Barriers to Bicycle Infrastructure: Why Do Some Communities Put the Brakes on Sustainable Transport?

A Thesis

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ABSTRACT

Bicycling is a form of transportation that has many environmental, health, economic, and social benefits. So why is this form of sustainable transport not more fully utilized? This thesis proposes that in many communities, economic conditions, cultural and class stereotypes and political factors influence the mode of transportation, but that these can be overcome with the implementation of bicycle-friendly policies and safe bicycling infrastructure.

This thesis seeks to formulate an explanation for the difficulties the author experienced in planning bicycle infrastructure while interning for Bicicleteros del Tropico de Cancer in San Luis Potosí, Mexico during the summer of 2004. It also attempts to identify why some communities have been successful at developing bicycle-friendly infrastructure while others have failed.

The aim of this thesis is also to analyze the current situation in San Luis Potosí that is experiencing rapid urbanization, congestion, air quality problems, and increasing incidents of fatal accidents involving cyclists and motorists. In addition, this thesis attempts to develop feasible policy prescriptions to mitigate the multi-faceted problems facing San Luis Potosí.
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# TABLE OF CONTENTS

Abstract ............................................................................................................................. ii

Acknowledgements ......................................................................................................... iii

Table of Contents ............................................................................................................. iv

Tables and Figures .......................................................................................................... vi

Abbreviations .................................................................................................................. vii

**Chapter One: Introduction** ....................................................................................... 2

  - Background and Importance of the Subject .............................................................. 2
  - Research Question ...................................................................................................... 4
  - Thesis Goal .................................................................................................................. 5
  - Methodology .............................................................................................................. 5

**Chapter Two: The Problem: Equity, Environment, and Everything Else** ............... 9

  - Social Equity Issues ................................................................................................. 10
  - Public Health Issues ................................................................................................. 12
  - Environmental Issues .............................................................................................. 14
  - Sprawl Links Them All .............................................................................................. 17

**Chapter Three: What is Sustainable Transport?** ..................................................... 18

  - What is Sustainability? ............................................................................................. 18
  - Sustainable Transportation Systems .......................................................................... 22

**Chapter Four: The Solution: The Bicycle** ................................................................. 27

  - Brief History of the Bicycle ..................................................................................... 27
  - Economic Efficiency of Cycling vs. Cars ................................................................. 29
Bicycle Infrastructure.................................................................30

Chapter Five: Case Studies.......................................................34

San Luis Potosí, San Luis Potosí, Mexico........................................36

Cambridge, Massachusetts, USA...............................................54

Case Analyses........................................................................67

Chapter Six: Conclusions and Recommendations......................70

Policy and Planning Prescriptions..........................................71

Infrastructure Improvements...............................................72

Behavioral Change...............................................................79

The Last Word.................................................................80

References.................................................................................81

Appendix A: San Luis Potosí Public Survey (English Translation).......86
Tables

Table 1: Number of Passenger Cars per 1,000 people

Figures

Figure 1: Example of Light Rail Transit
Figure 2: Baron Von Drais’ Running Machine
Figure 3: Typical Bicycle Lane
Figure 4: Typical Bicycle Path
Figure 5: Pedestrian Mall in San Luis Potosí
Figure 6: Cycling Difficulties in Historic Downtown of San Luis Potosí
Figure 7: Quasi-Shared Use Path in San Luis Potosí
Figure 8: Bikeway in Disrepair in San Luis Potosí
Figure 9: Bike Ownership Status: Male Respondents
Figure 10: Bike Ownership Status: Female Respondents
Figure 11: Percentage of Transportation Mode Use: Total Respondents
Figure 12: Percentage of Transportation Mode Use: Male Respondents
Figure 13: Reason for Not Cycling (More or Ever): Total Respondents
Figure 14: Reason for Not Cycling (More or Ever): Female Respondents
Figure 15: Reason for Not Cycling (More or Ever): Male Respondents
Figure 16: Percentage of Total Respondents Who Feel Safe Cycling in the City
Figure 17: Percentage of Total Respondents Who Would Cycle More If There Were Bike Lanes/Paths
Figure 18: Minuteman Trail Bikeway
Figure 19: Passenger Cars per 1,000 People
Abbreviations

BRT- Bus Rapid Transit
BTS- Bureau of Transportation Statistics
CDC- Center for Disease Control
CMAQ- Congestion Mitigation and Air Quality Improvement
CNG- Compressed Natural Gas
FHWA- Federal Highway Authority
ISTEA- Intermodal Surface Transportation Equity Act
LRT- Light Rail Transit
LRV- Light Rail Vehicle
MBTA- Massachusetts Bay Transit Authority
MPO- Metropolitan Planning Organization
NHTSA- National Highway Traffic Safety Administration
SAFETEA-LU- Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SLP- San Luis Potosí
STP- Surface Transportation Program
SUV- Sport Utility Vehicle
TEA- Transportation Enhancement Activity
TOD- Transit Oriented Development
UN- United Nations
UNCED- United Nations Conference on Environment and Development
USDOT- Department of Transportation

