the program, have you heard this as well? Is this your impression?

CC: Tourists yes.

I: But the targeted audience initially was the workers, taking the train in from outside the city and then using the bike to get to their jobs. They don't use it now because it's not dependable enough?

CC: That's right. It's too unsure, you don't know if you'll have a bike.

I: How do you feel about that, are you happy with it just being tourists? Or do you want to target the initial audience?

CC: Personally, I think that when you get more bicycles, more city-bikes, you can develop that part of the program as well.

I: So you want to do both?

CC: Well, they are building a new subway station. The subway stations will make it even more natural for people to use the city-bikes because it's a shorter distance that they will want to go.

I: You want to retarget those people.

CC: I hope we can yes.

I: How about the tourists? If the tourists come in and use the city-bikes, doesn't that mean less revenue for the rental places and shopkeepers because they won't be renting bikes, they will be using free bikes?

CC: It might be that they want to go outside the city-bike area; it's a restricted area where you can use the bicycles. The city-bike, have you tried it?

I: Not yet.

CC: It's not that good. ::laughI::

I: Looking at the City of Sandnes, in Norway. They apparently use one smart-bike system for the residence and one coin-deposit system for the tourists. What do you think about that?

CC: One for tourists, and one for residents? Who are the residents here?

I: The people who live on the outskirts of the city and take the train in.
CC: Yeah, well. It's more of a city administration there. So we have to some how deal with the cities outside our own city. Sandnes I think is a small town?

I: Yes, I think it's about 70,000 people.
CC: Actually, the city-bike area may be only 20, or 30 thousand... but the main users, might be a million, so it's difficult to organize.

I: How do you feel about the technology part, do you feel we should go into a smart-bike system, or a library system where you can keep track of the users?
CC: If there's a smarter system then the system now, I'd like to see it. Again, it depends on money.

I: We are wondering if bikes tend to go towards certain parts of the city, and if they need to be redistributed? Is that a problem here?
CC: It's not a problem, because we have an agreement with a workshop as part of a social project that repairs the bicycles and redistributes them.

I: How often are they redistributed?
CC: I'm not sure, but I think it's about every day. Because they know which racks are used a lot. That's how the city functions. And, I spoke with a woman last week. She tells me that every morning when they go to replace the city-bikes, they are taken immediately. That indicates that we, of course, need more bicycles.

I: So you still think that the program itself can target the initial users?
CC: It depends on how many bicycles we have. In the long term, perhaps.

I: Do you think it's only a number thing, or do you think that people aren't returning them, for example, someone might rent a bike and then keep it in his home.
CC: No.

I: That doesn't happen?
CC: You have to calculate that. It doesn't happen that often in Copenhagen. The main problem actually is that Sailors take them. They have been spotted all over the world. In Russia... and other countries... Morocco, New York actually.

I: Is it a small enough loss, do you think that you are better off combating it with more bikes rather than technology? If you have to give your name and information etc...
CC: This system depends on the public and how much they tell us. And actually, they call and say, we know there's a city-bike here... come and get it. Consistently, they get 40 calls a day from the public.

I: Recently there were about 1,500 bikes out in the city, about... roughly, how many are out at the end of the season?

CC: Umm.... We lose around 200 bikes. And that's a big 'around'.

I: Where are the city-bikes right now?

CC: They are in the workshop.

I: Are you concerned with the tourists' use of the bikes?

CC: The main function of the city-bikes is that the public uses them. You don't want to underestimate the profile of Copenhagen as a tourist city. We use it in our brochures, and presentations outside the city. I'm not sure if it's generating tourism. But it's a way to present the city.

I: It seems very important where the bike racks are put, how is it decided where exactly they go?

CC: I think first, of course, where the people are... that's where the racks are for advertisements. I think that has had an influence.

I: Who chooses the place to put them, the advertisement company?

CC: The agreement that we have now is an agreement between the advertising company and the Foundation of the city-bikes, which has been incorporated by the city officials, and as well by the city council.

I: What's the name of the advertising company that you work with?

CC: Afa-jc-decaux. It's a big company. All the advertising and billboards that you see around are done with that company.

I: If we were even going to talk about putting technology into it, they'd be the ones we'd have to talk to.

CC: The Foundation itself is non-profit. They don't earn money. When they get money, they use it. So if we were going to change systems, you'd have to upgrade the system, there must be an income. And the main income, really the only one... is the advertising.

I: It's not the advertising company directly that takes care of the bikes?

CC: As it is now, the agreement states that the social program maintains the city-bikes, and the advertising company maintains the area around the city-bikes. And it is the city's responsibility to take care of the area next to the area that the advertising company cleans. Why is it like that? It's because it's a parallel to the bus stops... and advertising billboards, where the advertising company takes care of the billboards, as well as the buses.

# Appendix C

Interview with Klaus Hilderbrandt, City Bicycle Foundation
Monday, 25 March, 2002

Interviewer: What are the responsibilities of the City Bike Foundation?

Klaus Hidebrandt: The basis of the program is to give the Copenhagen inhabitants free bikes, that's the background of it. What I do here, is two things. I have to get the funds, because it's not free to have bikes in the city, secondly I have to be aware of the city-bikes and keep the maintained. Those are the two main purposes.

I: For funds, you are partnered with an advertising company?

KH: Yes, you could say that, all kinds, directly.

I: Oh, we were under the impression that there's an advertising company, a French firm.

KH: Oh, you're talking about something different; you're talking about AFA Decaux. That's not an advertising agency; it is an outdoor company that sells posters in the city and in the country-side. I understand your confusion. But, the background for the city-bike is, first of all to get funds to have it running, two to have the maintenance done, and three to get more bikes, of course, because what we want is a lot of bikes, much more than we have. We have also had some difficulties, to get the funds. So what we did this year was to have a co-operation with AFA Decaux. Decaux is a very big worldwide company, which started in France. What they do in Denmark is have a co-operation with AFA. So AFA owns have the corporation and Decaux owns the other half of the outdoor company.

I: When you say 'outdoor company' what do you mean?

KH: It's billboard stand, poster stands; you rent for a few weeks.

I: Advertising?

KH: No, nothing to do with advertising. What they put on the posters is advertising. So, if I wanted to have something from Coca-Cola in the street, I would go to a media company which says "I think we should use some in Copenhagen" they would talk to AFA Decaux, like you're buying page in the newspaper, or TV commercials.

I: So when Coca-cola wants to sponsor a bike, they don't go directly to you they go to AFA Decaux?

KH: No, they go to us. The advertising companies are doing advertising, how it should look, and how it should sound. The media companies say 'what is the best way to use the money we use for media' then the newspapers, TV, and outdoor companies are where you buy these things.

I: Are the bikes themselves, advertisements? And AFA Decaux takes care of the racks?

KH: Yes, only the racks. They have nothing to do with us. The reason is that this year, we made a deal with them that all the racks we have, where the bikes are stored, and the poster stands, we sold to them. We will get a fee every year, which we use of course. Before, we sold the posters. But it was difficult for us to do because of the very small area. They can put a bigger poster set up and put it in the series that they had. So, what AFA Decaux is, is a sponsor for us. So that every year we get a fee from them for the next ten years.

I: You have the City Bike Foundation, and there are individual sponsors, and the city advertises?

KH: Ahh, yes. The City of Copenhagen will always buy a few; I would say 200 out of 1,200.

I: You have an outside company doing maintenance, you outsource?

KH: Yes, but it's a part of the deal now. Before that, Copenhagen had a special department for cleaning the street, etc. They did it. But that will change now, what we are doing is getting more income for the company and putting money away. Right now the maintenance is done by a company called Reva. It is a very social company, because the background for them is to get the unemployed to work. If you were to take a bike, it's not difficult to maintain the bike. Reva takes people that have a problem in society and are unable to find a job, and have received money from the community for the last three or four years. We have to start them again, when the come into Reva they must learn to get up in the morning, and after 9 months they will get another job somewhere.

I: Because it's done this way, is it cheaper?

KH: I will get more people, for the same price. But the people aren't very efficient. But there is a social background for it and then of course it has something to do with Copenhagen. But it's good for us.

I: They also redistribute the bikes?

KH: Yes, they have cars. They will pick them up and drive around, and if someone were to drive out of the zone they will take them back. Everyday, we have 110 stands where the bikes are, and everyday, they will drive around in a car and look at the bikes standing there and say "oh, there's something wrong with that. Could we do it here on the spot?" If they can not do it they will put it in the car. If you do it this way, you will always get the bikes in the car, and the next day when they drive through they will put in the racks where there is no one there. That's the way that we do it.

I: Do you get enough bikes in to redistribute them properly? Or do you still have some racks that are always short?

KH: The problem with this is that there are some racks that are more successful than others, if you are near a metro or something like that. And there are other places

that are not as popular where you can always find one. The only way to do it is to have more bikes.

