

**CREATING BICYCLE-FRIENDLY CITIES:
INCREASING BICYCLE RIDERSHIP THROUGH IMPROVED
SAFETY CONDITIONS, BICYCLE INFRASTRUCTURE, AND
THE SUPPORT OF A BICYCLE CONSCIOUSNESS**

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Abstract

This report examines the use of bicycling as a transportation alternative to the personal automobile in the United States. It begins with a review of historical trends that caused Americans to move away from bicycling for transportation and choosing to adopt automobiles as the primary mode of transportation. A review of articles, reports, and studies is used to consider the benefits connected with utilitarian cycling and electing to bicycle for transportation. The report focuses on three prominent barriers that affect an individual's decision to bicycle: bicycle safety, bicycle consciousness, and bicycle infrastructure. The study discusses how these three obstacles are considerable factors affecting bicycling. The study also discusses a number of exemplary solutions for overcoming these barriers that have been implemented in bicycle-friendly cities in the United States. An analysis of plans and policies for the bicycle-friendly cities of Portland, Oregon and Davis, California is used to determine what historical actions have led to a more complete bicycle network in these two cities which have elected to promote bicycling. An in-depth evaluation of Boulder, Colorado, provides insight for specific plans that have been adopted and strategies that have proven to be successful in improving bicycling for transportation. The report attempts to demonstrate that bicycling can be made a viable means of transportation in United States' communities by adopting comprehensive plans and policies that address the challenges of bicycle safety, bicycle consciousness, and bicycle infrastructure simultaneously.

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Dedication

For my beautiful fiancée,

Amy.

There are moments when I think it is not possible to love you more.

And then I do.

CHAPTER 1 - Introduction

Rising gas prices, environmental concerns, and various health benefits have increased the number of bicycles on the road today (Scheider, 2008). Whether it is to get fit, reduce pollution, or to save money, more and more people are making the decision to use bicycles to commute to work and school. The current push for sustainability and alternative transportation options has reached an all-time high, and people are demanding more integrated bicycle solutions. However, there are considerable barriers to creating a successful bicycle-oriented community. Identifying these barriers and generating solutions for them is a task that urban planners are facing in cities across America. To address this rising demand for bicycling, it is apparent that planners must become familiar with multiple modes of transportation including bicycling as an alternative to the personal automobile.

Americans today are faced with the task of reversing the historic trend of automobile dependency and reducing its negative impacts with which our motorized country has become familiar. Following the examples of a few select model cities in the United States, other communities can consider these examples to create their own successful bicycle-friendly cities. Beginning with the current state of affairs and continuing into future generations, planners and city officials should assume responsibility for expanding America's existing transportation network to include bicycles as a viable and integrated method of travel. In order to do this, an assessment of the prominent barriers to bicycling should be considered. This report will examine promoting and educating greater safety for cyclists, initiating attitude and behavior change through increasing America's bicycle consciousness, and improving the bicycle infrastructure network.

Purpose and Format

The purpose of this report is to educate Americans about biking as a transportation alternative to the automobile and determine what can be done within the planning field to promote bicycling. This research has been completed in an effort to answer this principal question: Why is bicycling such an under-utilized form of transportation in the United States?

What can be done to increase participation? After preliminary research, it was found that there are several important components to the under-utilization issue. This study then looks at three subsequent questions. The first question is what are the most prominent obstacles to getting more people to use bicycles for transportation? Second, what is being done to address these obstacles? And the final and most important question to be answered is what planning strategies can be used in order to create more bicycle-friendly communities?

To answer these questions, the following steps were taken. First, a review of works and reports was used to assess how bicycling in the United States has reached its current status. This includes beneficial reasons why individuals may elect to bicycle as well as the current level of bicycling in the United States. Next, a review of previous studies was conducted in order to determine what types of issues are affecting people's willingness to utilize bicycling as transportation in cities. Following identification of predominant barriers to bicycle use, a variety of solutions to these problems are examined. This is important in order to assess what methods can be used effectively to encourage and increase bicycle use. Then a prominent bicycling community was observed and its programs documented as a means of analyzing possible solutions that could be adapted in other cities. A review of current practices and initiatives in Boulder, Colorado, was used to examine what can be done by planners to achieve and support higher levels of bicycle use. A section is included which considers potential funding options for necessary bicycle infrastructure and support programs. Finally, a summary of the report is provided accompanied by recommendations and concluding remarks.

CHAPTER 2 - Review of Literature

United States Develops away from Bicycling

In the course of American history many factors have led to suburbanization, which in turn has decreased the capacity of efficiently utilizing the bicycle as a viable means of transportation. Perhaps the single greatest contribution to suburbanization in the United States was the introduction of the personal automobile and the subsequent policies that created and expanded the American love affair with the automobile. The desire of Americans to seek and live on country lots outside of the bustle of the large city led to the subdivision of open land around the fringes of cities. This action decreased the population densities of cities while simultaneously increasing the distances that must be traveled in order to reach work and obtain necessary goods and services, thus perpetuating the need for motor vehicles (Golob, & Brownstone, 2005). Since the introduction and adoption of the automobile as the primary mode of transportation in the United States, the country has continued to develop in ways that are not suited for bicycle transportation.

What is commonly referred to as the “modern bicycle” – with two equal-sized wheels, pneumatic tires, and a chain-driven rear wheel – became widely popular in Europe and the United States in the late 1880s. More than one million bicycles were produced in the United States in 1896 (Herlihy, 2004, 5). The growing use of bicycles in the United States during this time led to a great deal of independence for men – and especially women – of all ages. Working men were able to use the bicycle as cost effective transportation in place of horse-powered vehicles. Also, the freedom and liberation that a large number of women experienced as a result of riding a bicycle even led to social reform of which the strict Victorian style of women’s clothing gave way to looser standards. Less than a decade later in 1908, Henry Ford began mass producing his Model T using the assembly line method adapted from bicycle production. Ford’s automobile manufacturing techniques made a large quantity of automobiles readily available and at affordable prices. The popularity of the Model T took over in the United States and nearly phased out the bicycle (Herlihy, 2004). Enamored by the independence and versatility of the personal automobile, Americans quickly adopted the new means of travel as the country’s primary transportation.

Although interest in better roads was renewed by bicycle users, in the late 1890's, as the demand for more automobiles increased, so too did the need of effectively moving a growing number of vehicles on the road. Hence, new roads were constructed to accommodate this influx. Federal investments were made as a result of the Federal Aid Road Act of 1916 under which counties were able to improve rural roads for delivery of mail and for agricultural transportation (Weingroff, 1996). 40 years later, the United States roadway network culminated in the Interstate Highway Act of 1956. The highway system introduced by President Dwight D. Eisenhower solidified the present system of roadways connecting major cities in the United States (Weingroff, 1996).

Combined with the extension of the road networks and the availability of the automobile as the central means of transportation in the United States, evolving land use policies also contributed to the shift away from pedestrian centered development. As the roots of early planning practices were geared towards the improvement of health conditions and social environments in cities, a method of separating incompatible land uses was implemented. This involved different land classifications for industrial, commercial and residential uses with several sub-classifications of each. The result of these measures prevented homes from being located unnecessarily close to dangerous or hazardous activities as well as ensuring that other land uses such as schools were also not situated near factories or other potentially harmful industrial uses. The unintended consequence of this well-intentioned practice of zoning is the extended commuting distances between residential homes and jobsites and commercial centers, thus necessitating longer drive times and more cars on the road.

Over the years, as people have become accustomed to long commutes and the convenience of driving a personal automobile, coupled with fast food, drive through services and other automobile-oriented development, the need to leave the car has been virtually eliminated in many circumstances. An increasing amount of time spent in vehicles rather than choosing other healthier means of transportation has led to increased obesity and other health complications in the United States as well as the burgeoning dependence on fossil fuels and increased levels of pollution released into the environment. The following three sections discuss some of the potential health, economic and environmental benefits of bicycling for transportation instead of driving a personal automobile.

Health Benefits

An increasing number of people have begun to use bicycling for transportation as a means of exercise to stay fit and improve health. However, in a study conducted to compare obesity rates in Europe, North America and Australia, it was found that Australia, Canada and particularly the United States are extremely automobile dependent. This dependency is so entrenched that both self-reported and clinical measurements of obesity in these countries showed a direct correlation to each country's level of active transportation (Bassett *et al.*, 2008).

The United States Department of Health and Human Services states that the most crucial element to staying healthy is physical activity, followed by proper diet and avoiding risky behaviors such as drinking alcohol and smoking. Maintaining adequate levels of physical activity has been shown to play a major role in reducing the risk of obesity and related conditions including coronary heart disease, stroke and diabetes (United States Department of Health and Human Services, 2008). Bicycling to and from work, school, or other destinations can be used as time for increasing an individual's physical activity.

The Centers for Disease Control and Prevention recommends that adults need at least 150 minutes of moderate aerobic activity every week or 75 minutes of vigorous activity. Bicycling has been found to be an excellent means of meeting physical activity needs. It is a low impact form of exercise making it an activity that people of all ages can participate (Centers for Disease Control and Prevention, 2010). Although 150 minutes of physical activity per week may seem daunting, the Centers for Disease Control and Prevention suggests that meeting this goal is made simpler by breaking the activity up into smaller periods of time. So a 15 minute ride to work and 15 minutes back five days a week would complete the recommended 150 minutes of physical activity per week. Many European nations have higher levels of bicycling or walking than the United States. When combined with the use of public transit for longer commutes, bicycling can serve most people's physical activity needs (Bassett *et al.*, 2008).

Most trips that Americans make are short including 40 percent that are two miles or less. Of the 40 percent of trips under two miles, 74 percent are travelled by car (Bikes Belong Coalition, "When People Ride Bikes [...]," 2009). If these short trips were made by bicycle instead of automobile, countless numbers of Americans could meet their physical activity needs while also enjoying their commute to work and saving money by using a less costly mode of transportation.

Economic Benefits

In 2008, an average of 17 percent of annual household expenditures was spent on transportation which includes more than \$8,000 on private vehicle expenses and \$2,700 on gasoline and oil alone. Transportation is the second most expensive household expenditure behind only housing (34 percent). Even food (13 percent) makes up a smaller percentage of household costs than owning and operating automobiles (Pocket Guide to Transportation, 2010, 32-33). With an average annual cost of \$308 for a bicycle (Moritz, 1997), commuting by bicycle is less than 4 percent of the cost of driving. Assuming that gas is \$2.75 per gallon and a vehicle gets 20 miles per gallon of gasoline, an individual making the decision to bicycle five miles to work and back three days a week can save \$214.50 per year in fuel costs alone, not to mention the additional savings they may have spent on a gym membership or medical expenses.

A study of medical expenditures found that 9.1 percent of total annual United States medical spending was attributed to overweight or obesity related problems totaling nearly \$93 billion in 2002 (Finkelstein *et al.*, 2003, 224). It was also determined that obese adults incur \$395 more, an average of 36 percent higher annual medical expenses than individuals of normal weight (Finkelstein *et al.*, 2003, 219).

Further adding to the high cost associated with automobile use is the expensive road networks necessary to transport personal motor vehicles. Just one mile of a four-lane urban highway can cost between \$20 million and \$80 million with highly congested areas going well above this estimate. Bicycle infrastructure on the other hand, ranges from several thousand dollars per mile, to occasionally \$1 million per mile depending on infrastructure type and local conditions (Gotschi, & Mills, 2008, 18). For the same cost of a single mile of urban highway, hundreds of miles of bicycle infrastructure could be constructed, an investment that can potentially create a complete network of bicycle facilities for a moderate-sized city. Increasing the miles of bicycle network can lead to a greater flow of traffic for the same lane width of a motor vehicle road, thus leading to reduced traffic congestion as well as other positive environmental impacts.

Environmental Benefits

A recent study conducted by the National Aeronautics and Space Administration (NASA) revealed that motor vehicles are the greatest contributor to atmospheric warming as a result of the large quantities of greenhouse gasses that are emitted (Voiland, 2010). To combat this massive release of greenhouse gasses, a modest 3 percent increase of bicycling and walking levels from 10 percent of trips to 13 percent could reduce fuel consumption by as much as 3.8 billion gallons per year (Gotschi, & Mills, 2008, 5). This same savings can be roughly compared to the replacement of 19 million conventional cars on the road with hybrid cars (23). Furthermore, an increase in the number of bicycles on the road will lead to a decrease in the number of motor vehicles, thus relieving traffic congestion. The negative environmental impact of idling cars on congested roads is expected to waste nearly three billion gallons of gas per year in the United States (Bikes Belong, 2009). Reducing the number of cars on the road as well as the miles driven is an important step in controlling fuel consumption and the damaging impacts of pollution. In the 2009 Growth and Transportation Survey, when asked if future transportation investments should support the goals of reducing energy use, 89 percent of respondents agreed that reducing energy use should be a concern of transportation spending (National Association of Realtors, 2009, Question 17).

United States Characteristics and Participation

With all of the positive benefits that come from bicycling, it is no surprise that cycling has been on the rise worldwide. A strong indication of the recent increase in bicycling levels can be made by comparing production of new bicycles to the production of new automobiles. Bicycle production and automobile production were in close contention through most of the 1960s. However, from 1970 to the late 1980s, the demand for bicycles greatly exceeded that of cars. The 1990s saw a slight downturn in bicycle production, but high gas prices and environmental concerns caused a surge in demand for bicycles. In 2007, 130 million bicycles were produced, more than doubling the number of automobiles produced (52 million) in the same year (Roney, 2008).

Cycling in the United States has also been on the rise in the last decade. The National Sporting Goods Association conducts an annual study to determine the levels of participation in sports activities for individuals age seven and older and who participate in an activity more than

once. In the 2009 report, bicycle riding, not including mountain biking, ranks seventh at 38.1 million participants. When mountain biking is added to bicycle riding, the total is 46.5 million and moves cycling up to the fifth most popular sport in the United States (National Sporting Goods Association, 2009). An area of cycling that is growing in the United States is commuting to work by bicycle, though the total impact of bicycle commuting is still small compared to the use of automobiles. According to the United States Census Bureau's 2008 American Community Survey, 0.55 percent of Americans use a bicycle as their primary transportation to work. This is an increase of 14 percent from 2007, 36 percent from 2005, and 43 percent from the 2000 Census (United States Census Bureau, 2000).

