Smart Bikes: Public Transportation for the 21st Century
Commuter Choice/Bicycling Programs

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**Executive Summary:**

Bicycles are not commonly thought of as a form of public transportation, however this concept is being successfully challenged throughout the world with Public-Use Bicycles (PUBs). The introduction of the smartcard to the PUB concept has created the "Smart Bike" and set the bicycle on the path of becoming revolutionary to urban public transportation systems throughout the world. This paper will explain the PUB concept, examine a PUB, and discuss the present and planned applications of the Smart Bike.

**What is a PUB and How Does it Work?**

The basic premise of the PUB concept is sustainable transportation. PUBs are ideal for urban transportation due to their advantages over other types of public transportation because they:

- provide on-demand transportation,
- reach destinations that are not transit accessible,
- require less infrastructure than other modes of transportation,
- are less expensive to produce and maintain,
- do not add to congestion,
- do not create pollution,
- decrease theft of personal bicycles, and
- provide the user with the added benefit of exercise.

Few other modes of transportation provide many or all of these benefits.

A PUB is a bicycle that one may use in order to meet their transportation needs in an environmentally sound manner. One would use a PUB to reach their destination and then leave the PUB at that location for another to use. The theory is that with a few hundred or thousand PUBs on the street, there should always be a PUB available to use.

Three generations of PUBs exist, with a fourth currently being developed. To better understand the third and fourth generation of PUBs, which are better known as Smart Bikes, it is important to understand how the PUB concept came to be.

There are likely 50 cities throughout the world with PUBs. Most of these programs exist in Europe, with some in North America, and a few in Asia. These PUB programs are known under a variety of aliases, such as “City Bikes”, “Free Bikes”; and under a rainbow of colors that they are painted, “White Bikes”, “Yellow Bikes”, “Red Bikes”, etc.

**First Generation PUBs**

The PUB concept began in 1968 in Amsterdam, The Netherlands, as an ideology of a progressive era. Luud Schimmelpennink along with the Amsterdam city government launched the “White Bike” PUB program by placing a small number of PUBs in the city. The PUBs continuously circulated throughout the city and provided cheap and clean transportation. Unfortunately, the program was abused. PUBs were not left on the sidewalks, but taken inside homes for private use or thrown into Amsterdam’s many canals. Over a decade later, a similar program was launched in Milan, Italy, with 1,000 PUBs, but it also failed when none of the PUBs were returned to the street after a short period of use.

First generation PUBs, like this Dutch program, usually use donated mass-market bicycles, which are then all painted one color in order to stand out from other bikes. There are no specific locations where the PUBs must be returned, so one could find one or leave one propped up anywhere on the street. This type of PUB program would usually be free to the user. A community group, sometimes with the financial help of the local government, will administer the PUB program.

**Figure 1: First Generation PUB Program (Minneapolis/St. Paul, Minnesota)**

In the U.S. as of Summer 2001, there are about 25 first generation PUB programs. American cities with first generation PUBs include Portland, OR; Minneapolis/St. Paul, MN; Boulder, CO; Princeton, NJ; and others. The first generation American PUBs have been reasonably successful, however, stolen PUBs are large problem.

While the first generation of PUB programs is the least expensive to operate because most of the materials and time are donated, it is the least reliable for individuals wishing to use a PUB because there are no reliable locations to find one. In addition, there is no built-in security to prevent individuals from stealing the PUBs. This need for improvement lead to the second generation PUBs.

### Second Generation PUBs

Designers of the second generation PUBs learned from their experiences and developed a PUB program that was more reliable and less likely to be stolen. This time, specially designed PUBs were created. These PUBs were designed to be utilitarian and require less maintenance than earlier PUBs. Along with the PUBs, special racks were designed for PUBs to be taken and removed. The racks were strategically placed at train and bus stops, multi-story housing complexes, shopping districts, tourist attractions, and other areas that receive a high volume of foot traffic. The racks took the randomness out of finding a PUB.

To ensure the PUBs would be returned to the racks, a coin-operated locking mechanism was attached over the center of the handlebars. To use a PUB, one would insert a refundable coin

deposit into the device in order to unlock it from the rack. The coin deposit would have to be large enough to encourage the user to return the PUB to another specially designed rack and lock it so the deposit would be returned. The greatest value coin in the country would serve as the deposit for the device, ranging from $1 - $3, however, varying by country.

In order to ensure that a PUB would be readily available for use, it was important to concentrate the PUBs within a designated boundary. This boundary included the central business district of the city and nearby high-density neighborhoods.

Second generation PUBs are more expensive than their predecessors are, so a non-profit organization is sometimes created to administer the PUB program. In many cases, the local government will assist the organization with funding. Addition funding is provided by advertising, which can appear on the disc wheels of the PUB and display (as seen in Figure 2).