I: How about you, what is your job here?
KH: I am the managing director. There are two people here. I am in the same department.

I: You're selling advertisements?
KH: Yes, that's my main issue. Ian Elmelund is the other. He is in the board, the Forman of the board. He takes care of the financial things and stuff like that.

I: This is a non-profit organization?
KH: Yes, it is non-profit organization.

I: How many members are there on the board?
KH: There are three. And Ian is one of them, and the third one... I can't remember his name. But he is with the city. It is a small organization so it varies. What we shouldn't have is very heavy costs for the daily lives.

I: What is the goal?
KH: What our goal is, of course, is to get more money and we started this year, we will get a million DKK ($120,594) in from the stands, and we have sold the bikes of this year. And what we hope to do is buy 1,000 more bikes for the next year, and that's an important development from what we have.

I: How many bikes do you have now?
KH: Oh, we have 1,200.

I: Christian Christiansen, he didn't know the exact number, but said that roughly 200 are lost each year?
KH: Yeah, I would say that. But it's very strange to say, because we had some bikes out in 1995. We haven't seen them since, and suddenly they come back. You know, they have been somewhere, but we don't know where. I wouldn't say that Denmark is a big country but if you have to look for ten bikes (laughs).

I: Who are the targeted users of the program?
KH: The users? We want everyone to use the bikes. We don't have any main target, but we know who use them the most.

I: The tourists?
KH: No, well... the tourists, yes. But people between 14 and 25, they use it most. Then again, you have the second group, which is, of course, 25 to 35. That will be the users. Of course, I can take one all of the time, but that's not normal.

I: What we have gathered so far, is that mainly the tourists use them?

KH: Yes, the tourists use them a lot. But, not the main users in numbers because they are only here for a few months of the year, in the summertime. If you take Denmark and say, here we have the tourist season, then the tourists would go like this: (draws graph). Of course, in this period, 50% of the bikes are used by tourists. It has something to do again with, in that period some of the people of Copenhagen are away. It's easy for tourists to get them in that period because they are not so many Danes to take them.

I: From what we gathered the targeted users were people taking the train into the city and from the train station taking the bike to work.

KH: We'd want to say that yes. It is not the main idea, but it is part of the idea, of course. One is to get the targeted persons; the other is to say that we'd function. If you take the train, and there are no bicycles there... if you've done that twice, you won't count on it. Our problem today is that there are not enough bikes to fulfill that obligation.

I: For example, someone biking to work everyday, without using any train would not use this because they will have their own bike?

KH: Yeah, I will have to give you some figures here. If you take Copenhagen as a city, one third of the population coming in is cars. Do you know these figures?

I: Yes.

KH: Okay, you know them. So we are talking that about one third of the people coming in by train or buses.

I: Yes, and the main goal, is to have that part of the trip.

KH: I would like to say yes, but we haven't fulfilled it yet, which means we'll need to have bikes. But it's not the only goal; other goals are of course, to get cars away from the city. You don't have to take a bus in, people have cars. People who live in Østerport or Østerborg have a car, they don't need it; they could use a bike everyday.

I: Couldn't those people afford their own bike?

KH: Yes, but if they are out in the city, or have been out for the evening, and they need to come home again. They need a bike. Or they can walk.

I: Are you pleased with the current CBP?

KH: Yes, we are. Are you talking physically about the bikes?

I: About meeting the goals?

KH: No. We need more bikes.

I: So the only plans for the program are to get more bikes?

KH: That's the main plan. If you take paragraph one that is it.

I: So this year you expect 1,200 bikes?
KH: We have that, and we will buy a thousand more. We have just ordered them, and will get them in September.

I: Oh, so you've already ordered them?
KH: Yes, the 1,200 are finished. What we are talking about now is, will we put them on the street, or wait until next year. I would say that we will double our... Next year we will get more bikes, we know that now because we have the money for it.

I: Are you making a lot more money now through advertising than before?
KH: Well, I wouldn't say that we do it on the advertising but we sold our poster stand.

I: Was it a one time payment?
KH: No, we will get it for ten years. And then we will have to wait for this again, we have not given it away. We have rented it out.

I: So what is the cost of each bike?
KH: About $200 each. And then we have to paint them and put them together and get them spare parts.

I: How much does it cost to put them together?
KH: We do that through Reva. I know what I give them per year, but not per bike. That's about one to one point five million DKK (181,094).

I: Who determines where to put the bike racks?
KH: It has already been decided. We did it together with Copenhagen. What we want is the best places of course, and what they want is some places that are easy to put them there.

I: Are they in the same place every year?
KH: Yes. Yes. Well... it's not true, because there have been some buildings, so some have been taken away and put them in other areas... but a hundred of them haven't changed.

I: So they weren't put in places for advertising reasons, more for functionality?
KH: Yes, but we will take the advertising into view. My background for being here, I have been in advertising for 25 years, I have been the director of a few American companies. That is my background, and now if someone wants advertising on the bike, there should be something in it for them.

I: We've been looking a lot at Smart-bikes. How do you feel about that?
KH: We have talked a lot about it, but the main thing is cost. The investment and the maintenance cost.

I: Is the maintenance more?

KH: We think it would be, what we have learned from the city-bike in Denmark, which, by the way, is the world's biggest. One of the problems here is that there is a lot of violence; people destroy things that they didn't need to destroy. This is a free bike, you can take it for 20 DKK ($2.40), when you leave it, you get your 20 DKK ($2.40) back. We have a lock on it, and people somewhere, try to cheat and put something else in. I can't understand what is happening in their head. Now, we have a smart card, which we sold it. People who like to have a bike, we will sell them this smart card for 100 DKK ($12.07), 200 DKK ($24.14), whatever. You will be sure that there will always be a bike for you. Because nobody else could take it. What would happen? The people who couldn't afford, or wouldn't afford, to buy the smart card would destroy it. They would destroy the bike or take it away, something like that. I think that's what would happen. They would take it anyway; then you have some bikes without locks.

I: Have people broken the bikes off before?

KH: Yes, of course. Yes yes. The other part is of course that it would cost a million Kroner or something to put that on every one because you need to have station there with the card reader or something like that. And then of course, that part will cost too. Of course something would happen with that.

I: The 20 DKK ($2.40) is in the lock in the bike? Not in the lock in the rack?

KH: Yes. If you take a bike, you put 20 Kroner coin in drive around, put it back, you get the 20 Kroner coin back. Like when you buy groceries.

I: We don't have that in America, but we've heard about it. They are for free.

KH: Oh! You don't have that? Ahh... they are for free. See, we're better than you are. (laughs)

I: Have you talked to any of the countries that have used a smart card system?

KH: Yes, we've heard about it and talked to a couple engineers, and have followed what has happened around. It has been used on very small scales. 20 bikes or enclosed areas or something.

I: We have been talking to Sandnes Norway.

KH: Yes, there is one of them there. I don't know exactly what has happened there. I think it's too small. I would like to see a big city having it. In my head, I would like that. If I would like to have a bicycle, once a year go and buy a car or something like that which would allow me to do... because that will give me income.

I: But if you buy it or not, you could register the smart card, and they will have your information on it, so that if you steal it.

KH: Well, what happens is, if I have a smart card, I put it in it, take my bike, drive it over there, go in a shop, someone takes my bike when I'm not there. I would be registered for the person who has taken my bike. That's a problem. The good

thing about the system here is that if there is a bike standing over there, there could be 20 Kroner coin in it. Normally there would be. So, one little kid, or something could take the bike put it in the rack to get the 20 Kroner coin. That is the grand idea; it's not always as complicated as you'd think it would be. Someone would take the bike, drive out of the bicycle zone, which is in the inner of Copenhagen. And they will come 10 kilometers away, we don't know exactly. But we find them around. Because, people are very kind to call us and tell us "we find a bike in our back yard, would you like to have it back" so we go out and take it. And, after two or three months you get all of the bikes back. Of course, we miss one or two hundred, as we talked about. But next year, perhaps we'll get them back. Some of them are stolen; we know some have been on the back of campers, where they put two, and drive to France; you don't know what people are doing.

I: Someone said that they found one in Spain. (laughs)
KH: Exactly! One in New York! It's true, how it gets there, I don't know.

I: Also Rennes France.
KH: Yes, that's AFA JC Decaux.

I: Oh, we thought that was a company called Adshel
KH: I thought it was, it could be Clear Channel. Yes, it's Clear Channel. It's a strange company which hasn't sold anything in years, because of the stock market.