It is evident that there is an expanding interest in cycling in the United States. The data shows that there has been a steady increase in the number of cyclists for reasons of health, economy, and environmental factors pertaining to overreliance on the personal automobile. However, cycling levels in the United States are still far below those of many European nations. According to Pucher & Buehler, while the United States has a mere 1 percent share of all urban trips made by bicycle – including work, school and all other destinations – Denmark has achieved 19 percent travel by bicycle and the Netherlands an astounding 27 percent (Pucher, & Buehler, 2007, 3). As can be seen in some European countries, clearly it is possible to reach significantly higher levels of bicycle usage than the current level in the United States. A predominant thought in the United States is that bicycling is almost exclusively a form of recreation, whereas other countries view bicycling as a much more utilitarian alternative of transportation. For cycling levels in the United States to increase, Americans need to be able to accept that bicycling is a viable means of getting to work, school and other short trips. Yet most Americans are unwilling to make the switch to bicycling. This may be due largely because of concerns or perceptions that Americans have about bicycling that prevents them from utilizing this mode of transportation (Dill & Voros, 2007). In order to overcome these perceptions, it becomes important to understand what barriers to bicycle transportation exist and what can be done to improve bicycling levels in the United States.

CHAPTER 3 - Methodology

Bicycling in America has historical roots dating back more than a century, yet over the years, it has been overshadowed by policies and developments focused on enhancing conditions for automobiles. However in other countries, the bicycle remains an integral part of the transportation network. The intent of this research is to determine why bicycling is currently undervalued as a travel option in the United States and what can be done to change attitudes about utilitarian bicycling in the near future. My research effort was initiated by considering the following questions:

- Why is bicycling such an under-utilized form of transportation in America?
- How can bicycling become a more valued transportation option in the United States?

To begin to understand how bicycling has earned its current status in the United States, research was undertaken to determine what historical events shaped the introduction and advancement of the bicycle. This history also considers the inception of the personal automobile – the primary mode of travel in the United States – and how its role has affected bicycling in the past. A review of the historical content concerning bicycling and the automobile led to a better understanding of the progression of transportation means in the United States.

A collection of journals, reports, and studies were reviewed to determine if there are any potential benefits of Americans using bicycling for transportation purposes. Studies included reporting on health issues in the United States (Basset *et al.*, 2008; United States Department of Health and Human Services, 2008) and how a more active lifestyle would influence the health of the country. Other reports recognized the potential that bicycle commuting has to fulfill this need for physical activity on a regular basis (Centers for Disease Control and Prevention, 2010). Further sources looked at similar approaches but applied to the economic (Pocket Guide to Transportation, 2010; Morritz, 1997; Finkelstein *et al.*, 2003; Gotschi, & Mills, 2008) and ecological impacts (Voiland, 2010; Gotschi, & Mills, 2008; Bikes Belong, 2009; National Association of Realtors, 2009) that automobile use has had in America and how a greater number of bicycle users can begin to alleviate some of the cost and pollution of motor traffic. The

United States Bureau of the Census (2000) provides specific quantitative information regarding the current levels of workers who cycle as a primary means of getting to work, and a report from the National Sporting Goods Association (2009) identifying the number of recreational cyclists provided insight into the number of cyclists in the United States.

Further research looked at studies and surveys to gain knowledge of why bicycling is not a more widely utilized transportation alternative in America (Dill & Carr, 2003; Dill & Voros, 2007; Forester, 2001; Litman *et al.*, 2006; Pucher, 2001; Pucher & Buehler, 2007). Knowledge gained from reviewing articles and surveys directed attention to the presence of a number of factors that bicyclists and potential bicyclists find to be deterrents to cycling more frequently.

Recognizing that there are considerable obstacles that prevent more people to bicycle more frequently, further investigation into what barriers exist was necessary. By conducting research to follow up on this new material, it was soon recognized that there was more to the initial topic than was originally considered. Visiting several Internet forums from prominent bicycling communities confirmed that there were indeed many issues that were affecting people's decision to bicycle as a regular mode of transportation. Information from Internet forums was useful for identifying current concerns of cyclists using their bicycle networks and for tracking if and how problems were addressed. Observing the increasing number of concerns presented in forums and in surveys spurred the development of three new sub-questions to guide this research.

Research Questions

- Question A: What are the most prominent deterrents to bicycling as a means of transportation?
- Question B: What tools or strategies are currently being used to address these deterrents to bicycling for transportation?
- Question C: What options are available to planners to encourage and promote a greater acceptance of bicycling as an everyday mode of transportation?

While considering these questions, it became clear that that this type of research would be an iterative process. By answering some questions, new information is discovered which leads to more questions and further research. Beginning with a general topic, the primary research questions were asked which led to reviewing sources, analyzing information and consequently, more focused questions. This cyclical research process continues until the study results in an argument that is relevant and has sufficient evidence to support the claims that are made. This progression is illustrated in Figure 3.1.

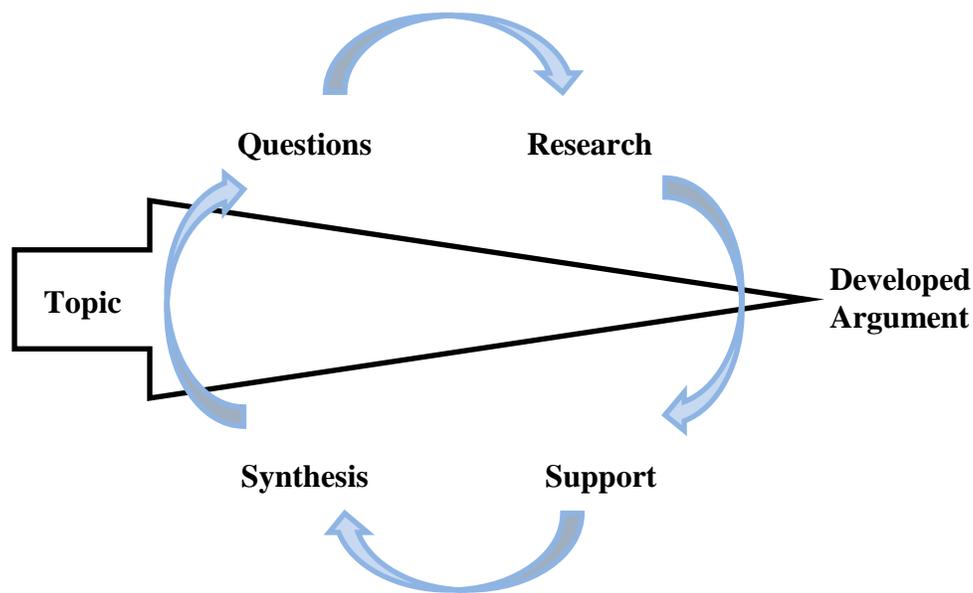


Figure 3.1. Iterative research progression.

To address Question A, a review of forum discussions helped to identify some of the more important and recurring concerns. A multitude of topics were brought up ranging from road construction, to disjointed bicycle lanes, to lack of automobile traffic awareness of bicyclists and many others. Using this information, the wide assortment of problems was grouped into a smaller number of encompassing categories based on subject and frequency. For instance, “dangerous road,” “heavy traffic,” and all accident related reports were grouped under the heading **Bicycle Safety**. The same process was conducted to create other subject headings for Bicycle Lanes, Routes and Proximity, Distance and Terrain, Climate, Parking and Storage, and Miscellaneous. Following this review and categorization, a keyword search assisted in finding a variety of articles, surveys and studies associated with these subjects and their relation

to bicycling. Several nationwide bicycle organizations such as Bikes Belong and the League of American Bicyclists publish many articles on topics similar to the subject headings above. These organizations were instrumental in finding information relevant to the headings and then refining the headings.

Many components of the selected headings were found to be interrelated with other categories. As an example, the presence of bicycle lanes often leads to an increase of bicycle parking and storage facilities. The availability of lanes and parking affects the proximity of cyclists' homes and destinations which also influences routing options. Considering the interconnected nature of some of these elements, the new set of headings was narrowed to **Bicycle Infrastructure** and **Bicycle Safety**.

However, there were still a large number of seemingly unrelated issues under the Miscellaneous heading that still warranted attention. "Inattentive Drivers," "Knowledge of Bicycle and Traffic Laws," and "Lack of Communication" were some of the common complaints that still lacked focus. In consideration of these miscellaneous topics, it became apparent that what was missing was not a more unified category, but rather, a more collective effort as a whole to understand and appreciate bicycling and those who choose to bicycle for transportation. This led to the final grouping of **Bicycle Consciousness**.

Now with a clear picture of the major categories for study – **1: Bicycle Safety, 2: Bicycle Consciousness** and **3: Bicycle Infrastructure** – a new search was begun to substantiate these headings as the three most prominent obstacles to bicycling for transportation. Establishing these three prominent concerns that limit the use of bicycling as a means of transportation in the United States, the research moves forward to Question B, what tools or strategies are currently being used to address deterrents to bicycling for transportation? To answer Question B, the research begins with identifying various methods of addressing each of the three headings separately. This includes reviewing articles, scholarly works, and local to national bicycling programs. Some physical improvements to the bicycle infrastructure network are isolated for discussion as well as some programs and initiatives that are aimed at enhancing bicycle safety and awareness. As a means of considering what types of strategies are being used in combination and to get some measure of success, a closer examination of two cities nationally recognized for their efforts in advancing bicycling for transportation is useful. Comprehensive Plans and specifically Bicycle Master Plans for Portland, Oregon and Davis, California (City of

Portland, 1998; City of Davis, 2006) are reviewed as examples of what can be accomplished in cities that adopt and support an integrated bicycle culture.

Question C – what options are available to planners to encourage and promote a greater acceptance of bicycling as an everyday mode of transportation? – is addressed by achieving a greater sense of how a community can build a bicycle infrastructure and a supportive culture. Research and observation was completed during a trip to Boulder, Colorado – the United States’ most bicycle friendly city according to the League of American Bicyclists. A study of Boulder was selected because of the city’s recognized prominence in bicycling as well as the relative proximity to Kansas State University where this report was undertaken.

A study of Boulder, Colorado, is intended as a case study to determine what has taken place in Boulder in the past that has enabled the city to become a leader in bicycling improvements and how similar strategies can be used by planners to increase levels of bicycling in other cities in the United States. This study focused primarily on three methods of collecting information.

First, a review was completed to determine what events, policy, and thinking has helped shape Boulder’s bicycling infrastructure. An examination of the Boulder Valley Comprehensive Plan and the Boulder Transportation Master Plan provides some brief narrative of historical events that have culminated in the system that is present today as well as the current plans that are intended to guide the future. The Comprehensive Plan and the Transportation Plan provide benchmark goals and assessment criteria for the City to use for gauging the effectiveness of the implemented plans. This information was used to compare the plans to the existing infrastructure to determine if the city is meeting its benchmark goals. The plans were also cross-referenced with those of Portland, Oregon and Davis, California for comparison purposes to see how different and geographically separated cities handle similar issues concerning bicycling.

Following analysis of publicly available documents and publications, a more personal assessment of Boulder’s bicycling network was required. This necessitated a visit to Boulder where personal communications with individuals involved with the City, bicycle advocate groups, and bicycle network users provided local knowledge not available in publications. Prior to a visit, contacts were established to arrange personal interviews. Individuals were selected from the City of Boulder, Bikes Belong advocacy organization, and Boulder bicycle shop owners/managers. Contacting the city was essential to get the newest information from within

the transportation department's staff. Bikes Belong is a national bicycling advocacy group headquartered in downtown Boulder. Advocacy groups such as this provide excellent insight into local developments while also considering a larger regional or national perception. Finally, interviews were scheduled with local bicycle shop owners/managers. Choosing to conduct interviews at bicycle shops was a logical choice: The individuals are clearly passionate about bicycling; they are most likely to be users of the bicycle network; and the store information and phone numbers are readily available making it easy to contact them and arrange interviews. Questions asked at the bicycle shops returned great knowledge of the physical bicycle network that bicyclists ride on every day for transportation. Familiarity with routes through the city, concerns for safety, and awareness of public perception were invaluable.

The final, and perhaps most valuable component of a trip to Boulder, was empirical research gathered by observing and using the physical bicycle systems directly. Following some advice received from interviews, I saddled up my bicycle, strapped on my helmet, and went for a ride. Over a span of three days, I covered over 50 miles of on-street bicycle lanes, multi-use paths, and examined firsthand the extensive bicycle network that Boulder has created. Armed with the knowledge gained from document research, reviewing plans, and conducting interviews I was able to appreciate Boulder by bicycle. My observations allowed me to make visual assessments of new infrastructure improvements, physically traverse various types of bicycle paths, and emotionally experience bicycling in the country's most bicycle-friendly city. Though it may frequently be overlooked, physically sensing and feeling what it is like to ride established routes is the best measure of success in any city. By interacting with the bicycling facilities, I was able to determine what types of improvements worked well and how bicycling can be better integrated into the transportation network. This method of observation allows a user to conclude invariably where there is a problem and where further work is still needed. It is by this method, that I was able to assess the relative ease of travel by bicycle lanes and paths, the feeling of safety, and the reflection of a supportive bicycle culture.

Limitations to Scope of Research

This report analyzes three of the major barriers that influence the decision to bicycle for transportation, however not all issues that affect the decision can be covered in the scope of this paper. Despite the many positive advantages that can be gained from using bicycling as an integrated means of transportation, cycling numbers remain far lower than their potential can reach. This is due largely to the presence of significant barriers that are preventing Americans from riding bicycles to work, school and other utilitarian trips. There are many considerations that factor into this unwillingness to ride bicycles. Unfavorable climate and weather conditions as well as difficult terrain are common reasons that influence people's decision to use bicycles. Other non-riders claim that they do not have the skills and experience to ride on roads or that they do not have access to a bicycle or proper biking equipment. Other reasons that can contribute to low cycling levels are the size and/or density of cities. Cities with a large land area can create lengthy trips for bicyclists just as current land use practices can separate distances to the extent that it makes bicycle transportation unfeasible. Because weather and terrain conditions cannot be altered, these factors will not be considered in this research. Similarly, this study will not assess the level of experience or access to bicycles as this is more of an individual issue rather than one which can be directed to the public as a whole. Although land use zoning, urban sprawl and population density can and should be addressed by planners, these components are covered at length in other works. Therefore, these issues will also not be covered in this report.

What this report attempts to discuss are three major obstacles that can be influenced by planners to improve bicycling networks in American cities. The first and most critical factor that limits bicycle use is the lack of bicycle consciousness. Generating awareness for bicycling is one of the greatest ways of improving conditions for cycling and thus increasing the number of cyclists. Convincing people to change their attitudes toward bicycling can be difficult especially considering America's reliance on the personal automobile and the convenience which it provides. Following a shift in attitude towards biking, the second key component to increasing bicycle ridership is to provide facilities for cyclists to ride and park their bicycles. A major concern of many would-be cyclists is that there is not an adequate network of bicycle lanes and paths in their community to safely transport an increase in the number of cyclists. The third obstacle stems from a complaint closely related with the lack of infrastructure which is the lack

of safety while riding. Infrastructure improvements can provide the necessary spaces for bicycles while simultaneously addressing the concern for safety by ensuring that bicycles have adequate space to ride on or off the road. This report will address each of these three barriers to determine what can be done to increase bicycling for transportation in the United States.