The maiden launch of the second generation of PUB programs was in 1995 in Copenhagen, Denmark. Niels and his father, Wilhelm Christiansen, co-designers of the Danish PUB; along with the City of Copenhagen government; and the City Bike Foundation of Copenhagen placed 1,100 PUB throughout downtown. The PUB program has been widely popular and reasonably successful. *Politiken,* a major daily newspaper of Copenhagen, followed a PUB for 12 hours and found it spent only eight minutes not in use. The Danish PUB is the longest running PUB program as it is functioning today.


**Figure 2: Second Generation PUB Program (Copenhagen, Denmark)**

The second generation of PUBs was more reliable than the previous generation. First, because the Bikes were specially designed to be more durable, and therefore require less maintenance. Secondly, individuals learned the locations of PUB racks, so finding a PUB became more reliable. However, even with these improvements, tracking stolen PUBs was nearly impossible, as theft is still a big issue for Copenhagen and similar PUB programs.

The third and fourth generations of PUBs, or Smart Bikes, improves upon this. Before we look at Smart Bikes, let us look at the design of second generation PUBs, which Smart Bikes rely upon.

**Close-Up of a Second Generation PUB**


**Figure 3: Second Generation PUB (Helsinki, Finland)**

**Basic Design** - Second generation PUBs have a unique design, which serves many purposes. They are designed to look different from all other bicycles and therefore are unmistakable in their appearance. Special tools are required to disassemble second generation PUB and the components are incompatible on other bicycles.

**Frame** - Second generation PUBs are built for utility and durability, not for speed, hence a strong steel frame. The top tube of the frame is oversized to make room for paid advertisements.

**Fenders and Chain Guard** - To provide a safe, comfortable, and clean ride. Both front and back fenders protect the user from street debris. The chain guard prevents the user's pant leg from being caught in the chain or soiled with chain grease.

**Brakes** - There is a coaster brake and some countries require a hand brake.

**Locking Mechanism** (see Figure 4 below) - Similar to shopping carts at supermarkets that require a refundable coin deposit, a locking mechanism is attached just below each PUB handlebar, connecting the PUB to the rack. A coin inserted into the bottom of the locking mechanism releases the lock at the top.


**Figure 4: Close-up of Locking Mechanism**

**Adjustable Seat Post** - PUBs are designed with an adjustable seat-post with minimum and maximum heights to fit a variety of individual shapes and sizes. A quick-release lock on the seat-post allows the seat height to be quickly adjusted. The maximum height setting prevents

individuals from removing the seat and seat post from the PUB.

**Solid Rubber Tires** - Solid rubber tires provide a longer life than air-filled tires and require less maintenance. Solid rubber tires are puncture-proof whereas air-filled tires are not.

**Disc Wheels** - Additional advertising is allowed on the discs. Beneath the discs are three large plastic spokes rather than many metal spokes. The larger plastic spokes allow the wheel to be more durable.

**Lights** - Motion sensors automatically turn the lights on when the PUB vibrates from use.

**Display Placed Adjacent to Each Rack** (See Figure 5 below) - The display presents locations of PUB racks, a boundary map of where PUBs must stay, PUB program rules, and possibly advertising.

**Figure 5: Display and Rack (Helsinki, Finland)**

**Gear** - PUBs are designed with only one gear because additional gears add to the manufacturing cost. One gear is usually sufficient.

The need for continued improvements to PUB programs gave rise to the third generation, the "Smart Bike". A high tech solution involving magnetic stripe cards allowed PUBs to be "smartened", and therefore better tracked. This greatly reduces theft and PUB replacement costs, which are a large percentage of PUB operating costs.

### Third Generation PUBs, the "Smart Bikes"

The design the third generation PUBs, or Smart Bikes, are very similar to the second generation PUBs. The main difference between the second and third generation is the tracking of the PUBs to prevent theft. Whereas the second generation PUBs are released from the rack with a coin, the Smart Bikes are released with a credit card-sized magnetic stripe, or "mag stripe" card. This card will contain personal data about its owner, such as their name and address. With the mag stripe card the PUB can be "checked-out" from the rack by swiping the mag stripe card through a reader and the rack will release a PUB. The computer can record the release of a PUB to the individual and should the individual not return the PUB to another rack, s/he could then be charged for the PUBs' replacement cost.

Five Smart Bike programs exist as of the summer of 2001. Four programs operated by the advertising company, Adshel, are in Rennes, France; and Bukit Batok, Bukit Gombak, and Pasir Ris, Singapore. (See Figure 6 below.) The fifth program is the modern "White Bike" program, or the Depo Bike, which is the smartened reincarnation of the first generation PUB program of Amsterdam. (See Figure 7 below.)