I: You've obviously heard about the smart-bike system.
KH: I would love to have it, but I think that it would cost me to get it, maintain it. I would rather say that I want more bikes. The best way to get violence away is to have a lot of bicycles on street. More bikes. That's the only way. Because if you have more bikes, all the slots will be filled up. There is no reason for, if you miss 2 or 3 hundred taken away from the city, you can't see it. The more bikes you have everyone will then say "oh, there are bikes everywhere, I can depend on it, if I take a train in, in the morning, there will be a bike." The main goal, why should I put a smart card in it if I have enough bikes. What will I do with a smart card? The only thing I'd get out of it is some people would think: "why couldn't I get a bike?" That's the main thing I would get out of it I think. Of course, there's some money into the maintenance and things like that... but the main thing is that some people, and it's not "I do not have enough money" or "I'm unable to get a smart card" or you have to 23 or have black hair... I don't know, what the way you should get a card should be... everyone should have it, if they want to. And they will say "hmm. It's not fair" and they will kick the bikes. Destroy them.

I: Even here?
KH: Oh yes, even here. We are not as beautiful as you think we are. It is like everyone else. I always think that people who destroy things for no reason are people who are bent with themselves. If you are well educated you don't go and kick cars.

Of course if you are young, between 14 and 18 you are more violent, in that period.

I: Wouldn't you have the same problem smart cards or no smart cards?

KH: I don't think we're talking about damaging the bikes now, it has nothing to do with kicking them away, it has nothing to do with driving a little too rough, or playing with it. When we started (laughs) the first year, all the young people would find out how many people could be on a bike, driving at the same time. But after one or two years they have tried that, but in the beginning when we have the bikes in the beginning we had this problem here. We have these little baskets, and it was not very heavy, but people would put their bag in it. Or sitting back, and what happened? It broke off. So we had to take it away. Things like that.

I: There's no rack on the back?

KH: No, for the same reason. If we put something on it, people will sit here.

I: Who are the main advertisers of the bike?

KH: We have two ways of saying, one is the three year contract. Which is of course, is less expensive per year than a one year contract. And what we have had there, we have had companies like Netto, which is a grocery store, we have Politeken, which is a newspaper... then we have a big one called Super Brugsen, a supermarket, like Netto yes. And those are the big ones we've had. And lots of small ones. I could give you a list of them. For example, the United Nations, Copenhagen, Copenhagen Energy, that is a private company. They will be the main sponsor this year, they will have 600 bikes.

I: The energy company isn't related to the government at all?

KH: No, they have been a part of the Copenhagen government, but they have been privatized so they are a free company now. And their reason for doing this, they are not sponsors because they have blue eyes; they are doing it because the energy market is getting free. Now you can come from Germany and buy the Danish Energy Company, so it's very important for them to get known in the public, so they can say... of course, they have some political goals themselves.

I: So they are doing that on their own, they are not doing it to promote biking?

KH: No, we had them last year.

I: Will the program be successful if you need more than one bike, or even one bike per person. The whole thing about it is sharing the bicycles, so is there ever a problem with the concept because everybody needs to be at work at about the same time, what do you think about that?

KH: What should we do? I don't know honestly, because it's a very difficult question. What I have said to myself is that we have to work in two ways. One is, of course, to get more bikes. That will solve itself. But the other way we could do it is, and we've talked a lot about it, to make a special bike, to make what we call, the train bike. We haven't done it, but we've been thinking about it, we think it's

a good idea, and if you are a peddler, and come in every day, you buy a car for a month, instead of biking every day. And you buy a month pass for the train, and one of the goals by doing that, you get this bike key, and the bike will be standing there, and the reason it could be a good idea, is if you have a bike with a lock on it, with a key, if you need it the next day, you'd have to come back.

I: Why not have them buy their own bike?

KH: It's cheaper, and it will always be okay, and you shouldn't be afraid of somebody stealing it, one of the problems in Denmark is that there are a lot of bicycle stealing. It could be because there are so many bikes. But young people: "oh we have to go home, what should we do?" take some bikes.

I: But they all have locks?

KH: Yes, but you wouldn't steal a bike like that. If you could steal another one you always would always take another one. That's part of the concept of the bike.

I: How should you get more peddlers to take the bike, and use it more to get the cars out of the city?

KH: Honestly one, I can't tell you. Two, the best way would be to take this bike with some sort of key, or put it in some area where there's a guy who will say "I'd like to have my bike" – "what number do you have?" – "number 25"

I: Why not sell a lock, or sell a place to park your bike? If you're going to have that lock system you might as well have your own bike?

KH: the reason as I told you before, when you come to Copenhagen and you put your bike by the train station, it will be there for twelve hours no body looks after it. I can talk for myself, if I came in... which I don't, because I have a car, I would like the opportunity that it is there. I don't always want to use it, I want to know that if I'm a little late I could use it. Of course, I could do that with my own bike too, and perhaps that's the reason we haven't done it... when you ask me about smart cards, I think what I know until now is that it will look fancy and I will get some income perhaps, I'd like to have more income... but in real life shows me that I will give some of the profits, therefore I will not do it. Of course the situation now, I can not do it because I don't have the money for it. If I were to put a smart card thing in now, I would use all my money instead of buying new bikes, and I wouldn't do that. And I think the main thing is, if I could, I have 1,200 bikes now, if I could get 3,000, I would have no problems. Then I have to think about another thing, now I have 3,000 bikes, should I make the area bigger. Then I'd need 6,000.

I: Do you think 3,000 is enough for the area?

KH: Yes. I have 110 racks, and you can count on them in those racks, there will be between ten and twenty bikes in each. So you take the average, that's 15, times 100 that's 1,500, I have 1,200 bikes. I could tell you, it'd be very difficult to find one in time. So if you had 3,000, they could be there.

I: Not relating to rack size, but to the demand, is 3,000 enough?

KH: I think 3,000 would be the figure we need for Copenhagen. Based on my knowledge on how it is now. But you can see here, the area we are talking about is (shows map) it's not a big area. There it is. We talk about Copenhagen; this is what we call the city within the city, the old city. City-bike was in bad condition when we got here, and now it's in good condition. If we were to make it bigger, it would be 3 times bigger.

I: So if there are city-bikes here (points to map) are you hoping that someone would take a bike there and then drive into the city?

KH: Yes.

I: Someone there would have their own bike though, and they wouldn't need a city-bike?

KH: No, not really. But if they were to go in and have a happy evening, they would have taken a bus in. And they have been at bars, young people out and it's 2 in the morning, and they have to go home. Perhaps they would take a city-bike. So, two goals. One is to get enough bikes here, to say, "Now. We have enough." This would be the number we'd need here. Could we stop there? I think if we have around 3,000 we'll be there. I don't know, nobody can tell us. What I know now, is that if I have 1,200 I do not have enough. The most important thing about it, is if you have all these stands, where you can put the bikes if there are no bikes in that one, people will not say, this is an opportunity I could use, because I could take one here. They would never bike there, they will forget. it should be a habit in some ways. Or they will say, there is no one there, I will have to go there. If you have 1,200, you can not be sure about that.

I: Another thing is that the primary users are not the tourists, but the tourists do use them.

KH: I would like the tourists to use the bikes all year round, they drive very carefully they put them back. No problem with tourists.

I: Financially for the city, Tourists are generally a fairly large part of income, but you're giving them this free bike.

KH: There are two reasons for this, one is: you can't say "Not for tourists"

I: Right. But, for example, a smart card is not like that it would make it very hard.

KH: Yes, that would be good for the whole thing... because they could say "you are a very good customer, I will give you a free card" But again I have to say, that we have talked about it and have decided not to do it.

I: Would you rather have only residents use them?

KH: No, no. I like the tourists to ride them. Of course it fits very well, because the period where there are not too many things in Copenhagen, there are a lot of tourists. There is a season. If you go to Denmark, and you want to have good

weather, you have to be here between first of April, or may... and that's what people do.

I: Do you have any records or statistics that we might find useful?

KH: What we have for Statistics, is what people think about city-bikes. You won't understand a word of it (laughs) I don't have it in English. But I have some pamphlets. There is one very funny part of it... (flips through)

I: Do you have any problem with people not returning it to the racks?

KH: Yes (laughs). Someone took one, *Painted it* put another thing on it, and used it like their own. Ahh! Here it is. When we talk about Copenhagen, how many have seen the bike 96 percent. 4 have not. How many have seen the advertisements 31 percent. If you take the whole country and ask them.... 55% have seen them. And 45 have not. It has something to do with traveling, but it also has something to do with... you have seen them in pictures.

I: You have 1,200 bikes now, how many of them are sponsored?

KH: All of them.

I: Do you generally have more people who want to advertise? Or is it about even?