The following work is arranged into chapters beginning with the three critical barriers which are covered in detail in Chapter 4. Following an analysis of the barriers, Chapter 5 explains what bicycle-friendly cities in the United States are and how some communities have adopted policies to address bicycling. This includes a closer examination of policies and strategies that have been adopted to make bicycling a more accessible means of transportation. Chapter 6 considers some potential sources where funding may be acquired in order to finance needed bicycle infrastructure and programs. The report is concluded in Chapter 7 with a summary of the report and accompanied by recommendations.

CHAPTER 4 - Barriers to Bicycling

The greatest challenge in promoting bicycling is finding a way to convince Americans to leave their automobiles at home and begin to ride their bicycles instead. However, this task is made difficult by a number of issues that discourage the use of bicycles. The first issue is the need for increased safety while cycling. Bicyclists of all ages face the challenge of safety while riding. Another prominent dilemma is the absence of a strong bicycle consciousness. Both bicyclists and non-riders lack awareness of many of the opportunities that exist for cycling. The final problem is the need for a more complete and connected bicycle infrastructure. Adequate space to travel and appropriate facilities for bicyclists rarely meet the needs of riders. Some of the more successful bicycling cities in the United States have begun to incorporate various methods of dealing with each of these three concepts. This chapter addresses strategies and solutions that are currently experiencing some success in shifting local attitudes to be more accommodating of bicycling as a viable means of transportation.

When discussing the topics of bicycle safety, bicycle consciousness and bicycle infrastructure, it is best to look at each one separate from the others. However, it should be noted that the three concepts cannot stand alone without the support of each of the other two. Figure 4.1 represents this relationship. It is important to recognize that all three components are interconnected in such a way that when creating a plan of action, attention should be given to each part simultaneously. Addressing all three elements will present the best chance for effectuating a change in attitudes and behaviors and increasing bicycling for transportation. This being said, for the purposes of this report, each one will be discussed individually.

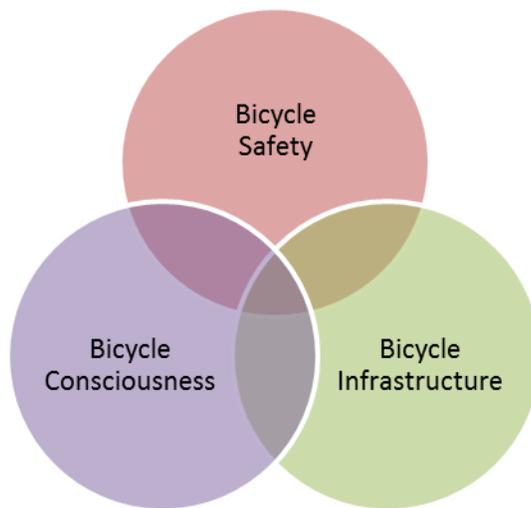


Figure 4.1. The relationship between bicycling safety, bicycling consciousness and bicycling infrastructure (Bird, 2010).

One: Bicycle Safety

A major concern of many bicycle riders as well as individuals who choose not to ride bicycles is safety. There are many objective and subjective variables involved with the level of safety for cyclists. Objective variables could include proper travel lanes, traffic volume or speed, and road or path conditions while subjective factors may pertain to a rider's skill level, comfort while riding alongside traffic, and a community's bicycle awareness and support. There are many ways of addressing each of these variables or multiple conditions simultaneously. Indeed it is clear, and statistics demonstrate that there is a need for improving bicycling safety.

The National Highway Traffic Safety Administration reports that there were 52,000 traffic related bicycle accidents in 2008, 716 of which ended in death (National Highway Traffic Safety Administration, 2008; Pocket Guide to Transportation, 2010). Since 1994, traffic accidents and fatalities have fluctuated from a high of 883 bicycle deaths in 1995 to a low of 629 deaths in 2003 as can be seen in Figure 4.2 (Fatality Analysis Reporting System, 2009). Cycling in the United States accounts for only one half of one percent of all urban commuter trips made by bicycle (United States Census Bureau, 2000). In contrast, bicyclist deaths accounted for two percent of all traffic fatalities and also two percent of all reported traffic related injuries in 2008 (National Highway Traffic Safety Administration, 2008).

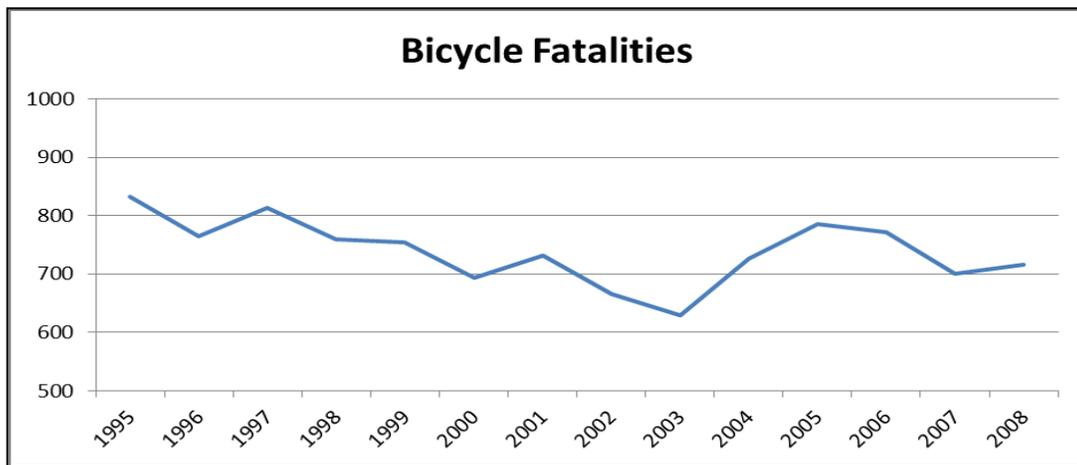


Figure 4.2. Bicycle fatalities 1995-2008 (Fatality Analysis Reporting System, 2009).

It is no doubt statistics like these cause bicycle users and non-riders to cite safety as the top reason for not bicycling. Whether it is the lack of bicycle awareness or concerns while riding in traffic, safety is a critical factor in a cyclist's decision to commute to work or school (Pedestrian and Bicycle Information Center, 2006). Although the number of bicycle fatalities and injuries has declined in recent years, it is still painfully obvious that more effort is needed to make bicycling safer and a more appealing mode of transportation. The role of planning in improving bicycle safety is to adopt policies and implement strategies that support an overall greater bicycle consciousness. There have been many different attempts to increase safety conditions for bicyclists ranging from on-street improvements, off-street paths for bicycles, and a range of education and enforcement programs.

Some cities in the United States have provided a variety of travel spaces designed to appropriately accommodate bicycles. Providing bicycle lanes in urban communities allows cyclists to travel on the roadway adjacent to traffic with an extra measure of safety. The presence of a striped lane can increase a cyclist's perception of safety and give the rider a minimum of four feet between passing motor vehicles and the gutter or curb (Litman *et al.*, 2006). It is this added space that gives cyclists a right-of-way adjacent to motorized traffic that can be safer than riding amongst motor vehicles. Yet others may prefer a separate path for bicycles to create further distance between cyclists and traffic. There has been a fair amount of debate as to whether on-street facilities are safer than off-street options. The answer perhaps depends on the type of cycling that the rider is accustomed to and comfortable with. Both on-street bicycle lanes and separate bicycle paths have advantages and disadvantages.

John Forester, bicycling transportation engineer, discusses both positive and negative views of bicycle lanes adjacent to motor vehicle traffic and bicycle paths that are not connected to roads. He approaches the situation with several arguments, of which safety is most important. Proponents of off-street paths claim that the greatest risk to cycling on the road comes from bicycles being overtaken by same direction motor traffic. They argue that by separating bicycle and motor traffic, travel will be safer for the cyclist. However, Forester points out that only about 1.2 percent of cycling accidents result from same direction vehicles overtaking a bicycle while 89 percent occur at intersections and crossings, which bicycle paths cannot completely avoid. Furthermore, the speeds at which the cyclist can travel are far slower than that which can be maintained on road adjacent bicycle lanes. Forester concludes that although bicycle paths remove bicycles from the road, it does not decrease the frequency of accidents and that following traffic laws on the road can be an efficient and effective way of reducing cycling accidents (Forester, 2001).

Regardless of the type of bicycle infrastructure that is integrated into the transportation network, a great deal of support and teaching is required to educate both cyclists and automobile drivers. Community outreach programs can be used to administer classes for explaining and demonstrating proper safety while using bicycle facilities or while driving around bicycles. New measures of encouragement and enforcement may be necessary to generate support for bicycle transportation or to raise awareness of cyclists.

A number of cities in the United States have adopted and implemented very successful strategies for including bicycling in their transportation networks. Planners in communities that wish to make bicycling more available in their cities should look to successful bicycle-oriented cities as examples of what might be adapted for use elsewhere. Many cities with large bicycling networks have created comprehensive bicycle plans to provide direction for future developments in the city. These bicycle plans assess the specific bicycle needs of the community and target areas that need safety improvements. The plans may also include detailed guidelines for the construction of safe bicycle lanes, bicycle paths and other needed bicycle facilities. Planners should observe the plans of other communities and modify successful methods for a more tailored fit for their individual location's circumstances. A strong effort from planners to develop a more bicycle-friendly community can greatly improve safety for bicycle users as well as other facilities for bicycling.

Two: Bicycle Consciousness

Bicycle consciousness refers to the overall level of awareness and support for cycling and for recognizing the needs that are presented by an increasing number of bicycle riders. Although America has a low level of bicycle consciousness at this time, it leaves plenty of room for improvement. Generating a supportive bicycle culture in the United States is a necessary step because building this support will ultimately lead to better safety for cyclists and to construction of needed bicycle facilities. Developing a stronger bicycle consciousness in the United States will require many groups at different local and national levels to participate in raising awareness for bicycling as an effective means of transportation.

There is some inconsistency in measuring participation and attitudes about bicycling as transportation versus bicycling as recreation. Many Americans participate in bicycling as a recreational, fitness or leisure time activity, but decline to make the transition to actively riding their bicycle for utilitarian purposes. Although furthering bicycling for recreation and leisure does encourage and promote cycling in general, to a large degree, cycling for transportation is overshadowed by the automobile dependent society in which we live. After three generations of Americans driving automobiles, it is easy to see how people have become so accustomed to driving for every trip regardless of the distance or purpose. Americans have become complacent with the ability to get in the car and go wherever and whenever the need arises. Furthermore, developments in the past have only led to further the dependence on motor vehicles. Roadways, businesses, parking lots – all have been designed and constructed with the automobile in mind. When something is constructed and finished to look like it is intended for automobile use, then automobiles are going to use it. The personal automobile is so indoctrinated in American culture that when a cyclist crosses the path of a car, the automobile driver often becomes upset that a bicycle is somehow inconveniencing them. However, if new infrastructure was introduced or existing infrastructure was retrofitted to resemble something that is intended for a bicycle, attitudes may begin to change and support can be gained for cycling as a transportation alternative.

As is evidenced by the large numbers of bicycles that are produced every year in the United States – over 130 million in 2007 (Roney, 2008) – there is a substantial interest in cycling. However, despite the number of bicycle owners, a very minor portion of the population has committed to using their bicycles as a means of active transportation. Perhaps one of the

greatest contributors to the low levels of bicycling is the culture in America that supports and revolves around the availability and convenience of the personal automobile. If attitudes in the United States are to be transformed to be more accepting of bicycles, a primary concern is to increase the awareness for bicycles and bicycle users. To do this, efforts must be made to educate Americans about the opportunities for bicycling and to promote the use of bicycles through cycling events and programs. Below are a number of methods which are currently being used to encourage bicycling in the United States.

Bicycling Organizations

One way of generating awareness for bicycling is to implement strategies which highlight the importance of cycling in America's transportation network. This can be accomplished by publicizing the health, economic and ecological benefits that bicycling can provide for individuals and for society as a whole. National organizations that promote bicycling exist to help raise awareness for biking. The Bikes Belong Coalition and the League of American Cyclists, among others, work to make information which supports bicycling available to the public. These organizations accomplish this through publications, online resources, and continuing research of new and immediate issues. The success of these organizations can be somewhat limited because their publications easily reach people who already support cycling; however, non-cyclists may not be looking for this information and hence it may not be spread to a wider range of audiences. Other efforts are made by organizations to promote bicycling through providing information and identifying needs to Congress in hopes of increasing support through legislation for increased funding and awareness campaigns from the governmental level.¹

An important resource for beginning riders as well as seasoned cyclists is the local bicycle shop or community bicycling club. These organizations provide a valuable service to bicycle users not only for their expertise in equipment and repair, but also for their role in encouraging local residents to ride more. This is done through a variety of ways, though most common is the organizing and participation in group rides. This is an excellent chance for novice riders to get to ride with more experienced cyclists which provides a positive example of how cycling can be an easy and efficient form of transportation. Not only do participants gain knowledge from experienced riders, but they are also able to observe how to safely ride on roads

or properly use the existing infrastructure in their community. Another added benefit of group rides is the ability for any rider to find which routes through and around town are ideal for the type of riding that they wish to continue.

Another essential service that many local organizations provide is education and encouragement programs. Often taking place at the local bicycle shop, veteran riders will instruct classes ranging from proper bicycle maintenance, to how to ride in traffic, to important safety measures. All of these topics are necessary components for a bicyclist of any age or ability to understand in order to be successful in using the bicycle for transportation. And the better cyclists are riding and the more they know about where and how to ride, the more comfortable they will be. When cyclists can be comfortable while riding bicycles for transportation, it serves as reinforcement and positive encouragement that will increase the desire to continue bicycling for utilitarian purposes and share the experience with others.

Bicycling Events

Another method of encouraging bicycling as a means of transportation is the sponsorship of cycling events. Events can range from a single day promotional effort for just one business to a nationwide movement for several days. May is recognized as National Bike Month a part of which is National Bike to Work Week. Bike to Work and Bike to School events are a great way to encourage cycling as an active mode of daily transportation. Other cycling events can also be used. Organized bicycle rides within a community or larger across state tours are excellent ways to increase awareness about bicycling for riders as well as non-riders. In addition to raising awareness about bicycling, events also provide a safe and easy opportunity for beginning cyclists to get started riding and get a taste of the benefits of bicycling as a means of transportation.²

While bicycling events provide opportunities for individual riders, they also benefit groups or projects as well. Most group rides involve a modest entry fee which can vary depending on the type of event, the length of the ride, and the level of support and services provided. Long multiple-day trips frequently have higher entry fees to accommodate sleeping arrangements for riders and water and food supplies. Some bicycle events utilize these entry fees as a means to fund the trip or for trips in the future. Yet other rides collect entry fees as a fundraiser for local and area projects which may include construction of new bicycle paths and trails. Another type of bicycle ride takes place for the cause of generating money for charities.