The Adshel programs have been put in place in their four locations over the past three years with additional plans to place two more programs in the U.K. in the next year. The Adshel programs use a special mag stripe card. To receive this card, individuals must read and sign a form stating they understand the guidelines of the Smart Bike program. There is also a clause stating they will not hold any organizations affiliated with the Smart Bike program liable in the case of an incident. Personal data is held on the card and should a PUB not be returned, the individual would be charged for its replacement. Because of this improved tracking of PUBs over previous generations, the Adshel programs are doing well.

The Depo program began in 1996 in Amsterdam, The Netherlands, and functions differently in that one must use a special telephone card to access the Smart Bikes. At the origin rack, s/he must notify the system of her/his planned destination rack. S/he also must reach the destination rack in a limited amount of time. Many have complained of the "Big Brother" aspects of these requirements. The Depo program has been having difficulty, however, plans to improve its service.


**Figure 6: Accessing an Adshel Smart Bike (Rennes, France)**

**Figure 7: Depo Smart Bike (Amsterdam, The Netherlands)**

As of the summer of 2001, the fourth generation of Smart Bike programs is in the planning stages for Annapolis, Maryland; and Alexandria and Arlington, Virginia. However, these programs will be the first to integrate a smartcard, rather than a mag stripe card, with the Smart Bikes. A smartcard is a credit card-size plastic card with an embedded computer chip that stores and exchanges data with a reader. The purpose of smartcard integration with the third generation PUBs is to increase the capabilities of the program in the amount of data to be stored on the card and to provide access to 175,000 customers who already have a smartcard which can be used Washington, D.C.'s, Metrorail subway system.

**Washington, D.C. Regional Activities to Develop the Fourth Generation PUB**

Annapolis, Alexandria, and Arlington are similar in many ways and each is an ideal candidate for the development of a fourth generation Smart Bike program. The three jurisdictions have urban areas with bike-friendly downtowns. Alexandria and Arlington are adjacent to each other, just across the Potomac River from D.C. and have many large job centers and a high level of transit service. Annapolis is about 40 miles from D.C. and has an active historic downtown, as does Alexandria.

Annapolis has made a commitment to use the Adshel Smart Bike program with plans to be functioning by late 2001 to mid-2002. Alexandria and Arlington have yet to decide which Smart Bike program to use. Regardless of which Smart Bike program(s) are tapped, it (they) will be integrated with the Washington Metropolitan Area Transit Authority's (WMATA) "SmarTrip" smartcard. The Washington, D.C. region is unique because, thanks to WMATA, the region was the first in the U.S. to use smartcards on its subway system. Plans are to expand SmarTrip card use onto all of the region's buses and trains, as well as those of the Maryland Transit Authority, serving the entire state of Maryland.

Smartcards will greatly help track the PUBs due to the SmarTrip's registration feature. WMATA allows individuals to register their SmarTrip card when first purchased. Registration of the card is encouraged, but not mandatory. About 90% of SmarTrip card owners do register their card. Registration benefits include lost or stolen card replacement with the stored amount minus a $5 replacement card cost. With the registration information stored on the smartcard, individuals who do not return a Smart Bike would be charged for the replacement cost of the PUB. Those who do not register their SmarTrip card would not have access to the Smart Bikes.

WMATA is examining a possible linkage of its SmarTrip card with one's credit card to allow the smartcard to provide a greater service to its owner in allowing him/her to be able to accomplish everything they would do with two cards (their credit card and transit smartcard), however, with one smartcard. In addition, this feature would also allow Metro to fine individuals who do not return their Smart Bike for its replacement cost. The replacement cost of a Smart Bike is around $500.

## Liability of Smart Bikes to the Administering Organization

Preventing injuries is important to the success of a PUB program. There are many ways to do this, including designing a more bicycle- and pedestrian-friendly central business district. However the easiest way to prevent injuries is to encourage helmet use to PUBs users. While wearing a helmet is a requirement for children when riding a bicycle, adults are not required to do so. Providing helmets with each PUB is possible, as the Portland, OR, program does with its first generation PUBs, however, few programs have taken the initiative. Alternatively, PUB programs could encourage regular users to bring their own helmet or, local businesses could cooperate by providing a helmet for a refundable deposit. To further prevent incidents, a minimum age requirement for use of the PUB program is important to ensure that the user has better traffic judgement. Also, the PUBs could be available to the public only during the day and not at night due to decreased visability.

PUBs are designed as "Use at Your Own Risk". A few of the American programs have attached a sticker on their PUBs with this phrase. No American program has gone to court to deal with a liability issue to date. One possible solution to the liability issue is to require individuals to electronically "sign" a Web document saying that they understand the rules of the Smart Bike program, the inherent risk of riding a bicycle, and that they will not hold the program liable should an incident occur. Once an individual completes the document with personal information; such their name, address, etc.; then they would have access to the Smart Bikes.