KH: It's difficult to get them. But we hope... the reason it's difficult, I have to say that when I first came into this, I told you that I was in advertising before. I had my own outdoor company which was sold 4 years ago. The reason I know something about outdoor, and the reason that people don't really want it, there are two reasons. One is if you have a big international company they advertise all over. And my main goal is that when I try to sell them I say that you will get two things. First of all, good coverage where there are lots of people in the special different way. The other one is that you will get... how do you say it... positive image to the company, because you are supporting a good thing. That is my main goal to sell this, and my problem has been, they have not looked so good... so that when people see it they say "I do not want to sponsor that because you say you will give it to my company, and it looks like trash."

I: Because of Maintenance problems?

KH: Yes, and because they have not been bikes enough, the way they stand in the stands looks awful. Because other private bikers put their bikes in the same stands, and we can't take them away because we're not allowed from the government and the police. Because they call it stealing, so if you have your private bikes in one of our racks, and we take them and put them over there, because we don't' want to have them here. Then you can't find them. And it's not allowed to do. We have really tried to talk to the police, and said "could we take them by someplace in Copenhagen and write on the racks, if you can't find your bike here you can come there and get it. Free? Or 100 DKK? I don't care. I would like to have the Kroner, I would like to learn them not to do it. Again, how should we solve that? Only one way. More bicycles. So there is no place for the private ones. And I think what will happen is that if there are very few bikes in

the racks people say "looks like we put our bikes here." Like graffiti, one tick on the wall, will attract more. If you have it look better, people will say "oh this is the city-bikes, we aren't allowed to put our bikes here."

I: Only Danish companies advertise?

KH: Coca-cola and Pepsi too. One of those that I think should have been there is Wonderful Copenhagen, what they have told me, is that we want to use our money to get tourists here. The other is Tivoli, but they say "oh we don't have enough money" honestly, they don't want to. That's what they are saying. Those you'd think would be obvious to get, you do not get.

I: Do you have any idea of the cost of a Smart-bike system?

KH: Oh yes, to get the smart card? It would cost around 2 million DKK ($241,718).

I: That's for all the racks?

KH: That's for the system, and you'd have to put it up too. It's too expensive. What could happen is if you needed a smart card, the number of racks could go down. Instead of 110, you could have only 50 or 25 because the people would know where they are. If you did that you could have the problem where everyone leaves them in the same rack.

I: How about when you get to 3,000 bikes inside this vicinity, would it be better to go with the smart-bike system, I'm talking about the 200 lost bikes each year. What would cost more, the loss of the bikes or the new bikes?

KH: That would be very much more expensive if you had 3,000. Because then you need place for all 3,000. If it was a smart card system, no one would put it on the corner. They would have to come back to it; otherwise they wouldn't be able to get their smart card back. Today we have around 1,500 parking spaces and that will be enough for 3,000 bikes because 1,500 will always drive around. If I have a smart card system, I need to have spaces for 3,000 bikes. Have you seen a rack? There's one just out here. It means I need more space, and the space I have we have got from the Copenhagen government, and honestly to tell you that this is not cheap. What they are giving us for space, you could put a car here and get money... parking fees...

I: But they are giving it to you for free?

KH: Yes, and for half of these places they have to take one or two parking spots away and you can count on getting 20 DKK. And after 14 hours per day 365 days a year, you'd get a lot of money. You'd have to double that. I don't know what the government would say to that.

I: What about the 200 bikes that are lost each year?

KH: When I say lost, I mean damage. If someone damages the wheels or something, we can throw it away and put something new on.

I: How many are stolen?

KH: That's the problem. We don't know how many are stolen and how many are driven away. We put it in one and that is the figure of 200 that you saw. The total number. And that has come rapidly down from the start. "oh that's a funny thing, we'll take one of them and put it on our wall." ::laughs:: on the back of the cars or something...as a souvenir in some ways.
So what we think will happen is we will get up to 3,000 we don't think the loss will be much bigger, because there will always be a group of bicycles that are stolen or taken out of the city area. But I don't think that it will grow. If we have 3,000 instead of 1,200 we will be more visible. Instead of driving out and taking a bike, people might drive out and take more. I don't know. We are learning by doing. What we have learned so far is that we are on a steady number now, I think that must be the number. We have more bikes; then there should be more bikes away and there are not. On the other hand, one of the good things of having more bicycles is that the maintenance costs will go down per bike because you will drive less per bike.

I: You mention maintenance, is Reva meeting the needs of the program?
KH: I would say so, yes. They have a lot of things to do. The good thing about Reva is that if we have more to do, we will have more people.

I: If a bike is damaged how long does it take to get through the system and come back? One day?
KH: Um... yes. You could say that because it will come back. They are working every day, and they do all the bikes that they can every day, maybe two and holidays, a little longer. If you have 3,000 bikes, you could take 500 out of the system and no one would see it.

I: If you have 3,000 bikes, how about at night, when there aren't enough spots. At 3 o'clock in the morning, where do you put the bikes? There are only spots for 2,000.
KH: Yes, I understand what you're saying. But, as far as we see now there hasn't been a problem with 1,200. If you have 1,200 bikes all 1,200 will never be in the stand.

I: Even at 3 in the morning?
KH: Nope. And that's the reason I say it.

I: When you say not all 1,200, is it 1,100 or 600?
KH: I'd say half. Well, 200 are away from the system as I told you. I think if, I don't know, but I think if you have 3,000 there will be 1,500 needing to be put in. But I'll find out next year. Learning by doing. Because I have nobody to look at. I have talked to Rennes and I have talked to Norway, but they have the same problems as we have. They can not tell me "if you have 1,200 how many?" we don't know. So you have to do it like this. I would like to have that knowledge, to know what happens, of course. I would like to have a system like you say, which is a kind of smart card, but I have decided to take the other one. Get up to

3,000, after that we can start talking about that. Again it has something to do with money. Always with money. Because we have no income, honestly, what we have is if we can sell the advertisements on the bike then we have something. We have not got every year income from renting out the rack posters. And that's very important for us, that we will have income enough just by that, that the CBP will work. Our next goal for the city-bike is through this year. The first year we have been here was to get funds so that we'd have the money to buy more bikes, and be able to again, next year. The trouble is that more we sell for bike advertisements the more maintenance we get. So the next goal is to get this rack very fine, so it looks good. Because the only way we can sell advertisements is to make it look well. If you buy a poster place in the city and it looks like this, you won't buy it. That will be the next year's goal.

I: And maybe with more bikes it would look better?

KH: I'm sure. Because every bike would look better, because there will not be so much maintenance. That means every bike will look better. And if it looks better, people will treat it better.

# Appendix D

Information obtained from phone interview with Sφren B. Jensen.
April 2002

Sφren B. Jensen was in charge of the CBP when it started in 1995. One thousand bikes were put out for the public to use. The municipality donated two million DKK and half million DKK was donated by the Green Foundation to purchase the first bikes. Half the users of the bikes were commuters going and coming from work or school.

The design of the bike was good, but it was too weak for heavy usage. In 1996, one thousand more bikes were bought resulting with a total of two thousand bikes for that year. Then the bikes started decreasing in number because they were worn out and taken out of the system; about ten to fifteen percent would be stolen each year.

In the beginning municipal services were used to repair the bike. The hip hops did not approve of the municipal investing so much money in the CBP so they began vandalizing the bicycles. To reduce the vandalism the hip hops were put in charge of repairing the bikes. After the hip hops, prisoners were used to maintain them. The problem with using prisoners was that the service was slow and they were not as skilled at repairing. Today the Reva-Centeret is in charge of the maintenance.

Sφren discussed using smart-bikes systems in Copenhagen with people from Amsterdam for about ten years. He decided against the smart-bikes while Amsterdam went ahead and used smart-bikes. Five thousand bikes is the number of bikes needed to resolve the availability problem in Copenhagen according to Sφren. He does not have any data to back this; it is only an assumption. His opinion of the changing the present CBP to SBS is negative in that it will take more time to take the bikes out because of the

pre-registering for the smart card. He believes that it will deter many users from using the bikes.

# Appendix E

Interview with Kim Madsen
Wednesday, 3 April 2002.

Interviewer: What are the responsibilities of this shop?
Kim Madsen: Well we have to make sure that all the bikes are there and make a guarantee for the sponsors that when they buy 200 bikes there are 200 bikes, and every year when we gather them together to take them home, we count them and if you have 200 bikes and we only have 150 left, we get 50 new bikes.

I: You are also responsible for the daily maintenance?
KM: Yes. We have made Copenhagen into four areas and we go to every station every day. Checking to see if the bikes are okay and repairing what we can, and taking home

I: You visit each rack once a day?
KM: Yes.

I: What date does the actual program start this year?
KM: We aren't quite sure, but I think it will be the sixth of May.
And we have two trucks driving all over Denmark collecting the bikes.

I: Where are you finding them?
KM: Everywhere. ::laughs:: even in Jutland.

I: Is this program non-profit?
KM: Yes, totally non-profit.