One of the most well-known charity rides is the Bike MS ride. Featuring rides across the United States, Bike MS enlists more than 100,000 cyclists annually to ride in support of Multiple Sclerosis research (National Multiple Sclerosis Society, 2010). Although each event may have its own purpose for collecting money, one thing that all events have in common is the ability to raise awareness for bicycling.

A highly under-utilized form of promoting bicycling in America, yet one which has tremendous potential, is the media. Both locally and nationally, news sources underplay the role of cycling as a transportation alternative. Media outlets across the country report on traffic conditions, letting citizens know where the most congestion is so that they might avoid it on their commute to work. But what the news doesn't tell you is that by cycling, it is often possible to avoid the road congestion entirely. News channels also rarely have coverage of local bicycle events that many people may have interest in if they were notified about them. Even major worldwide cycling events such as the Tour de France receive very little media attention. Only in the last decade has the United States enjoyed a great deal of success in the Tour de France. With American professional bicycle racer Lance Armstrong, national media has begun to cover events such as this with any interest. Armstrong has done a great deal to raise awareness for cycling through his achievements in the competitive bicycle racing arena. One can only wonder how much larger an impact riders such as Armstrong could make if given as much media attention as the growing American sport of NASCAR.

Bicycling Programs

Many types of bicycling programs exist to promote awareness of bicycling and to improve safety by initiating changes in infrastructure. Efforts may be made by advocacy groups, picked up from successful international programs, or begin with grassroots movements. However, most bicycling programs serve the purpose of increasing the appeal of bicycling. Many bicycling programs begin with a national effort and responsibility for continuing the programs may be passed on to lower levels of government or local leadership.

Bicycling is an activity that many people learn and begin to participate in at an early age. Many youth experience their first taste of independence when they are able to ride their bicycle to a friend's house or to school or another location. However, there has historically been very little effort put into educating America's youth on the importance of safety while bicycling and

the need to establish safe and direct routes to and from destinations. The current lack of investment into educating America's youth has resulted in a low level of interest in bicycling and walking to and from school. A 2007 study reported that there is little relationship between riding to school frequently or not riding to school as a child and regular bicycle use as an adult. However the results of the report do demonstrate that 73 percent of respondents who rode bicycles more frequently as a child were significantly more likely to be regular cyclists as adults (Dill, & Voros, 2007, 11-12). This evidence suggests that encouraging children to ride bicycles more often may result in higher levels of bicycle ridership as adults. However, there is still a need for an organized strategy for promoting bicycle use for utilitarian trips and an early education program for introducing safe bicycle riding.

The National Center for Safe Routes to School was developed to enable and encourage children to safely bicycle and walk to school. First introduced in Denmark in the 1970's to address a large number of children injured and killed on their way to school, the program's success was recognized and soon spread internationally. The United States began pilot programs with funding from the National Highway Traffic Safety Administration in 1998. The success of these pilot programs and other grassroots efforts throughout the United States led to federal legislation that established a national Safe Routes to School program in 2005 (National Center for Safe Routes to School, 2009). This legislation set aside \$612 million to be used over the 2005-2009 fiscal years with each state receiving no less than \$1 million each year.

Funding acquired through Safe Routes to School is used to address one of four critical areas: Education, Encouragement, Enforcement, or Engineering. Education activities include teaching students how to safely bicycle or walk to school as well as the benefits of doing so. But education is not limited to students; parents, neighbors and other drivers in the community are targeted to stress the importance of driving cautiously, yielding to pedestrians and taking other actions which make for a safer bicycle and pedestrian environment. Strategies for encouragement might include parents, teachers and school staff participating in bicycle or walk to school days to generate excitement among students for active transportation. This type of encouragement is generally inexpensive yet can have tremendous results. Enforcement policies serve to change unsafe behaviors of drivers by increasing awareness of laws or reducing traffic speeds in areas where bicycling or walking is prevalent. Enforcement may also include assistance from law enforcement and adult community members to ensure that cyclists,

pedestrians and drivers are aware of the rules and that they are being followed. The most visible use of funding is the engineering component. Engineering often consists of the improvements of the physical environment which provides safer places for bicycles and pedestrians to travel. Planners and engineers use various methods to create safer settings for bicycling and walking while also recognizing that roadways must also safely accommodate all modes of travel. When improvements are made, they may not only increase the safety of children traveling to school, but it may also encourage more walking and bicycling for the rest of the community (National Safe Routes to School, 2006).

At the time of this report, the initial five year period of funding has expired. According to local Congressman Jerry Moran's office, the Safe Routes to School program is currently on Senate Bill 1156 as part of the Environment and Public Works Committee. No action was reported as of July 22, 2010 (Office of Congressman Jerry Moran, personal communication, July 22, 2010). However, reported success of active programs suggests that the program will continue and funding may be increased. Senate Bill 1156, "Safe Routes to School Program Reauthorization Act" proposes amendments to expand the use of available funds to a broader range of approved infrastructure improvements and non-infrastructure improvements such as education and enforcement policies. The bill also proposes to increase funding to \$600 million for the 2010-2014 fiscal years (S. 1156, 2009).

The Safe Routes to School program begins to address some of the transportation needs for elementary and middle school students with the potential to carry over to other community members. However, there is also a growing need to accommodate all bicycle users in areas that are not near a school where a Safe Routes to School Program is not in effect. One such program that attempts to provide a solution for all roadways in a jurisdiction is the Complete Streets program. The National Complete Streets Coalition has set a goal of designing streets with safe access and operation for all users. "All users" is intended to include all modes of travel for all ages and abilities: this accounts for public transit, bicycles and pedestrians along with the automobile traffic as well as for children, elderly and people with disabilities (National Complete Streets Coalition, 2009).

There are already a number of cities across the United States which have enacted and adopted policies consistent with the Complete Streets program. Many of these existing programs have demonstrated a wide range of success by incorporating multiple modes of transportation or

by showing a substantial return on investments into roadway infrastructure. The success of these pioneering cities has generated enough attention to warrant the proposal of a bill in the United States Senate. The “Complete Streets Act of 2009” was introduced and is currently being considered in the Committee on Environment and Public Works. Although the bill does not propose the provision of any funding for Complete Streets programs, if passed it will require states and metropolitan planning organizations to adopt laws or policies requiring all transportation projects to “accommodate the safety and convenience of all users in accordance with Complete Streets principles (S. 584, 2009).” Furthermore, the bill specifies that the Complete Streets principles shall apply to all new roadway construction as well as the retrofit or resurfacing of existing roadways. At the time of this report, no action has yet been taken.

The intention of Complete Streets programs is to provide safe access to all roadways for all users. However, the effort to accommodate all users is an excellent opportunity for the addition of on-street bicycle lanes, adjacent bicycle/pedestrian paths or other shared use system. Some design features such as traffic calming devices to slow automobile traffic or raised medians greatly improves bicycling safety (National Complete Streets Coalition, 2009). Complete Streets can enhance the travel experience of users to such an extent that new procedures for measuring the Level of Service are being developed. The traditional Level of Service measure is a function of the ratio of the number of cars on a specified road to the carrying capacity of that road and is expressed in assumed delay of each vehicle. This method of calculating the ease of travel on a roadway is no longer appropriate on streets where there is a growing number of bicycles and pedestrians that may reduce the volume of vehicular traffic. A traditional Level of Service may be acceptable for automobile traffic alone, but some cities are developing a more comprehensive measure that accounts for the comfort and sense of safety for bicyclists and pedestrians (McCann, & Rynne, 2010).

The Complete Streets initiative and the Safe Routes to Schools program are not intended solely for improvements geared toward bicycling. Rather, they are intended to improve the transportation networks as a whole. This provides an excellent opportunity for including bicycling infrastructure needs and bicycling safety concerns into new and future developments. As a result, by providing adequate spaces for bicyclists to travel and by improving the level of safety for cyclists, the decision to use bicycles for transportation becomes much more attractive.

A different approach for raising awareness and support for bicycling is a movement started by the Bikes Belong Coalition. Peopleforbikes.org is a campaign that is attempting to gain 1 million pledges in support of bicycling in the United States. Peopleforbikes.org has hopes of gaining support of Senators and Congressmen for when the federal government allocates money for transportation expansion and improvements. The goal of peopleforbikes.org is to raise 1 million voices in unison to influence leaders in Congress and in cities and states throughout the country to help make bicycling safer, more convenient and more appealing for everyone (Bikes Belong Coalition, 2010).

At the time of this writing, 153,306 individuals have pledged their support at Peopleforbikes.org.



Figure 4.3. Peopleforbikes.org logo is a simple but moving promotional image for bicycling (Bikes Belong Coalition, 2010).

Despite the current American automobile-centered transportation paradigm, advances are being made to improve the public perception of bicycling. National and local organizations are making efforts to promote and educate cyclists and non-cyclists alike by providing information and services at local bicycle shops. Bicycle ride events allow new cyclists to gain exposure to bicycle culture while garnering support and funds for projects and charities, subsequently gaining media attention on occasion. Programs encourage and promote bicycling to school and as a transportation alternative. New infrastructure designed to improve bicycle travel strengthens the safety and appeal of bicycling, which in turn attracts a growing number of riders. And national campaigns raise awareness and support to influence government officials and initiate proposed legislation to enhance bicycling for transportation. All these efforts and more unite to

help change America's attitude toward bicycling to make it safer for cyclists and more acceptable to non-cyclists – to create a collective bicycle consciousness.

Three: Bicycle Infrastructure

With a greater understanding of bicycling through the development of a renewed bicycle consciousness, there will be an increase in bicycle use and commuting. This influx of new riders will require spaces for travel as well as end of trip amenities. Bicycling infrastructure consists of all of the facilities that are needed to accommodate the movement, storage and support of cyclists and their equipment. If the overall goal is to encourage bicycle ridership ahead of automobile travel, cities will need to provide accessible and convenient transportation for bicycles and also include amenities for comfort and security.

Existing literature on various methods of enhancing infrastructure for commuting by bicycle to work or school has taken many different forms. Scholarly articles written in the past have examined factors that affect the decision to commute by bicycle in cities. Some discuss principles and guidelines that can improve conditions of on-road travel while others promote separating bicycle traffic from motorized traffic by means of a bicycle path or bicycle boulevards. Others account for public opinion through surveys to determine what influences the rate of cycling in communities and what cyclists feel would make trips more accessible. Furthermore, city organizations have taken great care in producing comprehensive master plans for bicycles. These plans include the current bicycle infrastructure as well as the proposed programs that will be implemented in the future and the means by which they can achieve success. This section examines the needs for facilities at cyclists' destinations as well as some of the more popular or successful infrastructure strategies for expanding the bicycle transportation network.

End-of-Trip Amenities

Aside from the need for physical bicycle infrastructure for travel routes, a most frequently overlooked detail is the provision of facilities for bicyclists once they arrive at destinations. Some programs to improve bicycle awareness and bicycle transportation are taking root, but they do not necessarily assure that upon reaching the end of a trip, the bicycle user has a secure place to park and lock their bicycle and belongings. Other useful end-of-trip facilities may include showers, lockers, clothes or towel services, and basic bicycle repair equipment. These features are generally not considered a part of the transportation network and thus may be the reason for oversight. The responsibility of providing facilities rests with individual business or organizations which make the decision to support employees or students who bicycle for transportation. However, by choosing to incorporate end-of-trip amenities, public or private businesses and organizations show their respect and support of an active bicycling culture.

A common deterrent to commuting by bicycle to most destinations is the general absence of secure places to park and lock up bicycles and belongings. An August 2009 count of bicycles present in downtown Boulder, Colorado tallied over 4,000 in a four day period. This is up more than 14 percent since 2008, and 46 percent since 2007. Of the more than 4,000 bicycles in downtown Boulder, 22 percent were not in designated permanent bicycle parking areas (Urie, 2009). Obviously, when a community has a large number of cyclists, there will be an increased need for secure places to park and lock up bicycles. A lesson from the United States Department of Transportation, Turner Fairbank Highway Research Center indicates that people who ride bicycles to various destinations require adequate facilities to accommodate bicycle parking. The study identifies various methods of providing secure places for cyclists to store and lock their bicycles. Parking solutions range from bicycle racks, to bicycle lockers, to bicycle lock-ups. Special consideration should be put into the style and location of bicycle parking and depending on the destination the parking is serving, the type of secure parking and location may change. The report goes on to discuss strategies for promoting public and private parties to provide areas for bicycle parking (Turner Fairbank Highway Research Center, 2007).³ Creative parking solutions are being developed that provide various levels of security as well as indoor options that provide protection from weather and space saving designs.



Figure 4.4. An example of a common outdoor bicycle rack (The Park Municipal and School Catalog, (2010).



Figure 4.5. A space saving indoor bicycle parking solution (The Park Municipal and School Catalog, (2010).

Addressing the need for safe and convenient parking is the first step to providing adequate facilities at destinations. Another troubling issue that comes as a result of bicycling to work or school is the component of physical exertion which may cause sweat, odor or other appearance problems that require attention. Potential commuters who may otherwise bicycle to their destination choose not to because they are unable to clean up or change clothes when they arrive. Private shower and changing facilities can provide cyclists the opportunity to ride to work or school despite potential perspiration and regardless of most weather conditions. Locating showers at the workplace or other institutions may also encourage cyclists to commute from further distances knowing that they have the opportunity to do so (Cycle Note, 2006). Closely associated with the need for showers and changing rooms is the desire for towel service and a station for washing or drying clothes. Though not necessary, if the effort is being made to include shower facilities, these amenities add another level of comfort and accessibility for bicyclists. At the very minimum, lockers are required to store clothes, towels, bicycle equipment and other belongings while showering or at work. Other considerations that might be included are courtesy items such as mirrors, iron and ironing board, hair dryer and other comforts.

In addition to secure parking and amenities for preparing for work or activities, another valuable service that should be anticipated reflects the transportation mode of bicycling. Providing basic tools allows bicycle riders to perform needed adjustments or repairs when they

are away from their home and their own equipment. At the least, an air pump, tire levers, and a puncture repair kit can permit cyclists the opportunity to remedy a flat or low tire to make it home safely. A more thorough repair station might include common wrenches, screwdrivers and hex wrenches for adjustments and chain lubrication. A power station in a secure location may be beneficial for charging headlamps, lights and other devices while away. To take the service one step further, there may be one or more individuals who are appointed to be designated repair technicians. Someone knowledgeable in servicing bicycles could be in charge of the repair area and tools and provide assistance when needed.

Providing necessary end-of-trip facilities and going the extra mile to provide an added level of security and comfort make the notion of bicycling for transportation more appealing. A safe space for parking and locking bicycles is a must. Changing rooms and shower facilities make the notion of bicycling to work more appealing for potential cycling commuters. And going the extra mile to ensure that cyclists are comfortable and have the services that may be needed on a bad day may just be enough to push riders over the edge and decide to bicycle for transportation. Making end-of-trip amenities available and useful improves the experience of bicycling for utilitarian trips enjoyable and thus encourages more people to bicycle more often.