## Additional PUB Benefit: Decrease in Theft of Privately Owned Bikes

Bicycle theft is a problem in most places. In Denmark in the 1981-1991 period alone, an average of about 90,000 bikes a year were reported stolen. One of the many goals of Copenhagen's PUB program is to decrease bike theft by offering an alternative to a potential thief. The police estimate that roughly two-thirds of thefts are "convenience thefts" - where a bike is stolen simply to be used as a mode of transport, then the bike is abandoned. In Copenhagen, PUBs have caused convenience thefts to drop dramatically. Statistics from the Danish Statistics and Insurance Information Organization reported bicycle thefts were down for the 3$^{rd}$ and 4$^{th}$ quarters of 1995 and all quarters in 1996. The Copenhagen PUB program began mid-2$^{nd}$ quarter in 1995, just before this decline in private bike theft.

## How Can Government Begin a Smart Bike Program?

### Gain Support

To begin a Smart Bike program, support from the highest levels of the local government is necessary. To launch Copenhagen's PUB; the support of Bente Frost, Mayor of Copenhagen; and Søren B. Jensen, General Secretary of the Fourth Magistrate Department for Municipality of Copenhagen; were key in getting the project off the ground. They obtained permission from

Copenhagen's City Council to construct the racks over increasingly rare public parking spaces and in pedestrian-only plazas.

**Find Funding**

There are many funding sources in the U.S. at the local, state, and federal level for this type of program. These funding sources include the Federal Transit Administration, the Transportation Equity Act for the 21st Century (TEA-21) funds, Congestion Mitigation and Air Quality (CMAQ) funds, your state Department of Transportation, and local transportation demand management funds. The amount of funding you will need is dependent on the PUB program you have.

**Decide Who Will Administer the PUB Program**

There are a variety of ways to administer a PUB program. It can be done by the local government (as in the case of Helsinki's Department of Transportation), by a for-profit company (like Adshel is doing in France and Singapore), or by a non-profit organization (as in the case of the City Bike Foundation of Copenhagen).

Adshel is an advertising company, which installs and maintains bus shelters, kiosks, and other street furniture at no cost to the local government in exchange for roughly 95% of the advertising revenue the street furniture earns. Adshel gives the remaining 5% to the jurisdiction. In many cases, Adshel will provide a Smart Bike program to a local government as an award for using its services and administer it depending on the level of revenues they receive from the street furniture ads. The free street furniture can be a boon to some governments, however, others may have a "billboard ban" and either not allow large bus shelter panel-size advertising.

**Create a Boundary and Select Strategic Rack Locations**

Create a boundary map of the densest part of your city in which the PUBs must remain. The boundary will usually be the central business district with adjacent high-density residential neighborhoods. As mentioned above, these locations will include transit stations, commercial and residential centers, and other large employment sites.

**Purchase and Install PUB Program**

The cost of PUBs vary widely due to technology and administration agreements. Contact information is provided in the bibliography on the three major PUB designers.

**Maintain PUB Program**

Due to the wear-and-tear of daily use, PUBs will need regular check-ups. A bicycle mechanic would visit each rack to inspect PUBs. At this time, the PUBs can receive tune-ups and worn down parts can be replaced.

## Conclusion

Transportation agencies exist to assist individuals' movement over short and long distances. Public transportation, such as buses and trains, are efficient modes of assisting people with longer distance travel, however, these modes are expensive and cannot meet everyone's needs. In addition to these modes, a more personal mode of public transportation is needed to assist in serving the individual over shorter distances.

Smart Bikes should not be seen as a competing mode of public transportation, rather as a complementary mode that is another tool in the toolbox of public transportation. In most cases, Smart Bikes would be used where other public transportation is not available or is not timely enough to meet the individual's needs. This niche is present and being underserved. Not everyone will want to ride a PUB, but the option should be there for those who would consider or prefer it.

Smart Bikes would assist the transportation agency to meet the needs of the public, which they are tasked to serve. Smart Bikes are much less expensive to operate and maintain than other forms of public transportation. A fleet of 100 Smart Bikes would cost in the range of tens of thousands of dollars to operate and maintain annually, compared to a fleet of 100 buses, which would cost in the range of hundreds of thousands of dollars, or more.

PUBs are a remarkable example of an increasingly successful and sustainable concept that is helping to solve many urban problems, such as vehicular pollution and traffic congestion, while providing an efficient means of transportation, decreasing the need for parking, and improving the local quality of life. With recent technological advances in smartcards, Smart Bikes are becoming a viable form of public transportation for the 21$^{st}$ century.

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For a listing of cities with PUBs, visit www.ibike.org/freebike.htm.