I: Does it get money from the state? Or just from the City Bike Fund?
KM: We are getting mostly from the City Bike Fund and a little bit from the state. You could say that the city-bike workshops are only a tool for us to make what we are to do for the people who are working here.

I: Do you have any number as to how much you get from the City Bike Fund and the state?
KM: That's very difficult to say. The City Bike Fund is paying for tools, the cars, the spare parts for the city-bikes, and some of the rent.

I: And the city is paying the people?
KM: Yes, they are paying the people who work here and some of the rent.

I: Are you involved with getting the people to come and work here, or is that a different organization?

KM: No no, I do that too. I am responsible for the workshop, and I am responsible for some of the things that are happening with the people here. I'm looking over the progress all the time. Things like that. I try to find jobs for the people.

I: These are unemployed people?

KM: Yes.

I: Do they make more money here or is it just to keep them busy?

KM: They don't make any money when they are here. No. They have their welfare. But when they are here, we work with them. We've got social workers and job contractors. And once a week we gather all the people into a meeting and talk about "What are your plans for the next week and where are you? Are you getting further? What do you have to learn to get a job?"

I: Do any of the people go into fields related to bicycling?

KM: Some, not many.

I: How long do they usually work here?

KM: I think, maybe, half a year.

I: How many bikes pass through here day to day?

KM: Normally it takes about 40 or 50 bikes a day. That's the number we put on the street each day.

I: In general how many do you take off the streets, and how many do you fix on site?

KM: I think it's about the same. About 40 or 50 bikes on the street and the same in the workshop.

I: You have three vans?

KM: We have four small vans in the city, and four trucks to gather bikes at the moment.

I: What is the percentage of bikes that you get in needing repair because of vandalism or misuse, or normal use?

KM: I think it's mostly vandalism. Yes. People are not treating the bikes very well.

I: Is it the vast majority?

KM: I think it's about 67%.

I: What do they do to the bikes when the vandalized them? Is it the lock?

KM: There's a lot of paint. Graffiti. They just try to break it apart; they do everything to those bikes. ::laughs:: We take a lot of bikes out of the canals of Copenhagen.

I: So what are the most common problems to fix? Repainting?
KM: It's difficult to say, because when a bike is painted on the site we have to take off the plates where the advertising are and change them all. I think it's mostly painting and removing.

I: Do you have any suggestions to make the bikes more durable? What are the most common problems with general failure, not because of the vandalism?
KM: I think it is the system at the stands with the chain and the lock, people don't use the kickstand. That's a big problem with the bike. People don't use it when they are through with it. A lot of people put the chain into the lock, get their 20 back, and walk from the bike, and then it falls. And if you have 10 or 15 bikes standing, it will take all the other ones with it.

I: How many employees do you have here?
KM: I think at the moment we have about 25 people.

I: Each is here for about 6 months?
KM: Yeah.

I: When you go to pick the bikes in the vans, do you notice any migration of the bikes from certain parts to any other parts?
KM: Yes, I think that most of the bikes are gathering around the center, around the Norrebro Station.

I: In the mornings, do they leave?
KM: Well, I don't think that it's common people in Copenhagen using the bikes. I think it's mostly tourists. When we are taking the bikes from here to put them out in the city, we always put them at the big stations, and people take them from there.

I: How many bikes in a year are too damaged to repair, and you must throw them away or use them for spare parts.
KM: In this winter we had to throw away about 21 bikes.

I: Normally, you take a bike in to be repaired, how long does it take to be repaired?
KM: I think it would take you, an hour. From when you found it until it's back on the street, maybe two days.

I: How bad does it get, what's the worst?
KM: I think in the summer season, it's maybe 3 or 4 days. When they are used a lot the damage is too much in the city and sometimes we lose spare parts or can't get them.

I: During the summer at the peak hours, how many bikes would you say are off the streets in the shop?
KM: I think the biggest count we've had here is about 200. It's not much.

I: Are you happy with the effectiveness of the shop?
KM: Yes.

I: Do you have any ideas for improvement? Or is it fine?
KM: I have some, I would like to have people driving around ON bicycles in Copenhagen [repairing bicycles as they go]. That would be good.

I: On site repairs?
KM: Yes. You know about the streets that you're not allowed to drive in? [Having these bicycles there] would be good. But I can't get people who want to drive them. ::laughs::

I: Do you notice any common parts of the bikes that fail frequently?
KM: I have some problems with the wheels because they are made of plastic, in time they get smashed in. That's a problem, but I think it's the best solution to have a plastic wheel because if you made it out of steel or aluminum, it would get bent. But the plastic, when you smash it... it will just go out again. But we are working on making a new wheel in plastic with another connecting device.

I: What makes up your operating costs here?
KM: At the moment it's about 1.5 million DKK a year. But that's only our costs. Then the Foundation pays for spare parts. That's about 0.5 million.

I: One of the big concerns with the program, we were talking to the City Bicycle Foundation's Klaus and he said it costs around $75 per year to maintain the bikes, per bike, and the bikes cost around $200. And that seems a bit high.
KM: I think that $75 is a bit high, I'd say it costs maybe 350 DKK about $40 per bike. I think that's more accurate.

I: The plan is almost doubling next year. Do you think the cost per bike to maintain will go down?
KM: I think it will go down. I think when we have twice as many bikes as we have now, the look of Copenhagen will be bikes everywhere and people will respect it more.

I: You say in the summer season it's busier?
KM: Well, in the winter season we are repairing all the bikes and getting them ready, painting them. But when the system starts, the day after we put them on the street, we start repairing and gathering.

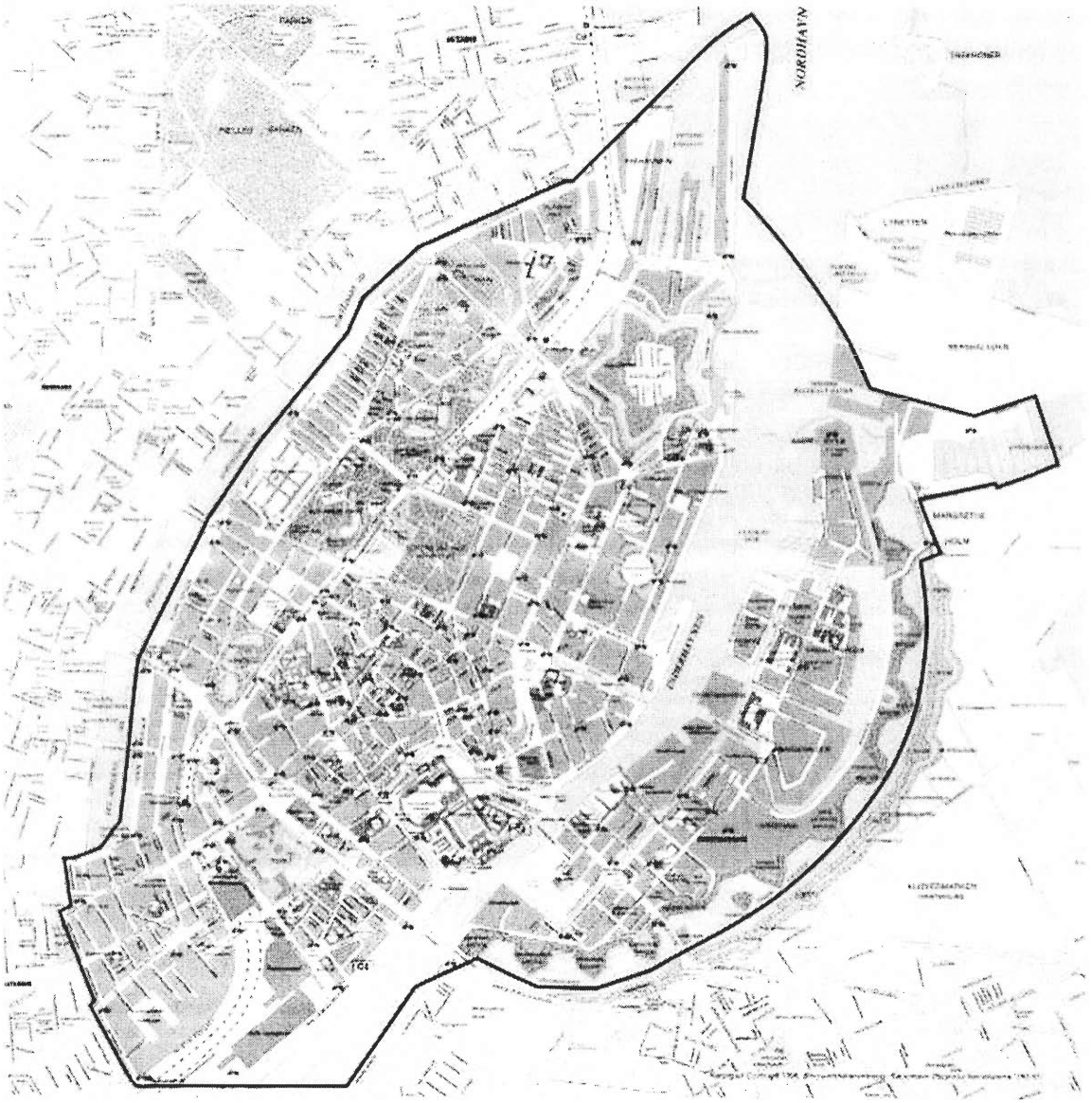
I: Are there some times when there is more damage than others?
KM: Yes, in the holiday times. Summer holiday. In June and July, there's very big damage.