Transportation Facilities

A recurring complaint from many potential bicycle users is that there is insufficient bicycle infrastructure linking their destinations. It is one of the most often cited reasons for why people do not use the bicycle as transportation. However, before money is spent on increasing and updating bicycle infrastructure, there should be reasonable proof that providing bicycle infrastructure has an effect on the likelihood that bicyclists will use the facilities. A 2003 study of the largest cities in the United States (populations over 250,000) analyzed the number of bicycle commuters to the miles of bicycle facilities in each city. The results of the analysis demonstrate that “higher levels of bicycle infrastructure are positively and significantly correlated with higher rates of bicycle commuting” (Dill, & Carr, 2003, 7). According to the study’s calculations, each additional mile of on-street bicycle lanes would potentially result in a one percent increase in the share of workers commuting by bicycle (6). Although this would more than double some cities’ bicycling numbers, it cannot certify that there is a cause-effect relationship between an increase in infrastructure and an increase in the number of bicycle

commuters. However, it does imply that cyclists will use infrastructure if it is provided making it clear that there is a need that is being met (6).

There is a significant debate concerning how exactly to address the travel needs of bicyclists. A wide range of methods for improving the bicycle network have been tried in different cities across the United States and each has demonstrated its own level of success. There are nearly an infinite number of solutions or combinations for enhancing bicycle networks; however any given solution can generally target only one problem at a time. Some prescriptions address multiple issues, but success may depend largely on the circumstances of its usage. This section looks at some common issues that bicyclists face while commuting as well as some of the more prominent infrastructure remedies for those challenges.

When discussing strategies for improving physical bicycle infrastructure networks, it is important to recognize that there are often multiple solutions to address the same problem or similar problems. One method may work to solve one problem while other methods may prove more useful under different circumstances. Yet there is a third option in which multiple solutions are necessary to address multiple issues for the same distance of travel. Regardless of the selected strategy, other secondary improvements can further enhance bicycle consciousness and safety. For instance, adding signage in all examples increases comprehension and alerts cyclists and drivers to what can be expected ahead.



Figure 4.7. An example of bicycle signage (Municipal Uniform Traffic Control Devices, 2009).

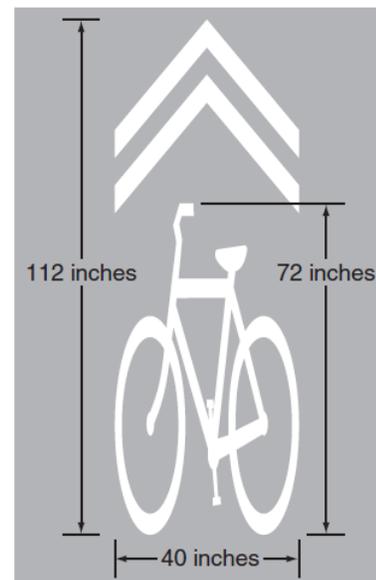


Figure 4.6. Proper pavement markings for a shared on-street bicycle lane (Municipal Uniform Traffic Control Devices, 2009).

Assuming a basic set of challenges that commonly affect a cyclist's ride allows a discussion of several solutions under the same conditions. In general, cyclists need to get from point A to point B along a road with automobile traffic. There may not be sufficient space for bicycles to safely travel and automobile drivers are not always aware of the presence of bicycles or the space needed to safely ride bicycles on the road. The solutions discussed below – bicycle lanes, multiuse paths, and bicycle boulevards – are three methods that address similar conditions in different ways.

The first method of accommodating bicycles is to create a designated bicycle lane on the road. Bicycle lanes share a portion of the road with automobile traffic and are always one way in the same direction of travel as motor vehicle traffic (Litman *et al.*, 2006). This may be accomplished by reducing or narrowing the vehicular travel lanes to make space near the outside of the road for bicycles. Bicycles need a minimum travel space of four feet although the recommended space is five feet and is not to include the street gutter as this is intended for drainage and not for travel. The bicycle lane is most often separated from automobile traffic by a painted white line and marking the lane as intended for bicycle use only (American Association of State Highway and Transportation Officials, 1999). Example design guidelines can be seen in Figure 4.8 and 4.9 below.



Figure 4.8. Example design guidelines for on-street bicycle lanes for roads with side-street parking permitted (American Association of State Highway and Traffic Officials, 1999).



Figure 4.9. Example design guidelines for on-street bicycle lanes for roads where side-street parking is prohibited (American Association of State Highway and Traffic Officials, 1999).

The bicycle lane is often a desirable option when space for bicycles is needed but funding is low. Because bicycle lanes are a part of the street, no new construction is required, reducing the overall cost of the project. Resurfacing of roadways provides an opportunity to include bicycle lanes as new lines will be painted and the addition of a stripe for bicycles would not be much additional work (Federal Highway Administration, 2006). On-street bicycle lanes have been the choice of many utilitarian cyclists because of the overall connectedness of the street network to destinations. Furthermore, utilitarian cyclists and other cyclists with higher riding abilities prefer the higher travel speeds of bicycle lanes where there are fewer intersections than other alternatives and where there are no pedestrians which can cause conflicts. When cyclists choose to use on-street bicycle lanes, the bicycle is treated as every other vehicle on the road and is subject to the same traffic laws as automobiles. When held to the same regulations as motor vehicle drivers, and when drivers are aware that bicyclists are following traffic laws, there is a reduction in confusion. Bicyclists traveling in the same manner as traffic make the actions and movements of bicycles and automobile traffic more predictable.

A method that is similar to bicycle lanes is the use of bicycle paths or multiuse paths. Bicycle paths can provide safe travel to and from destinations like bicycle lanes, however they differ in that bicycle paths are not adjacent to the street network. Rather, bicycle paths are completely separate from the road network to provide an additional level of safety for riders who are not comfortable or able to ride on the roads. This could be a viable alternative in areas where there is a higher incidence of children riding and should not be expected to ride alongside

automobile traffic. Another situation when a bicycle path would be desirable is where motor traffic volume or speeds are too great to safely accommodate on-street bicycle lanes. Bicycle paths have also been used as a means of connecting destinations more directly for cyclists, such as access through a residential neighborhood, connecting parks, or routes to schools (Litman *et al.*, 2006). Regardless of where the path is used, it is always separate from roads and has minimal intersections with automobile traffic. Some paths can be shared use paths which provide exclusive right-of-way for bicyclists and other forms of non-motorized travel. Multiuse path is not synonymous with sidewalk. A typical urban sidewalk is four feet across, but bicyclists require a minimum of four feet of space for travel (American Association of State Highway and Transportation Officials, 1999), thus creating a conflict. In order for a path to be acceptable for bicycles or to be designated as a multiuse path, the paved surface must be a minimum of eight feet. Furthermore, the terms “path” and “trail” are often used interchangeably, although, “trail” most often implies that of an unimproved recreational facility and clear distinction is necessary when posting signage for bicycle paths. When considering the use of bicycle or multiuse paths, the facility should not be a replacement for on-street bicycle alternatives. Instead, bicycle paths should be used as an extension of the roadway network to offer a variety of transportation choices for cyclists (Federal Highway Administration, 2006). Providing multiple route options for bicycles allows cyclists to select the alternative that best suits their needs and will thus likely influence the decision to use bicycling for transportation.

A third alternative attempts to combine the potential benefits of both the convenience of on-street bicycle lanes and the separation and comfort of off-street bicycle paths. Although only a small number of cities in the United States have adopted this strategy, the bicycle boulevard has proven to be effective when adapted and implemented. Bicycle boulevards are urban streets that have been modified using traffic calming devices (bulb-outs, roundabouts, barriers, etc.) to control motor vehicle traffic while permitting easy mobility for bicyclists. The bicycle boulevard gives preferential treatment to through cyclists but maintains access for local motorists (Litman *et al.*, 2006). The bicycle boulevard is intended to be a through street for bicycles with a limited number of intersections. Where intersections cannot be avoided, bicycles are given the right-of-way whenever possible and when not possible, controlled signal lights may be used. The bicycle boulevard concept is successful when it is used as an alternative to cycling on a congested arterial street. The route would ideally be one street over from the arterial on a one way or

residential street. This diversion from the heavy traffic in addition to the preferential treatment provides a safer on-street facility that can connect bicyclists relatively close to their destinations (Federal Highway Administration, 2006). Other options that can accompany bicycle boulevards are reduced traffic speed limits, increased signage, speed humps and colored pavement markings. All of these items further contribute to the safety and awareness of bicycle users and consequently will increase levels of bicycle transportation.



Figure 4.10. Bicycle Boulevard with side-street parking and clear signage, Portland, Oregon (Safe Routes to School, 2006).



Figure 4.11. Bicycle Boulevard intersection with street, Berkley, California (Livable Streets, 2007).

As has been evidenced by the growing numbers of cyclists in cities where major infrastructure improvements have been incorporated, the addition of bicycle facilities supports the needs of individuals wishing to commute by bicycle. New bicycle lanes on roads and off-street bicycle paths not only increase the available travel opportunities for cyclists, but they also improve the level of safety for riders and enhance community awareness about bicycling for both bicyclists and non-riders. Providing adequate secure parking for bicycles as well as making appropriate end-of-trip amenities available can further influence the decision to bicycle for transportation more frequently.

Summary

This chapter has covered three major barriers that act as deterrents to bicycling and examines multiple ways that each barrier can be addressed. There is a clear need for improved safety conditions for bicyclists considering the alarming number of traffic accidents involving bicycles each year and especially noting the high counts of bicycle accident fatalities seen above in Figure 4.2. Some solutions for improving safety are providing designated bicycle lanes on streets or parallel off-street bicycle paths. Although there is some debate as to which type of facility is better, it is obvious that an effort to promote and educate bicyclists and other community members is necessary to create a greater bicycle-consciousness. Generating more awareness and support through bicycling organizations, events, and programs will lead to improved safety for bicycle users. Also contributing to a higher level of safety is the construction and maintenance of improved bicycling infrastructure. On-street bicycle lanes and off-street bicycle paths combined with other traffic control devices and end-of-trip amenities provide safe transportation routes for bicyclists while also creating a visual acknowledgment of support and bicycle consciousness. Table 4.1 below summarizes the methods discussed in Chapter 4 that have been successful in cities in the United States.

Chapter 4: Summary of Bicycling Strategies

Strategies Discussed		Barriers to Bicycling		
		Bicycle Safety	Bicycle Consciousness	Bicycle Infrastructure
Bicycle Organizations	National Bicycle Advocacy Groups	+	+	
	Local Group Support	+	+	
Bicycle Events	Bike to Work / Bike to School	+	+	
	Organized Group Rides / State Tours	+	+	
	Charity Bicycle Rides	+	+	
	Media Coverage of Bicycling Events	+	+	
Bicycle Programs	Safe Routes to School	+	+	+
	Complete Streets	+	+	+
	National Promotion Campaigns		+	
Transportation Facilities	Increased Signage	+	+	+
	On-Street Bicycle Lanes	+	+	+
	Off-Street Bicycle Lanes	+	+	+
	Bicycle Boulevards	+	+	+
End-of-Trip Amenities	Secure Bicycle Parking Racks		+	+
	Shower and Changing Facilities		+	+
	Locker / Storage		+	+
	Bicycle Repair and Maintenance Equipment		+	+

Table 4.1. Chapter 4 Summary Table showing some strategies with overlapping purpose (Bird, 2010).

While the methods mentioned in this report have proven to be successful, any one individual solution may not address all three of the major barriers to bicycling. Focusing too much attention on one solution may cause other critical areas to be overlooked even though there are some overlapping characteristics from one strategy into multiple barriers. It is important to recognize that all three components are interconnected in a way that requires each part to be considered simultaneously. Addressing all three elements will present the best chance for increasing levels of bicycling for transportation. Following examples such as these that have been applied in some of the United States' most bicycle-friendly communities can allow other cities to begin to improve their own bicycling networks and facilities to make the bicycle a more appealing mode of transportation.

CHAPTER 5 - Bicycle-Friendly Communities

Some cities in the United States have received national recognition as leading communities that actively support bicycling from the League of American Bicyclists. The League of American Bicyclists is a national advocacy organization dedicated to promoting bicycling and creating a more bicycle-friendly America (League of American Bicyclists, 2010). The Bicycle-Friendly Community program distinguishes cities based on their overall level of integrating bicycle facilities into the transportation network, creating awareness of bicycling, and improving safety conditions for cyclists. After applying for Bicycle-Friendly Community status, the city may be awarded a rating of bronze, silver, gold, or platinum (League of American Bicyclists, 2009). Award criteria is judged based on five criteria commonly referred to as the 'Five E's.' These principles are Engineering, Education, Encouragement, Enforcement and Evaluation & Planning. In order for a city to receive an award rating, significant achievements must be accomplished in each of the five categories. Cities that receive awards, as well as those that fall short of meeting the necessary requirements, continue to receive feedback from the League on how to improve the community's cycling (League of American Bicyclists, 2010). Merely applying for the program provides cities with an educational opportunity. Attempting to meet the criteria in the application can help cities identify areas that need attention and assist planning departments with refining plans for improving bicycling. The Bicycle Friendly Community program also permits communities to gauge their success against similarly sized or comparable cities (Nesper, 2009).

In an effort to accommodate the needs of residents and their desire to utilize bicycling as an alternative mode of transportation to the personal automobile, some cities have implemented a series of bicycle lanes, bicycle paths, and bicycle boulevards as well as other infrastructure and program improvements. Following is a brief glimpse at some of the strategies that have been applied in two of the most touted bicycle-friendly communities in the United States – Davis, California and Portland, Oregon.

A brief look at Davis, California, reveals that the University of California in Davis has a current enrollment near 30,000 of which, the predominant mode of transportation is bicycle. Nearly 50 percent of students and 20 percent of faculty and staff bicycle to campus from off-

campus residences and some from neighboring cities (Davis General Plan, 2007). While the Davis General Plan covers a very wide range of issues to encompass all aspects of development and functioning of the community, only a portion of that plan is directed to transportation. The section on “Mobility” accounts for all types of transportation in the city including a few basic goals and actions related to bicycling. But to accommodate the very large share of bicycle commuters, the city has also adopted a comprehensive bicycle plan to supplement the city’s general plan. The primary purpose of the bicycle plan is to improve bicycling infrastructure in Davis by ensuring that there is a complete and current plan for development and design of all projects where bicycling can be promoted. To meet this goal, the plan outlines goals and objectives for meeting those goals in four core aspects of bicycling: Education, Enforcement, Engineering, and Encouragement. Specific goals are aimed at increasing safety and awareness initiatives as well as improving enforcement of bicycle and traffic laws. Other specific goals target increasing access for cyclists through the addition of new facility projects at key locations. Similar efforts beginning in the 1960’s have resulted in a current bicycle network consisting of 50 miles of bicycle lanes and 52 miles of bicycle paths (Davis Comprehensive Bicycle Plan, 2006). The combined miles of bicycle infrastructure can be found on 95 percent of all arterial and collector streets (Nesper, 2009, 12). Due to the extensive existing bicycle infrastructure in Davis, along with expanding the bicycle network, the bicycle plan also makes suggestions for regular maintenance practices such as clearing bicycle lanes to keep them safe and free of debris. Additionally, the plan provides precise measurements and procedures for the engineering of bicycle lanes and paths including guidelines addressing route speed, grade, and various intersection considerations. The guidelines also include specifications for on-street bicycle lanes, separate bicycle paths and coordination of alternate paths (Davis Comprehensive Bicycle Plan, 2006). The nearly 50 years of work and dedication to improving bicycle facilities and programs has led to a 14 percent share of bicycle commuters – an astounding 35 times the national average (Nesper, 2009, 12).

A survey of adults in Portland, Oregon found that 20 percent of the respondents claimed to be regular year-round cyclists and 22 percent identified as utilitarian cyclists. This included trips for work, school, shopping, errands, visiting people, or other similar activities with a destination. People who responded to questions concerning proximity and accessibility to bicycle lanes that connected with multiple destinations were more likely to be regular bicycle

commuters (Dill and Voros, 2006, 18). Recognizing the needs of residents and the potential to make the community more accessible for cyclists, the City of Portland, Oregon created a comprehensive bicycle plan in 1973 and has updated it several times, the last of which was 1998. In Portland's plan, the existing bicycle infrastructure is recorded at 150 miles of bicycle lanes and bicycle paths with future plans for adding an additional 480 miles to total 630 miles of bicycle infrastructure by 2018. The report outlines benchmarks such as this at 5, 10, and 20 years accompanied by the estimated cost of completion (City of Portland, 1998). In addition to bicycle lanes and bicycle paths, there is also a concerted effort to integrate bicycle travel with transit and other modes of travel to further increase Portland's travel options. In 2008, the city opened a bicycle facility at a transit station that serves as an important link between two highly utilized bicycle routes (Nesper, 2009, 13). Other goals like this are also presented for providing end of trip facilities and education and enforcement programs. For all of these projects, city-wide policies have been put in place to reach the goals. Furthermore, in order to meet policy guidelines and accomplish the goals, objectives are provided in the bicycle plan; the process by which progress should be made. For example, the plan states that whenever a road is constructed, reconstructed, relocated, or resurfaced, it should be examined for possible bicycle use improvements. It suggests that streets with a traffic volume of 3000 cars or less be retrofitted with an adjacent bicycle lane by either narrowing or eliminating motorized traffic lanes or widening the shoulders. For streets that have more traffic or where adjacent bicycle lanes cannot be included, bicycle facilities should be constructed on a nearby parallel street within a quarter mile. Lanes with side street parking and a low traffic flow may be made bicycle boulevards in which cyclists have priority over motorists through the use of traffic calming devices, intersection treatment, and increased signage. A wide range of other design and engineering guidelines are also provided (City of Portland, 1998). The plan also includes bicycle/motor vehicle crash statistics for the City of Portland and benchmarks for reducing the number of accidents. Methods for educating both cyclists and automobile drivers to prevent accidents has proven successful as no bicycle fatalities were recorded during four out of eight years between 2000 and 2008 (Nesper, 2009, 14). As Portland continues to strive to meet their goals, the reward for the effort speaks for itself. Between 2007 and 2008 citywide ridership increased by 28 percent (13).

Only three cities in the United States have made enough substantial progress in each of the ‘Five E’s’ set forth by the League of American Bicyclists to have earned the award of platinum status as of 2010. Davis, California, and Portland, Oregon, are two of the cities that have led the country in design for bicycle transportation and awareness: the third is Boulder, Colorado. Visiting successful bicycle-friendly communities like Boulder allows researchers to observe what the city has done that works well and what areas are still in need of improvement.

Boulder, Colorado

The City of Boulder, Colorado, is situated in a wide level basin at the base of Flagstaff Mountain along the continental divide and roughly 35 miles northwest of Denver, Colorado (City of Boulder, 2010). Boulder has an estimated 2009 population of 100,160 (United States Census Bureau, 2009). This includes a student population of roughly 30,000 in attendance at the University of Colorado which is located within the city (City of Boulder, 2010). The city covers a land area of approximately 25 square miles and results in a population density of just over 4,000 people per square mile (City-Data, 2010). The median age of Boulder residents is remarkably low at 26 years old compared to the state and national averages of 36 and 37 years old respectively (United States Census Bureau, 2009).

The city is 5,340 feet above sea level in the Rocky Mountains where the climate is typically mild and dry. Summers in Boulder are moderate with an average temperature of 73 degrees Fahrenheit and winters are typically mild with an average temperature around 32 degrees. The nearby mountains shelter the city from the most severe storms and consequently Boulder boasts more than 300 sunny days each year. Most precipitation is received in the winter and spring totaling 102 inches annually including 83 inches of snowfall (City-Data, 2010). A large volume of runoff comes from seasonal snowmelt in the mountains and drains through several large creeks running through the center of Boulder. The basin created by this melt-water runoff is astonishingly flat considering the close proximity at the base of the mountains (City of Boulder, 2010).

The generally temperate and sunny weather combined with the flat topography, compact design of the city and the relatively youthful population including college students makes conditions in Boulder nearly ideal for bicycling. Yet Boulder’s extensive bicycling transportation network and reputation for being the most bicycle-friendly city in the United

States did not happen overnight. An examination of Boulder's history provides a better idea of what it takes to shape a city into a bicycling paradise. An understanding of historical events is crucial for determining the current state of affairs and assessing what actions are necessary to continue making sound planning decisions in the future. Furthermore, visiting Boulder and examining the bicycle system is extremely valuable for analyzing how well it works. Personal interviews with City of Boulder staff and bicycle shop employees gain insight as to how residents use and perceive bicycle facilities. But nothing explains the situation better than physically going out and riding a bicycle to experience the nuances of Boulder's platinum rated bicycle network.

History

Boulder, Colorado, began as a mining supply camp to provide needed supplies and entertainment services for gold and silver seekers in the mid 1800's. The population grew steadily until the 1950's when it nearly doubled (City of Boulder, 2010). In response to the surging population, Boulder implemented a 'blue line' charter amendment that limited the extension of water lines to an elevation of 5,750 feet to preserve the mountain backdrop. As the city continued to grow in the 1960's, citizens were concerned about protecting the natural setting of the nearby mountains. Boulder was the first city in the United States to institute a dedicated sales tax in 1967 for the purchase of land preserved for open space surrounding the city. Then in 1970, the city created and adopted the Boulder Valley Comprehensive Plan to protect the natural environment and to guide the decisions and future development of the Boulder Valley. The plan was revised in 1977 and has been updated periodically since with the last update completed in 2005 (City of Boulder, 2005). The Boulder planning commission is currently in the process of updating the plan again with the review and adoption scheduled for early 2011 (City of Boulder, 2010). To supplement the Boulder Valley Comprehensive Plan, the City of Boulder Transportation Master Plan was first adopted in 1989 and has undergone several revisions. The current version was approved in 2008 and guides the current and future direction of the city's extensive transportation networks (LSA Associates, Inc., 2008).

Boulder has remained at the forefront of innovative planning initiatives and design solutions when it comes to transportation opportunities as well. In the last several decades, plans for the City of Boulder have incorporated a substantial network of bicycle facilities and programs

aimed at promoting and increasing the use of bicycling for transportation. In order to discuss the changes that have taken place in Boulder, actions will be divided into categories of Bicycle Safety, Bicycle Consciousness, and Bicycle Infrastructure as was done earlier in this report. Similar types of sources are used, but also included in the discussion of Boulder is information that was gained from personally visiting the city in March, 2010. Interviews were conducted to get input regarding local residents' opinions about bicycling for transportation as well as safety related issues that they have encountered. After collecting data and interviewing individuals, I set out on my bicycle to ride the bicycle lanes and bicycle paths and to confirm the information that had been gathered.

Boulder Bicycle Safety

High priority goals of the current Boulder Transportation Master Plan place safety for all transportation system users at the most concern (LSA Associates, Inc., 2008). This includes special attention to bicyclists and pedestrians since they are the most vulnerable in traffic accidents. A two phase study conducted by the Colorado Department of Transportation (CDOT) attempted to correlate bicycle and pedestrian traffic accidents with recurring trends involving the details of the accident. Boulder was selected as the survey city due to the higher number of cyclists and pedestrians that use the transportation network. Phase I of the study assessed 717 bicycle and pedestrian involved traffic accident reports that occurred between January 2001 and December 2005. Of the 717 reported accidents, 67 percent (479) involved automobile collision with a bicycle. Of the same 717 reported accidents, over half (55 percent) occurred at intersections and most were during daylight hours (71 percent) with dry roads (86 percent) and no adverse weather conditions (87 percent) (Carter & Burgess, 2006, 19).

Based on information gathered in Phase I of the report, Phase II determined that at 25 selected intersections involving vehicles colliding with bicyclists (70 percent) and pedestrians (30 percent) there was a significantly higher incidence of accidents involving vehicles making right turns (Carter & Burgess, 2007, 23). One possible determination of this result that was presented is when a vehicle approaches an intersection to make a right turn, the driver looks left for oncoming cross traffic and once clear, begins to make the right turn without rechecking for bicyclists or pedestrians crossing (Carter & Burgess, 2007, 25).

In order to address this concern, at some intersections in Boulder, the right turn lanes have been channelized. Channelizing the right turn lanes permits drivers to deal with traffic and bicycle or pedestrian conflicts separately. At these channelized intersections, crosswalks are raised and often colored to alert drivers of their presence. As the driver approaches these crossings, more attention can be given to bicycle and pedestrian movements. Once past the raised crosswalk, vehicles may then approach the yield line and begin looking at automobile conflicts. According to Phase II of the CDOT report, where this type of design was present, accidents caused by vehicles making right turn maneuvers was not significantly higher than other types of accidents (Carter & Burgess, 2007, 26). Observation of this engineering solution proved the effectiveness of slowing automobile traffic and bicycles and pedestrians in the crosswalk were more visible as a result of the raised path. However, the channelizing island does present a challenge for bicycles in some situations. If no bicycle lane is marked on the street, cyclists attempting to go straight through the intersection must merge with traffic to prevent going into the right turn lane.

In other situations, the City of Boulder has found it best to eliminate bicycle intersections with automobile traffic altogether when possible. Since 1989, Boulder has been constructing a network of paths intended for bicycle and pedestrian travel that is separated from roadway vehicle traffic. The network of bicycle paths connects riders with most destinations or gets users close to destinations to minimize traffic conflicts. Where these paths approach busy streets and highways, Boulder has been very ambitious in constructing underpasses to allow uninterrupted travel on the paths and to avoid dangerous intersections. With 75 underpasses existing, the city has been averaging more than two underpass construction projects per year and more are planned (GO Bike Boulder, 2010).



Figure 5.1. Bicycle and pedestrian underpass in Boulder, Colorado (LSA Associates Inc., 2008).

By providing separated paths with underpasses to limit intersections, bicyclists in Boulder have a choice that puts extra distance between automobile traffic and bicycles that can increase safety for riders. Following the Boulder Creek multiuse path, I was able to bicycle from the Pearl Street Mall on the west side of town to Valmont City Park on the east side with only minimal interaction with vehicular traffic. This ride covered nearly four miles and included a number of underpasses and one overpass to avoid busy streets.

Where intersections with streets cannot be avoided, Boulder has instituted policies that are intended to reduce traffic speeds where possible and increase signage for both vehicle traffic and bicyclists in all situations. More intense measures include specially designed traffic signals for bicycles including traffic signal phasing that allows time for cyclists to cross before vehicle traffic begins to move (Carter & Burgess, 2007, 28). Other solutions include raised medians to control where bicycles can cross streets more safely and introducing “No Right Turn on Red” signs to further improve safety at vehicle right turn maneuver conflict points (33-34).

After visiting a bicycle shop on Pearl Street on the west side of Boulder, I learned that one employee typically commutes by bicycle to work from a home roughly two and a half miles by road to the northeast. The employee stated that “I used to worry about safety riding on the road and busy intersections so I would ride a couple extra miles out of the way to get onto Boulder Creek Path” (Boulder bicycle shop employee, personal communication, March 18, 2010). Since that time, the employee claims to have become accustomed to using the bicycle lanes on the streets to get to work and around the city.

To promote safer bicycling in Boulder, the city has adopted and actively supports the Safe Routes to School program. By educating youth to actively bicycle to school, safe practices can be taught and riding can be encouraged under controlled and safe conditions. Twelve public schools and four private schools have initiated the program and continue to look for ways to improve their programs. By involving 70 percent of its students in bicycling and walking activities, Bear Creek Elementary School earned the 2008 James Oberstar Award for participation (Nesper, 2009). Many of the routes that are suggested for bicycling to school follow separated bicycle or multiuse paths that connect the school with residential neighborhoods and the larger transportation network. Utilizing the bicycle paths improves safety conditions for school aged children because it removes the dangers of bicycling on the road that youth are often not ready for. The City looks to expand and improve the Safe Routes to School program by

seeking proposals for infrastructure improvement projects within two miles of schools and within Boulder City right-of-ways (GO Bike Boulder, 2010).

Boulder Bicycle Consciousness

The Safe Routes to School programs and safety in general is greatly enhanced by Boulder’s superior support and awareness of bicycling and the needs of cyclists. The active lifestyle and culture of Boulder works very well to continue to promote bicycling as a means of transportation. Residents are accepting of alternative modes of travel and encourage events that increase the opportunities for bicyclists to enjoy riding. Boulder is also fortunate to be the headquarters of the national Bikes Belong Coalition. According to a personal interview with a bicycle shop manager, “We are really lucky to have such a prominent organization here to help guide bicycle practices. We [Boulder] get to experience a lot of new programs from Bikes Belong before other cities do” (Boulder bicycle shop manager, personal communication, March 18, 2010).

In addition to the presence of Bikes Belong and other local bicycle organizations, the City of Boulder as a whole has adopted a campaign for promoting bicycling to citizens and visitors. Part of the GO Boulder program for providing “Great Options” is GO Bike Boulder. GO Bike Boulder is a pilot program funded by a federal grant and the City of Boulder to reduce vehicle miles. The program is dedicated to reaching the goal set forth in the Boulder Valley Comprehensive Plan of reducing single occupancy vehicle trips from 44 percent to 25 percent of all trips by 2025. To achieve this shift in mode share away from automobile travel, the GO Boulder program is promoting alternative modes of travel including bus transit, walking and bicycling. GO Bike Boulder has created a website with many attached links for information about the program and what its goals are, as well as a wide range of information regarding safe cycling and promotional events (GO Bike Boulder, 2010).