I: How many racks are there?
KM: Um... 110.

I: The new bikes are coming in September, but they won't make it in until next year?

KM: Yes, there will be 1,200 new bikes in this season, but not until next year.

# Appendix F



# Appendix G

Independent research carried out in 1999 and 2000 involved two separate studies of the SmartBike system. The first was conducted by a group of 6 students in June 1999, during which 252 people were questioned, 15% of whom were Clear Channel Adshel SmartBike users.

Results of this survey showed that SmartBike was generally very well perceived:

- 66% of people scoring it seven out of ten. The average mark among all persons asked was 7.8, with an average score of 8.1 given by users of the system
- 46% of card holders said they used the bikes on a regular basis
- 69% confirmed they used SmartBike along with other means of transport.

For nearly half of all users, Clear Channel Adshel's SmartBike had become their main mode of transport across the city.

The second study was commissioned by the French Ministry of Transport, and was carried out by an independent company. Results of the survey of 200 users produced the following statistics:

- 38% of cardholders are women, 62% are men
- their ages are broken down as follows:

| | | | |
|---|---|---|---|
| 16-18 | 4% | 35-44 | 22% |
| 19-24 | 26% | 45-59 | 16% |
| 25-34 | 26% | 60+ | 6% |

Their reasons for using SmartBike are:

| | |
|---|---|
| Home to work | 24% |
| Home to school / University | 15% |
| Leisure / Pleasure | 22% |
| Shopping | 27% |
| Exercise | 2% |
| Others | 10% |
| Total | 100% |

- 83% of users chose to use SmartBike for trips they previously made by other means of transport
- 33% remarked that SmartBike gave them the opportunity to undertake journeys they had never made before
- 92% are rather or very satisfied with the system.

In 1999, over 40,000 trips using SmartBike were recorded. Typically, the journey lasted 26 minutes and the average age of a user was 32 years. In more than two thirds of cases, the bike was returned to a different station from where it was borrowed.

The number of loans was found to have increased steadily over the year, with lower levels of rental during the peak holiday periods. Rentals reached the highest levels in June, September and October.

Loans were distributed evenly across all working days, and showed a drop over the weekend. Usage was spread throughout the day, with a significant increase during peak commuting hours.

These results indicated that people were using the bikes to get to and from their place of work or study - a finding supported by the fact that more than 50% of bikes loaned were situated next to universities, at a bus interchange point or following a park-and-ride pattern.

# Appendix H

| Population | Country | City | # of city bikes | Currenlty operating | Planning on starting | Considering city-bikes | Program was abandoned | Unknown | Notes |
|---|---|---|---|---|---|---|---|---|---|
| 1.5 million | Denmark | Copenhagen | 1200 | X | | | | | Section 4.2 |
| 200k | France | Rennes | 200 | X | | | | | Section 4.5.1 |
| 50k | Norway | Sandnes | 150 | X | | | | | Section 4.5.2 |
| ~1.5 million | Netherlands | Amsterdam | 250 | N/A | | | | | Section 4.5.3 |
| ~1 million | Netherlands | Rotterdam | 25 | | | | X | | Funding: 50% city of Rotterdam, 50% city province of Rotterdam |
| 100k | Norway | Stavanger | ? | | X | | | | System starting this year - same bicycles as Sandnes |
| 555k | Finland | Helsinki | ? | | | | | | 26 stands, deposit of 2 € |
| 572k | USA | Washington DC | ? | X | | | | | Smartbike integrated with subway smart-card |
| 34k | USA | Olympia | 32 | | | | | X | |
| 400k | USA | Tucson | 100 | | | | | X | |
| 70k | USA | Missoula | 50 | | | | | X | |
| 50k | USA | Rapid City | 50 | | | | | X | |
| 440k | USA | Portland | 700 | | | | | X | May have been abandoned |
| 2.5 million | Singapore | Bukit Batok | 180 | X | | | | | 17 racks, smart cards issused to residents over 21 |
| 60k | Norway | Drammen | 250 | X | | | | | 28 racks, 1300 users |
| 327k | Wales | Cardiff | ? | | | | | X | |
| 36k | USA | Annapolis | ? | | | | | X | |

# Appendix I

Sandnes kommune

Sykkelbyen Sandnes

# Cycling in Sandnes, NORWAY.
# Sandnes City Bike System.

Part of WHO Project:

Promotion of Energy Efficient Personal Travel in a Network of European Cities

Sandnes, 08.04.2002
Mangor Eikeland
**Chief Municipal Developing Director**
**Civil Engineer B.Sc.**

## 1.0 Introduction

The municipality of Sandnes has a population of 56 000 and is located on the south-western coast of Norway. Sandnes is Norway,s 9th largest city. Its annual average growth is about 1.9%. The 2001 City Budget for Sandnes is about kr. 1.700.000.000,- or approximately 215.000.000,- euros.

Sandnes was established in the 1600`s as a built up area, and in 1860 Sandnes was granted city status.
In the beginning the city was known for its brick works and pottery industry. Later it was production of woollen goods, textiles and bicycles, which placed the city on the map. Today the city boasts a sizable petroleum-related industry, a computer industry plus one of Norway,s two chinaware factories. Sandnes joined the Healthy Cities Project of WHO in 1991 and is a full member of the international network.

In 1993 Sandnes was awarded the Environmental Price in the County of Rogaland for the idea and the work on organizing facilities for cyclists and in 1997 the town was awarded the Norwegian Environmental City Prize for the work on the City Bike Scheme in the city centre.

Fig. 1 Sandnes City Centre looking south – west.

## 2.0 The pilot bicycle project in Sandnes

In 1990 the government decided to start a 4-year pilot bicycle project in order to reduce car traffic and Sandnes was chosen to be one of two pilot towns. The two main goals of the project were:

- to make the town more friendly for cyclists, i.e. a *construction* part; see fig. 2
- to make more people use the bicycle, i.e. a *campaign* part, see fig.3.

In 1994 the politicians decided to prolong the project in our city and as a result there has been spent about 100 mill. Nkr. ( 12,5 mill. euros ) in the construction of new bicycle lanes and roads and about 10 mill. Nkr. ( 1,25 mill. euros ) to carry out campaigns over the last 10 years ( 1991 – 2001).

As a result of 10 years work and money spent there as been an increase in cycle traffic of about 10%. The use of helmets have increased from 10 % up to 46 %.
In our district the percentage of cycle traffic is 5% (wintertime ) and 12% ( summertime ) of the overall traffic.

Today Sandnes has the best facilities for cyclists in Norway

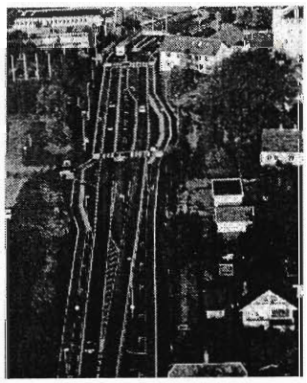


Fig. 2. Red bicycle track through the town centre.

Fig. 3. Campaign. Introducing free city bikes to the citizens.

### 3.0 The City Bike project

As part of the campaign scheme the administration and the politicians decided to introduce a public bike system in Sandnes starting in June 1996 as the first City in Norway.
There are three systems of city bikes:

- Free or the open system ( using a coin to open a lock )
- Subscriber system ( the subscriber has a special key )
- Rental system ( paying a rental cost or deposit )

As Copenhagen in Denmark , Sandnes also introduced the free or open City Bike System using a 20 Nkr coin to open the lock. The City Bike was an ordinary bicycle with a special green colour. This system was, however, a vulnerable system and it did not function in our city. The public did not deliver the bikes back into the stands after use ( no bikes in the stands ) and the ordinary bikes were to weak. Also parts or units were stolen from the bikes since it was an ordinary bike.