Figure 5.2. GO Bike Boulder program logo (GO Bike Boulder, 2010).

According to a Boulder City staff person, bike to work days are one of the greatest outreach programs sponsored by GO Bike Boulder. “We try to generate a lot of excitement by advertising upcoming bike to work days and by having drawings for great door prizes [...

including ...] bicycle equipment” (Boulder City Staff, personal communication, March 19, 2010). The scheduled events are citywide and encourage people to sign up to pledge their support of bicycling. In 2009, 7,137 individuals and 322 organizations participated in bike to work day. Of the 7,137 participants who signed up, nearly 25 percent (1,670) bicycled to work for the first time (GO Bike Boulder, 2010). Results like this demonstrate how effective and how successful the program can be.

Another valuable service that the program provides is a bicycle road map of the city. The map includes markings for all existing bicycle infrastructure and it delineates between on-street bicycle lanes, separate bicycle or multiuse paths, and other available bicycle services. The map is large enough to show sufficient detail, but is folded into a size small enough to tuck into a pocket while riding. The City prints these pocket sized maps and gives them to Boulder bicycle shops and other area businesses to distribute free of charge (GO Bike Boulder, 2007). This resource is excellent for visitors, although residents may use it as well. However, residents have an additional option for using the map. On the physical map that I picked up at a bicycle shop is a suggested link for the GO Bike Boulder website. Visiting the website at a later time, I found that the website has an interactive map that allows route planning to get from one destination to another and includes calculations accounting for how far the trip is, how many calories will be burned, and how much money would be saved by bicycling instead of driving (GO Bike Boulder, 2010). These features demonstrate that the online map service is intended to encourage residents to utilize Boulder’s bicycle network for transportation rather than driving.

A visit to Boulder makes it easy to see the great effort that the City has put into promoting bicycling. The ample signage warning drivers of bicycles on the road, advertisements for upcoming cycling events, and the map of city bicycling routes were all welcoming sights for a cyclist. But nothing speaks for the positive attitude the city has about bicycling more than the physical bicycle facilities in place throughout the city.

Boulder Bicycle Infrastructure

Upon driving into Boulder for the first time, one is immediately taken aback by the level of integration of bicycle lanes into the roadway network. Drivers traversing the city who are unfamiliar with bicycle lanes may find it challenging with the presence of such a large number of on-street lanes and watching out for bicyclists, although, drivers quickly adjust to the cyclists frequently riding alongside traffic.

Boulder has made this reality possible by actively pursuing policies to promote a multimodal transportation system that emphasizes bicyclists and pedestrians as the primary mode of travel. The multimodal transportation plans have been modeled on the Complete Streets program and pending available funding, the city plans to expand public transit bus service and increase bicycle and pedestrian facilities while maintaining the current level of service for automobile traffic. Boulder is looking for new and innovative ways of incorporating bicycle lanes and bicycle paths to complement existing automobile roadways to reach their goal of reducing single-occupancy vehicle travel (LSA Associates, Inc., 2008). To date, Boulder has over 380 miles of integrated bicycle lanes, paths and designated routes accounting for 95 percent of the cities arterial and collector streets (Nesper, 2009).

Using this extensive bicycle network, “There’s almost nowhere in town you can’t get to on a bike” according to another bicycle shop worker. The only decision that a cyclist must make is whether to use on-street or off-street facilities. A large portion of Boulder’s bicycle travel is provided as on-street bicycle lanes or designated bicycle routes. Some on-street facilities include paved shoulders that provide enough space for cyclists to safely travel. Another option is the multiuse path system. These paths are graded and paved to make travel easy and efficient for bicyclists. While the paths do allow riders to stay out of traffic, there are some areas where the paths do not go. For these areas, the on-street facilities provide a greater level of connectivity. An interview with Boulder City staff revealed that there are some stretches of road with off-street paths running parallel to them. Although this can be viewed as being excessive, the redundancy is acknowledged by the City and accepted because it offers multiple options for cyclists to choose a route that they are most comfortable with. It is the hope of the City that by providing a variety of opportunities for a range of experience and skill sets, more people will make the choice to use bicycling as an alternative mode of transportation for automobiles. The aforementioned bicycle map and online interactive version are excellent resources for individuals

planning routes to get to work, school or other destination. The interactive map on the GO Bike Boulder website assists cyclists by allowing them to select whether the route follows on-street facilities or off-street paths (GO Bike Boulder, 2010).

While getting from one location to another is a critical component of cycling for transportation in a city, facilities to place a bicycle upon arrival is also important. The presence of secure parking facilities at desirable locations will influence cyclists to ride to their destination. In August of 2009, the city conducted a survey of downtown bicycle parking behavior. Over a four day period, 4,088 bicycles were counted in the study area. Of these, 22 percent were locked to objects that were not designated bicycle parking. This demonstrates that the need for parking in the downtown area is not fully being met (Urie, 2009). Personal observations during a trip to the same area showed that even though there were fewer bicycles during March rather than August, several designated parking locations were full and multiple bicycles were locked to trees, signs, fences, or whatever was convenient. However, the city is making efforts to address this problem. Over 225 bicycle “U” racks and “loop-and-post” parking meters have been installed or converted (Nesper, 2009).

After questioning employees from several different bicycle shops, a consensus was reached that providing locker space for clothes and equipment at the workplace would make commuting by bicycle easier. It was agreed that shower and changing facilities at work would likely result in more employees bicycling instead of driving. Several of the shop employees I interviewed indicated they had a room for employees to store belongings and separate places to lock their bicycles. One shop contained an employee break room which included hanging racks for employee bicycles, lockers for storage, and bathrooms that employees used to clean up after arriving to work. An employee who had just arrived explained that “I probably wouldn’t ride here from my place ten miles away if I couldn’t clean up and change shirts.” Another worker commented that the shop was fortunate to have their facilities because “most businesses don’t have places to change or clean up” (Boulder bicycle shop employee, personal communication, March 19, 2010).

It is without a doubt that the extensive facilities available for bicyclists are a major contributor to the success of making Boulder accessible for bicycles. Of the \$304 million transportation budget, 88 percent (\$268 million) is used to continue operation of existing facilities and to perform maintenance services. The remaining 12 percent (\$36 million) is

dedicated to enhancing the system by increasing bicycle and pedestrian infrastructure (LSA Associates, Inc., 2008). Factoring in the safe environment and the community's willingness and desire to improve bicycling within the city, the result is a platinum rated bicycle-friendly city.

Success in Boulder

Earning platinum status, the highest rating awarded by the League of American Bicyclists, is certainly not the end of the line for Boulder – the honor must be maintained. This modest town nestled in the foothills of the Rocky Mountains did not reach such lofty heights easily. The process of becoming one of America's most successful cities for bicycling has required a great effort on the part of planning initiatives and citizens who demand integrated bicycle transportation. This section looks at some of the factors behind Boulder's successful bicycle revolution.

Beginning in the late 1960's, Boulder began adopting policies and plans to guide the future development of the city. It was recognized that in order to attain any realistic goals, changes would have to occur gradually. That is why the objectives set forth in the Boulder Valley Comprehensive Plan and the Transportation Master Plan are incremental rather than extreme. Achievable goals are in place with available funds planned for new development and these are reassessed periodically when the Comprehensive and Transportation Plans are revised (City of Boulder, 2005; LSA Associates, Inc., 2008). Also, the adopted plans for transportation have been successful because they are intended to improve all types of travel. By adopting the Complete Streets approach, the plans account for all users of the street network. If the transportation plan was targeted towards increasing only bicycle facilities, there would be far less citizen support.

Another reason for the success of Boulder's bicycle network is the availability of multiple travel options. As discussed in previous sections, the city feels that it is important and appropriate to provide a reasonable level of redundancy in the bicycle and transportation network to accommodate users of all abilities. As an experienced cyclist, I was comfortable riding on streets for the increased connectivity and convenience. However, after riding on both roadways and the separated bicycle paths, I certainly understand the desire for increased space away from vehicle traffic as well as the more relaxing and scenic qualities offered by the paths. To further enhance travel options, many bus stops have bicycle parking for "park and ride" opportunities

for longer distance commuters. Most busses also have bicycle racks on the front or back or both for transporting bicycles with their riders.

When it comes to the construction of bicycle facilities in Boulder, the city has been very opportunistic. Instead of starting from scratch and attempting an entire project from start to finish, bicycle lanes have been added when appropriate. When road conditions become very poor and more than normal maintenance is required, opportunities for including bicycle lanes or routes are considered. Similar situations were presented for the construction of stretches of multiuse paths alongside creeks. An interview with city staff revealed that locating bicycle paths along the creeks was coupled with other department efforts to control seasonal flooding from snowmelt. It was stated that in the past when the snow began to melt each spring, the sudden rise in water levels was causing widespread erosion and severe damage to crossing roadways. As an effort to regulate the flood waters, large concrete channels were being constructed beneath streets. By collaborating on the project, the city was able to adapt the channels to use as underpasses for bicycle paths as well. Looking for chances to work together with multiple departments enabled the city to pool funds to help mitigate flood potential along creeks while simultaneously providing transportation alternatives for cyclists.

Perhaps the most important contribution to Boulder's success in making the bicycle a viable means of transportation is the residents' attitude towards bicycling. For the most part, people living in Boulder have made a conscious decision to live in an outdoors-oriented and active community. It is the combination of the bicycle facilities and the active lifestyle of Boulder that attracts elite athletes to live and train in the city. Boulder has honored more than 20 Olympic and world-class professional athletes who reside within (Nesper, 2009). This includes the professional cycling team, Garmin-Transitions (Slipstream Sports, 2010).

Some other riders are equally dedicated to bicycling, only in a different way. During my time in Boulder in early March, a winter storm blanketed the city with over ten inches of snow. Yet despite the adverse weather, I observed more than a few devout cyclists riding through the snow. Although I was content to bicycle three miles from my hotel to bicycle shops for interviews, I did not have the proper equipment to make the journey. Others did however, as I witnessed a number of people wearing suits with briefcases lashed to fenders sliding along in the cold. Fortunately for those brave enough to attempt the ride to work, the city is equally devoted to clearing the bicycle lanes and paths. The bicycle network has its own crew that begins

removing accumulated snow at the same time or before the street crews (GO Bike Boulder, 2010). The bicycle lanes were clear even before the snow had stopped falling.

The commitment of the City of Boulder to create and act on well-founded plans has been paramount to the addition of bicycling facilities to the transportation network. Using a Complete Streets approach and seeking collaborative opportunities to make incremental adjustments to all modes of transportation has improved connectivity and availability for bicyclists. And the positive attitudes of residents have pushed the city to continue to improve upon their established systems. The efforts and support of city personnel and the support of residents have led to Boulder being recognized as one of the United States' most successful bicycle-friendly cities.

Improvement Needed in Boulder

Even though the League of American Bicyclists has awarded Boulder with its highest honor, it does not mean that everything is perfect. Boulder has experienced a great deal of success in implementing their bicycle networks and programs, but there are still areas that need attention and improvement.

While riding my bicycle around Boulder, there were a number of places where the bicycle lane in which I was riding suddenly ended, leaving me in the midst of automobile traffic. When I brought this issue up with a bicycle shop owner, the response was "I know of a couple places where that is a problem. Sometimes that happens when a bike lane is added when the road is redone and where the roadwork ends, so does the lane" (Boulder bicycle shop owner, personal communication, March 18, 2010). These disconnects in bicycle lanes can lead to dangerous situations where a bicyclist must suddenly merge with traffic without warning, especially for those riders who are relying on the bicycle lane as their necessary distance for safety.

A related issue involves areas where a bicycle lane or bicycle path would greatly benefit a cyclists' route by improving network connectivity. These "missing links" occur where there is currently inadequate space or utilities to add bicycling infrastructure. This problem is also common in commercial centers where retail developments and automobile parking has taken up valuable potential bicycling space.

As mentioned previously, there is a shortage of available bicycle parking spaces in some areas. Many of the bicycle racks around the Pearl Street Mall were consistently occupied and I

had to find an open rack at a nearby parking area. Other areas on Pearl Street west of the mall were also full. Several bicycles were locked to trees or signs or other stationary objects. A small number of bicycles were also left unchained and unattended. As the number of bicycles in Boulder is likely to increase in the future, so too will the need for more available secure bicycle parking.

When some of these issues were discussed with City of Boulder staff, the city is aware of the challenges that it is faced with. The city conveyed that increasing bicycle parking in some key areas was a concern. Also, addressing the problems of missing links and disconnects in the bicycle network was of great importance to the city. Boulder has plans to “connect gaps” in bicycle facilities by following the goals and objectives of the Transportation Master Plan and the Boulder Valley Comprehensive Plan. The comprehensive plan states that “The city and county will strive to make bicycling [...] convenient and safe by completing the systems [...] and providing seamless connections between the systems developed in the city and county” (City of Boulder, 2005, 44). The transportation plan goes one step further and outlines specific policies to guarantee “coordination with [...] other government entities and plans to ensure that all [...] projects connect with and help to complete the corridor network” (LSA Associates, Inc., 2008, 30). Boulder has made an obvious commitment to support and enforce the standards that have been established in their guiding plans and to continue with the tradition of providing excellent travel options.

CHAPTER 6 - Funding

There are significant costs associated with making improvements to a city’s bicycling infrastructure network, promotion, and education programs. The availability of existing funds and expected funds for all departments and expenditures of the city are recorded in Boulder’s annual operating budget. Contained within the budget are the allocated funds available for each city department, including transportation (City of Boulder, 2011 Recommended Budget Overview and Operating Budget, 2010). An essential implementation tool for adhering to the budget and for carrying out the transportation goals outlined in the Boulder Valley Comprehensive Plan is the Capital Improvements Program (CIP). The CIP is a plan for setting spending priorities, scheduling projects to direct available funds, and coordinating public improvement projects within the city (City of Boulder, Capital Improvements Program 2011-2016, 2010). From 2000 to 2008, Boulder, Colorado, has dedicated an average of 15 percent of the annual transportation budget to maintaining and improving bicycle elements within the city. That 15 percent over a nine year period amounts to \$11.1 million for operation and maintenance of existing facilities and \$22.6 million towards new bicycling enhancements (Boulder City staff, personal email correspondence, April, 2010).

Modal Investment of Boulder, Colorado Transportation Budget				
Bicycle				
Year	Operations/ Maintenance	Enhancement	Total	% of Trans Budget
2000	\$1,191,800	\$1,525,000	\$2,716,800	14%
2001	\$1,197,353	\$2,488,130	\$3,685,483	14%
2002	\$1,317,516	\$2,456,128	\$3,773,644	13%
2003	\$1,032,756	\$3,522,434	\$4,555,190	19%
2004	\$1,075,769	\$2,122,793	\$3,198,562	15%
2005	\$1,050,009	\$3,618,072	\$4,668,081	20%
2006	\$1,033,544	\$1,174,930	\$2,208,474	12%
2007	\$1,934,028	\$3,555,938	\$5,489,966	18%
2008	\$1,281,535	\$2,151,289	\$3,432,824	12%
Total	\$11,114,310	\$22,614,714	\$33,729,024	15%

Table 6.1. Bicycling expenditures 2000-2008, Boulder, Colorado (Boulder City staff, personal email correspondence, April, 2010).