## 3.1 The subscriber system

The Sandnes City Bike Foundation therefore decided to construct a new solid bike ( see fig. 4 ), to invent a new electronic key system ( see fig. 5 ) and to use a subscriber system. In such a way all the city bike users are owners of the system and wants the system to function at all time.
The electronic lock system is very unique ( all in one system) e.g. " every ones bicycle ( all subscribers ) when the bicycle is placed and released in a public stand and only yours ( the subscriber ) when placed or locked anywhere else". When the bicycle is locked outside a public stand only your key can release the bicycle.
As a subscriber you buy a key paying 100 Nkr ( 12,5 euros ) for one year. You register in a computer system, name, age, male or female etc.. Every time you use or release a bicycle, it will be registered and stored in the stand. There are certain rules for time use. It is allowed to use the bike for 6 hours only.
Within certain periods the data are collected for reporting reasons. If anyone of the subscribers has misused the system, this can be discovered. Misusing the system gives you a penalty point. After 4 penalty points the key will stop to function. The system also can trace the journeys ( from one stand to another).

To run the system The Sandnes City Bike Foundation has two agreements:

1. Agreement with the municipality to be allowed to have 20 advertising plates or boards located in the city centre ( see fig 6 ).
2. Agreement with an advertising firm or organisation to operate the system.

In this way The Sandnes City Bike Foundation has no expenses. The advertising firm is operating the system by income from the advertisement. The agreements will last for 20 years.

In the year, 2000, The Sandnes City Bike Foundation tested out the subscriber system in the city using 55 brand new solid special city bikes and 20 stands spread around in the city centre. About 350 people were subscribers or test persons.

## 3.2 The City bike as part of a transportation chain.

In 2001 The Sandnes City Bike Foundation were supposed to have a full scale program in the centre of Sandnes using 225 city bikes (1 pr. 250 inhabitants ) with gears and 30 new city bike stands containing 350 parking spaces. Up to now there are installed 75 brand new city bikes with 4 gears, 15 brand new stands containing 125 spaces for parking ( see fig. 7 ). The full scale plan will be finished in 2002. Our customers or subscribers ( hopefully 2000 ) will be working people or school pupils using the system as part of the transportation chain ( train and bike, bus and bike, car and bike ), tourists visiting our city and inhabitants for shopping reasons.
Negotiations will be held with the Norwegian Railway Company and local bus companies in order to cooperate in selling monthly or yearly pass to regularly passengers or customers. In this way the regular passenger will get both a bus or train pass and a City Bike key. In such a way the passenger will be more flexible in his journey to and from work or school by combining bus, train an a public City Bike.
The overall aim to have City Bikes in a town or city is to reduce the amount of motorised traffic which gives more environmentally friendly towns and cities.

### 3.4 Survey.

Results obtained from the data stored in the stands will be presented twice a year. After the first test period in 2000 (June, July and August) some of the results were as follows:

- The ( subscribers) or users are: 66 % male and 34 % female.
- Age of users:3 % (6-10), 21 % (11-15), 11 % (16- 20), 45 % (21-45), 19 % ( 46 –70)
- Time used: 66% (0-1 hour), 26 % ( 1-4 hours), 8% > 4 hours.
- Weekdays: 11% Monday, 15 % Tuesday, 17 % Wednesday, 19 % Thursday, 24 % Friday, 13% Saturday, 1% Sunday.


Fig.4. New solid City Bike design

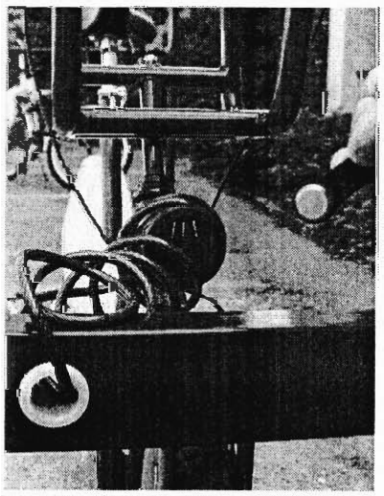


Fig. 5. Electronic lock system.

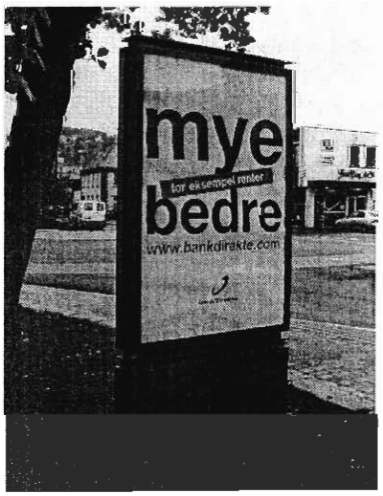



Fig.6. Advertising board.

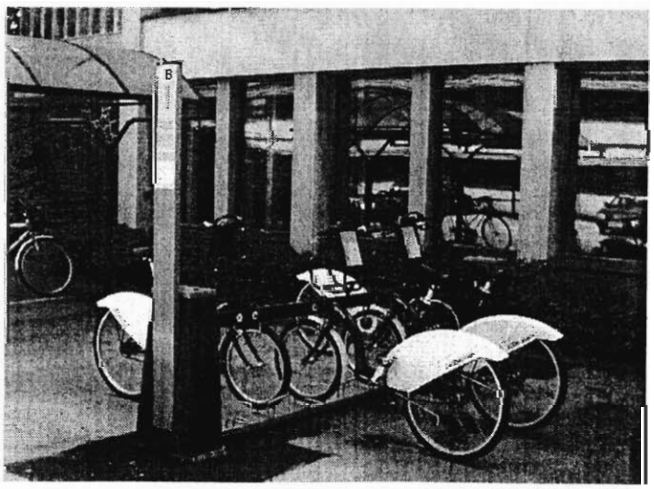


Fig.7. City Bikes and Stand, model 2001.

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**E-mail: mangor.eikeland@sandnes.kommune.no**

# Appendix J

**FIBERGLASS:**
Depending on the type of graffiti. work your way up the thinner list. Beware that acetone-based solvents will soften plastics. Use paint remover full-strength and rinse carefully. Try Peel Away in an inconspicuous place first to assure it will not mar the surface.

Products: See thinner list, Off, Procon, Peel Away

**GLASS OR PLEXIGLASS:**
On regular glass any razor blade can scrape away cured paint. For other marks any solvent can be used. Use the clean rag technique and hold the rag over the graffiti for a moment to let the solvent work. On plexiglass be careful of the lacquer thinner-type solvents as they can attack the surface causing it to fog and smear. Make sure your product is compatible with the type of surface you are cleaning. Rinse thoroughly.

Products: See thinner list.

**METAL:**
On any unpainted metal (iron or stainless steel) surface, any solvent can be used. Some polished aluminum surfaces will cloud or oxidize with aggressive cleaners like lacquer thinner. Use the clean rag technique. If you are unsuccessful, try paint remover.

Products: See thinner list.

**ETCHING:**
Surfaces scratched or scored with sharp objects can only be filled with fillers or the material will have to be replaced. Some new types of glass have replaceable covers or film layers that are cheaper to replace than the etched glass. Automotive body fillers can fill deep gouges then be repainted. The only other recourse may be to replace the glass. If that is not possible, you might discourage future etching attacks by using fogged glass. You might deny the vandal visibility by etching over the vandal's mark, thus turning a "P" into a "B" and so on. It's a psychological solution, demonstrating that this area will not tolerate the vandal's message.

## PRODUCTS MENTIONED

**KILZ II** A primer coating used to prevent bleeding through of new paint.

**PROCON** Comes in quarts or gallons; can be wiped on with a rag and hosed off.

**GOOF OFF** Comes in a spray can; spray on and wipe off with a rag.

**PEEL AWAY** Comes in buckets and goes on like peanut butter. It takes 24 hours to set then can be washed off with high pressure hose. Works well on fiberglass and porous surfaces.

**BLASTER** A type of remover like Procon, Goof Off and Peel Away that can be used with a pressure washer if the area is porous or a very large job.

## TO REPORT GAFFITI PLEASE CALL 286-8715 or E-mail at graffiti@milwaukee.gov

### *TIPS TO HELP PREVENT GRAFFITI*

- ✔ Keep an eye out for suspicious behavior. Pay special attention to individuals or groups who are loitering. If it appears they are about to apply graffiti, call 911.
- ✔ Improve lighting on your property. If graffiti is a problem in your alley, consider installing motion detector lights on your garage.
- ✔ Report all incidents of damage to your property. Reporting is important because it may be possible to identify patterns through accumulated reports, helping police deal with the problem. Call 933-4444 to report it.

## The Broken Window Syndrome

In New York City, sociologists coined a phrase the "Broken Window Syndrome."

Along big industrial corridors they discovered that if a single window was broken, it quickly escalated into additional broken windows and other vandalism. Yet, by repairing the single window quickly, future damage was avoided.

Most importantly, the public's perception about safety and neighborhood values rose. Graffiti works the same way.

One small graffiti scribbling may not appear threatening. However, it entices other vandals to do likewise in nearby areas.

Any graffiti, no matter how small, needs immediate attention.

To wait is to feed the broken window syndrome and jump start the spiral of neighborhood decline.


Limited free paint is available for graffiti removal at

Milwaukee Christian Center N.I.P., 1223 S. 23rd St., by appointment ONLY!

Paint is available in six different colors.

**Call the N.I.P. at 643-7704 for information.**

City of Milwaukee Department of Neighborhood Services

# HOW TO WIPE OUT GRAFFITI

- ✔ Tips for Property Owners
- ✔ Where to Find Help
- ✔ Resource & Product Guide

DNS-190 Graffiti Removal Tech V3.7 tnw 3/7/02

# BASIC CHEMISTRY OF SOLVENTS

A solvent is a substance, usually liquid, that will dissolve another substance. Choosing the right solvent will make a job easier; using the wrong one can damage tools or a work project. To avoid costly mistakes, one should be familiar with the most useful solvents and where, when and how to use them. The longer the graffiti has to dry, the stronger the solvent and more difficult the cleanup process will be. Time may be your best tool...don't delay remove it TODAY!

Obviously, most chemical solvents are flammable and release toxic fumes. Be sure to read the manufacturers' instructions before using them and observe all safety precautions. Buy them in limited quantities — only as much as you need—and store them in metal containers away from children, pets and flames.

## *THINNER LIST*

• **Turpentine** is produced by distilling the oleoresins from pine trees. It is also known as spirits of turpentine or turps. The best grade of turpentine is called pure gum spirits of turpentine. Turpentine has more solvency than mineral spirits. Even though turpentine is less toxic than petroleum-based solvents, it can cause an allergic reaction in some individuals.

• **Mineral spirits**, also called "white spirits", is a petroleum distillate specifically manufactured as a substitute for turpentine. Most painters prefer it as a paint thinner because it costs less, is not so sticky and has a less offensive odor than turpentine.

Turpentine and mineral spirits are good first-try cleaners, although turpentine can remove paint that has hardened slightly. Mineral spirits will dissolve only fresh paint.

• **Naphtha** is a petroleum solvent similar to mineral spirits but with a greater volatility. It is used chiefly as a paint thinner or as a cleaning agent. Naphtha is a more powerful solvent than mineral spirits, so less is needed to dissolve the same amount of paint. Naphtha is highly flammable. When using it, work in a well ventilated area and wear rubber gloves and a respiratory mask. Good on crayons.

Alcohol is sold in many forms: isopropyl, methyl, wood, ethyl and denatured alcohol.

• **Isopropyl alcohol** is the familiar rubbing alcohol formulated for external medicinal use. It is also useful for removing resinous stains and for removing the gummy tar residue such as in shoe polish and magic markers.

• **Denatured alcohol** is used for thinning shellac and for cleaning brushes used to apply shellac. It can be used to remove light pencil marks on wood. It can be used to clean certain permanent markers.

• **Lacquer thinner** is a blended mixture of two or more solvents. Acetone, amyl or ethyl acetate, keotone and toluene are common ingredients in lacquer thinners. Lacquer thinners are designed to thin lacquers and clean equipment used for lacquer finishing. It can soften and dissolve most paints even after they've hardened. It is highly effective at removing spray paint. However, it can soften underlying paint and many plastics and vinyls.

• **Acetone,** a common ingredient in lacquer thinner, is a useful solvent for working with plastics. It is effective in removing residue from plastic cements, especially the cyanoacrylates (also called instant or super glues). It is the recommended thinner for polyester resins and fiberglass. It will melt plastic vinyl.

Acetone and lacquer thinner are useful for removing paint and varnish, but they will soften and dissolve many plastics like plexiglass. Do not use a nylon brush for applying these solvents because the acetone may attack the bristles. Both acetone and lacquer thinner are highly flammable, and both release toxic fumes, so avoid inhaling them as much as possible.

• **Methylene chloride** is the principal ingredient in most paint removers and in heavy-duty brush cleaners. Sometimes it is combined with other ingredients and sold as "graffiti remover." It is effective in removing all finishes, but it too attacks and softens plastics. It can be hard on human skin, so wear rubber gloves when working with this solvent.

*If you know the type of graffiti (crayon, spray paint, magic marker) go right to the type of solvent you need. Otherwise, work your way up the solvent list and see what works.*

*Technique is as important as the right solvent. You must use a CLEAN low-nap rag and keep using a clean part of the rag with each wipe. Otherwise as the graffiti softens, you'll just end up smearing it around. See the Graffiti Removal Techniques Section for details.*

# GRAFFITI REMOVAL TECHNIQUES

## *Painting Over Graffiti*

If a large portion of a property has been vandalized, it may be cheaper to simply repaint. A $10 gallon of paint covers the average 100 sq. ft. garage door for an average cost of 10¢ a sq.ft. It will also give you the opportunity to possibly change paints to a glossy enamel which will resist future graffiti attacks better than a flat finish. For added protection, an extra gallon of the same type of paint will help ensure a quick and painless perfect match if graffiti returns.

Before painting, try to clean the surface of any dirt or grease. Certain marker pens and indelible markers have the ability to absorb paint pigments. That's what makes them permanent so use a special paint called a stain blocker. Also, if the base color is light and the graffiti a dark color, use a stain blocker first. This special type of paint prevents the darker paint from seeping through the fresh paint.

## *Oil or Latex paint? Sealers? Foam brushes?*

Oil base paint is tougher than latex. Latex is cheaper and easier to clean up. Though not recommended, oil base, can be applied at below freezing temperatures if needed. Oil base takes longer to dry, but can be used if light rain threatens. Once the new paint is on, you might consider using a "sealer" or "protectorant." These types of products seal the small surface pores and prevent graffiti's ability to adhere. Once sealed, the new graffiti is easier to remove with less work. Some protectorant systems sacrifice a small amount of the the sealer and need to be reapplied after the graffiti is removed. As a good insurance policy, buy some foam-type brushes. If graffiti reappears, use the foam brushes and the new paint will blend into the old with perfect results. Then just toss the brushes away since they are inexpensive.

## *Identify Type of Surface*

### BRICK, CEMENT, CONCRETE:

Use extra strength paint remover, graffiti remover or Peel Away. Apply with a wire brush to work into holes and pores of stone. Allow time to activate and rinse with a forceful stream of water from a hose. Use of a pressure washer or soda-blaster may be needed.

If the surface is uniformly flat, a light grit (60) sand paper can remove paint, but will also scratch the surface. Consider using a sealer after removal to close pores and make future removal easier.

Products: Procon, Peel Away, Blaster

### STUCCO:

Due to the multi-faceted surface of stucco, it is impossible to sand off. Use paint remover or Peel Away and follow up with a high pressure water hose or better yet a pressure washer. Use stucco paint and go over the graffiti carefully. Consider using a sealer as a finish coat.

Products: Off, Procon, Peel Away

### ALUMINUM/VINYL SIDING:

Aluminum siding is usually coated or painted. Vinyl siding is made of plastic which can be marred by lacquer thinner-type cleaners. Solvents may work too aggressively and remove the coating as well. Experiment in a small inconspicuous area first and then tackle the more visible areas. Use paint remover sparingly and carefully. Use a clean rag and keep turning to a clean part of the rag before each wipe. The longer the solvent stays on the surface, the deeper it penetrates. In most cases, you will probably have to repaint. Peel Away may work better on certain types of vinyl.

Products: Off, Procon, Peel Away

### WOOD:

Try working up the solvent list if the marks are new. Most thinners will remove magic markers and acetone will remove day old spray paint. You must use a clean rag and keep using a fresh part on each wipe. On latex or oil-based paint, use a stain-killing primer for exterior use. After the primer or stain blocker coat has dried, you can proceed with regular paints, oil or latex. Most oil base paints are more durable to solvents and hence could make future clean up easier. Consider a sealer coat after final finish. Avoid using flat paints as they readily absorb pigments from markers and spray paint.

Products: See thinner list, Off, Procon, Kilz II

# Appendix K

Dansk Cyklist Forbund

**Til hvem det måtte interesser**

Dansk Cyklist Forbund er ved at gennemføre et mindre projekt om bycykler. Dels om bycyklerne i København og dels om bycykler generelt. Projektet har til formål at belyse hvilke systemer af bycykler der findes og hvordan de kan anvendes i forhold til forskellige bystørrelser, herunder vedligeholdelse, sponsorer og finansiering. Projektet udføres i samarbejde med Worcester Polytechnic Institut. Projektet gennemføres af 3 studerende herfra Disha Vachhani, Stephen Herbert og Michael DiDonato. Projektvejleder er professor James Demetry og direktør Jens E. Pedersen.

Projektet vil blive afsluttet i maj 2002 med en rapport på engelsk.

Venlig hilsen

Jens E. Pedersen
Direktør
16.4.2002

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