The more than \$33 million spent on bicycling facilities in Boulder in just less than a decade comes from a variety of sources. The largest portion of Boulder's transportation budget comes from a city-wide dedicated sales tax while other contributing sources include a highway user's tax, city automobile registration, and reimbursements from the Regional Transit District (City of Boulder, 2011 Recommended Budget Overview and Operating Budget, 2010, 172).

While not all cities wishing to expand their bicycling network have the same budget as Boulder, nearly all cities do have an annual budget and a CIP in place. Therefore, any city that chooses to pursue bicycling enhancements has the opportunity to include bicycling plans in the CIP and to use funding from within the city's budget. One tradeoff with this strategy is the resulting fewer funds available for other public projects. In order to adjust for this imbalance in city funds, alternative sources of revenue should also be considered.

Fortunately, because of the growing interest in bicycling and its benefits discussed earlier in this report, many external funding sources are becoming available. Several potential funding sources are included here, but cities are certainly not limited to those discussed in this report. Provided here are some sources that are available to most cities, but every community may also seek other opportunities and be creative to attract local revenues.

The federal government is considering increasing the federal transportation budget from the \$77 billion enacted in 2010 to \$78.8 billion for 2011. President Obama is attempting to initiate a new program that supports more environmentally friendly forms of transportation. The proposed 2011 Federal Budget is requesting \$530 million for the President's Partnership for Sustainable Communities. This program is intended to help state and local governments integrate sustainable transportation opportunities into existing facilities to connect housing developments with other critical investments (United States Office of Management and Budget, 2010). If approved, this additional funding may be available for specific infrastructure improvements related to bicycling in addition to other funds distributed by State Departments of Transportation.

Other financial assistance at the federal level may come from new legislature acts that are under consideration. As the federal government may adopt new bills that favor transportation alternatives to the automobile, cities should capitalize on opportunities to secure funds for advances in bicycling facilities. The United States Senate is reviewing a proposed bill that would benefit bicycling causes greatly. Senate bill 1156 is intended to reauthorize the Safe

Routes to School program and increase available funding to \$600 million for fiscal years 2010 through 2014. Funds from this act are not limited to making infrastructure improvements like some other sources may be, but are made available for education and enforcement programs as well (S. 1156, 2009). The Safe Routes to School program is an excellent strategy for cities to pursue a more complete approach to improving bicycling infrastructure, bicycle safety and bicycle consciousness.

In addition to federal funding, other national organizations provide grants for a wide range of bicycling initiatives. The Bikes Belong Coalition has a competitive grant program aimed at helping communities achieve their bicycling facilities goals. Since 1999, the Bikes Belong grant program has awarded over \$1.6 million in nearly every state to contribute to the completion of more than 1,450 miles of bicycle paths and trails. Bikes Belong, the League of American Bicyclists, and a number of other advocacy organizations work together to provide grants for bicycle facility construction and bicycle education and safety programs. Because of the large number of applicants to these grant programs and the limited available funds, awards are often in the \$5,000 to \$15,000 range (Bikes Belong Coalition, “Bikes Belong Grant Program,” 2009).

Because grant awards can be somewhat limited, communities may look for other sources to match grant money received. City or State parks departments are possible candidates for matching funds. Other options may include businesses or individual donations from bicycle-supporting benefactors. Communities should always look for local interests for financing opportunities. Organizing bicycling events and group rides is a good way to enlist the support of local sponsors and to raise awareness for both the bicycling cause and supporters. Organized rides have proven to be beneficial as fundraising activities in the past. Entry fees and donations from bicycle events have been used to pay for construction of new bicycle paths and support increasing bicycling awareness. Communities can expect a great deal of assistance from local bicycling groups and individuals.

To further supplement these potential funding options mentioned, communities should also continue to actively search for new sources of revenue. It is doubtful that a bicycling system will be totally self-sufficient, and therefore, communities should remain vigilant when trying to acquire funds. Some assets may come from the least expected sources; hence communities that are creative when searching for income are likely to be rewarded.

CHAPTER 7 - Conclusion

Summary

This report has attempted to determine why bicycling is an under-utilized form of transportation in the United States. Although bicycling has strong historical roots, the introduction of the personal automobile which led to suburbanization and more sedentary lifestyles has had lasting effects on urban development and decision-making. Longer travel distances and automobile oriented development have had a critical impact on the role of bicycling in urban settings. Despite setbacks to bicycling, many areas in the United States are experiencing a resurgence of individuals interested in commuting by bicycle. Increased health benefits, economic savings, and decreasing environmental impacts have convinced a growing number of individuals in the United States to choose bicycle travel as their transportation method. But with less than one percent of all urban trips made by bicycle, there are obviously considerable barriers facing individuals who choose not to bicycle for transportation.

The research questions posed at the beginning of this report will now be revisited. Each question will be addressed individually to explain the major obstacles to bicycling, strategies to overcome these obstacles, and implementation strategies for communities to improve bicycling as a viable means of transportation.

Question A: What are the most prominent deterrents to bicycling as a means of transportation?

Following a review of sources and examination of Internet bicycling forums, it becomes clear that there are a wide range of factors affecting a person's decision to use bicycling for transportation. This report contends that there are three critical barriers to bicycling that are most important and that can be overcome or improved through conscious community planning. The first issue is the need for increased safety while cycling. Reported traffic statistics clearly indicate that safety while bicycling is a problem. Less than one half of one percent of all urban commuter trips are made by bicycle, while bicyclist deaths account for two percent of all traffic fatalities and also two percent of all reported traffic accidents involve bicycles (National

Highway Traffic Safety Administration, 2008). Another prominent dilemma is the absence of a strong bicycle consciousness. Both bicyclists and non-riders lack awareness of many of the opportunities that exist for cycling. The final problem is the need for a more complete and connected bicycle infrastructure. Bicycle riders often find that needs for adequate travel space and appropriate facilities for bicyclists are rarely met.

Question B: What tools or strategies are currently being used to address these deterrents to bicycling for transportation?

For each of the three barriers to bicycling outlined in this report, there are numerous methods for improving conditions for bicycling. Because of the interrelated nature of the barriers, some methods are designed or intended to address multiple issues at the same time. Consequently, providing bicycling infrastructure such as on-street bicycle lanes meets the needs of adequate facilities for cyclists to ride while also allowing a measure of safety while riding in vehicle traffic. Separate bicycle paths also create needed bicycle infrastructure while increasing the level of safety by moving bicycles off the street to avoid traffic and busy intersections. Improving secure bicycle parking and end-of-trip amenities increases accessibility for more bicyclists to utilize the bicycle network. National advocacy groups such as the Bikes Belong Coalition and the League of American Bicyclists use programs to generate interest and support for bicycling while local organizations may sponsor rides and other events to increase local awareness for bicycling. Still other initiatives are aimed at addressing all three critical barriers at once. Bicycle boulevards are an efficient way of allowing bicyclists to have a roadway that is safe and the extra traffic calming effects and increased signage alert automobile drivers to the presence of bicyclists. The Safe Routes to School program can be used to provide safe bicycling facilities for students to get to and from school while efforts in the classroom are aimed at improving education of safe practices and encouragement for students and families to bicycle more frequently.

Question C: What options are available to planners to encourage and promote a greater acceptance of bicycling as an everyday mode of transportation?

By looking at cities that are recognized leaders in expanding bicycling for transportation, lessons can be learned and their examples can be adapted for use in other locations. For this report, examining Boulder, Colorado, provided valuable insight for successful strategies for improving bicycling in a community. Boulder began by creating comprehensive plans to guide the growth of the city which included establishing service boundaries, securing open land around the city, and levying a dedicated sales tax. In addition to a city comprehensive plan, Boulder also adopted a more specific transportation master plan. Altogether, the plans are in place to ensure that policies and goals for all aspects of the city, including bicycling, are considered. Policies and plans should not place too much emphasis on a single component of bicycling. Rather, more complete approaches should address all aspects of improving bicycling while still maintaining an adequate level of service for other modes of transportation.

The Complete Streets model has been adopted in Boulder to ensure quality transportation options for all users of the road network. A part of Complete Streets is providing proper bicycling infrastructure as an integrated asset of the street system. This can be accomplished by designating bicycle lanes on the street, constructing separated paths, and improving intersections to safely accommodate bicyclists. Providing multiple travel options permits cyclists to decide which route is best for their abilities and destination. An important strategy for increasing the number of bicycle riders in a community is to get youth started bicycling. The Safe Routes to School program can be implemented to help create needed bicycle facilities connecting with schools and to begin educating students about safe bicycling practices. To engage an adult audience, bike to work events are an excellent way of generating awareness of bicycling and encouraging more individuals to bicycle of utilitarian purposes. To finance needed bicycle infrastructure and bicycle programs, cities should look for opportunities to pool funds with other departments and should be aggressive and creative when searching for grants and other external funding sources.

Recommendations

In this report, barriers to bicycling were examined individually. However, when considering the three barriers to bicycling – bicycle safety, bicycle consciousness, and bicycle infrastructure – it is important to recognize that all three components are interconnected in such a way that when creating a plan of action, attention should be given to each part simultaneously. Focusing on just one part can result in a lopsided approach to the situation and may ultimately cause other parts to be overlooked. Addressing all three elements will present the best chance for effecting a change in attitudes and behaviors and increasing bicycling as a means of transportation.

Operating under these circumstances, it is recommended that communities that wish to make bicycling enhancements begin with a careful examination of their bicycling needs and opportunities. Planners should work closely with citizens to create a vision and goals for the community that will guide future developments to include bicycling options for transportation. Community bicycling plans might be adapted from examples used in other cities, emulating successful bicycling solutions. The League of American Bicyclists’ Bicycle Friendly Community program establishes a good tool for planners to use while making improvements to bicycling plans. The “Five E’s” approach – Engineering, Education, Encouragement, Enforcement, and Evaluation – is an excellent way for communities to gauge their success and make further adjustments. Planners should pay close attention for chances to improve all modes of transportation using the “Five E’s” including bicycling. Programs such as Complete Streets and Safe Routes to School are excellent ways to increase bicycle infrastructure elements while also improving safety for cyclists and creating awareness of bicycling in communities. Many other programs and campaigns are useful for educating and promoting safe bicycle practices and should be implemented in communities to create a stronger bicycle consciousness. In order to finance bicycling improvements, active and creative measures must be used to identify and secure potential funding sources. Most importantly, updating and improving bicycling networks is a cyclical process. Constant evaluation, reformulating, and implementation is critical to the ongoing success of making bicycling a safe and effective transportation alternative in the United States.

Notes

¹ More information is available for several major national bicycle advocacy organizations. To learn more about some of these organizations, visit the websites listed below.

Bikes Belong Coalition	http://www.bikesbelong.org
League of American Bicyclists	http://www.bikeleague.org
Alliance for Biking and Walking	http://www.peoplepoweredmovement.org
Pedestrian and Bicycle Information Center	http://www.bicyclinginfo.org

² A multitude of websites are available for cyclists to see what events are going on in their area. Many annual rides maintain their own website while other local events are recorded on a statewide bicycling website. Bicycling websites often contain hyperlinks to navigate to other related resources for bicyclists. A Kansas bicycling website that exemplifies this can be visited at <http://www.kansascyclist.com>.

³ More specific parking solutions and detailed guidelines for bicycle parking are available from the Association of Pedestrian and Bicycle Professionals at http://www.sfbike.org/download/Bike_Parking/APBPbikeparking.pdf or from the United States Department of Transportation's Turner-Fairbank Highway Research Center at <http://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/pdf/lesson17lo.pdf>.

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Appendix A - Example Bicycling Checklist

City Bicycling Recommendations Checklist	
<i>Steps</i>	<i>Actions</i>
<p>1 Assess the Situation</p> <p>This step involves gathering information concerning the context of the existing situation. Every city has different circumstances and different needs.</p>	<input type="checkbox"/> Gather Data <input type="checkbox"/> Identify the Problem
<p>2 Generate Possible Solutions</p> <p>In this step, all possible solutions should be considered. An analysis of the possible solutions will eliminate some options leaving only a few feasible solutions.</p> <p>At this point, funding sources should begin to be identified.</p>	<input type="checkbox"/> Generate Solutions <input type="checkbox"/> Narrow Solutions <input type="checkbox"/> Identify Funding
<p>3 Choose the Best Solution</p> <p>This step includes evaluation of the expected results/outcomes of each solution. Based on this analysis, the single best solution should be adopted. A plan should be created and framed upon the policies and goals of the selected solution. The plan should include what programs are intended to be used and benchmark goals outlining where the community wants to be by a certain time period.</p> <p>At this point, a campaign program should begin to generate awareness, interest and support.</p>	<input type="checkbox"/> Evaluate Solutions <input type="checkbox"/> Draft Plan <input type="checkbox"/> Create interest/ support
<p>4 Implement the Plan</p> <p>Implementation consists of following through with construction based on the programs and goals outlined in the plan. Begin construction of a high profile section of infrastructure to be used as a model of what the community can expect in the future. (Bicycling Infrastructure)</p> <p>Initiate programs that promote and encourage people to ride bicycles more frequently. Bike to work events or other organized community rides are useful in accomplishing this. (Bicycle Consciousness)</p> <p>Encourage local bicycle shops or other organizations to instruct classes that teach safe bicycling practices for both cyclists and non-cyclists. (Bicycle Safety)</p>	<input type="checkbox"/> Begin construction of infrastructure <input type="checkbox"/> Promote bicycling <input type="checkbox"/> Educate safety
<p>5 Evaluate Results/Outcomes</p> <p>After construction on a project is finished, it is important to evaluate whether the project is successful or not based on the goals and benchmarks established in the plan.</p> <p>At this stage it is important to continue to seek funding for programs.</p>	<input type="checkbox"/> Evaluate Success <input type="checkbox"/> Continue Funding

<p>6 Expand Infrastructure</p> <p>Allowing for modifications to be made based on the initial construction's evaluation, the next phase of infrastructure can begin. Promotion and safety education programs should continue.</p>	<input type="checkbox"/> Begin next construction phase <input type="checkbox"/> Continue programs
<p>7 Review and Repeat</p> <p>This process is cyclical. At the end of each project, success should be evaluated and modifications made for the next portion of the plan.</p>	<input type="checkbox"/> Review project <input type="checkbox"/> Revise plans

Figure A.1. A basic checklist for communities beginning to make bicycling improvements (Bird, 2010).