USEPA- United States Environmental Protection Agency

WCED- World Commission on Environment and Development
Barriers to Bicycle Infrastructure: Why Do Some Communities Put the Brakes on Sustainable Transport?
Chapter One

Introduction

Background and Importance of the Subject

Transportation is an integral part of everyone’s lives. People need to get places: they travel to their workplace, school, grocery store, place of worship, the doctor’s office, and the bank. How do they get to their destinations? Is the mode of transportation safe, rapid, convenient, and does it have a limited impact on the natural environment? This thesis proposes that in many communities, economic conditions, cultural and class stereotypes, and political factors influence the choice of mode of transportation, but that these can be overcome with the implementation of safe bicycling infrastructure.

In this thesis, bicycling infrastructure refers to designated bicycle lanes, bicycle paths, shared-use paths, parking, signage, or other physical construction that is intended for the exclusive or near-exclusive use for those individuals operating a bicycle for transportation purposes. For simplification throughout this paper, bicycle lanes, bicycle paths, and shared-use paths are collectively referred to as “bikeways”.

It appears that in the poorest societies any mode other than walking, such as cycling is desired, but as incomes increase the preferred mode of choice appears to be the personal automobile. At a certain level of affluence, education, or change in values, the car loses some of its appeal and sustainable forms of transportation, such as cycling, regain social acceptance. The concept of ‘transport culture’ can be viewed as one of the forces determining which modes of transportation are socially acceptable and desired in

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1 The different types of infrastructure are explained in more detail in Chapter 4.
particular societies. Transport culture theory hinges on an individual’s economic prosperity as directly linked to the individual’s mode of transportation.

Bicycling as a form of transportation has many environmental, health, economic, and social benefits. So why is this form of sustainable transport not more fully utilized? It appears that class and economic status are huge barriers to the promotion and growth of bicycling as a primary form of transportation. The preferred modes of transportation vary across different levels of economic development. Particularly in countries with developing and transitional economies, personal automobile ownership is a symbol of wealth for which members of the smaller middle and upper class can distinguish themselves from the lower class poor. The elites shun the bicycle as the poor man’s transport.

In middle income countries such as many in Latin America, the bicycle is not a symbol of wealth\(^2\). In San Luis Potosí, Mexico, the bicycle is widely regarded as a mode of transportation used by the lower class workers for the purpose of commuting to the outlying factories. The culture of Machismo permeates society and is extremely visible in the aggressive driving of Mexican men. As a result, there is little respect granted to cyclists whose presence on the roads is viewed as an intrusion upon the space of automobiles (Aquilar, 2003). Bicycle infrastructure could mitigate some of these unsafe conditions, but still there is little to no consideration for cyclists in the process of the planning and designing of roads creating a dangerous environment and resulting in many accidents and deaths of cyclists and pedestrians (Rietveld, 2004).

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\(^2\) One may argue that there exists no place where bicycle ownership is a symbol of wealth. However, in regions of extreme poverty such as the Northern Region of Ghana, a bicycle is a luxury for many families and can have transformative effects on one’s life.
In developed countries such as those in Europe and in the United States, many communities embrace the bicycle as a viable mode of transportation that is both environmentally friendly and promotes physical fitness. It is not uncommon for well-paid professionals to commute to their workplace on bicycles that cost as much as the average used car. However, this is not a uniform phenomenon throughout the United States. Massachusetts has many miles of bicycle lanes and a decent public transportation system while states such as Oklahoma are dominated by Sport Utility Vehicles (SUVs) and have little to no useful bicycle infrastructure. It appears that transport culture is also a factor in the United States as more affluent areas embrace sustainable transportation while in less affluent areas there is more segregation amongst social classes and there exists less willingness to use/share public facilities such as buses and trains.

This thesis hypothesizes that if governments and high profile organizations/companies support and advocate for cycling as a form of transportation for people of all economic classes and if this is backed up by the implementation of a safe cycling environment, there would be more cultural acceptance of cycling and an increase in the use of bicycles as a mode of transportation for short trips. In addition, the increasing obesity epidemic may act as a driver in pro-cycling policy change.

**Research Question**

The primary research question in this thesis is: “what are the motivations for and barriers to the implementation of bicycling infrastructure?” In support of this focal question, this thesis attempts to answer the following additional research questions:
• What are the social, political, and cultural factors that create a hostile environment for bicycle infrastructure planning?

• Why do some cities embrace non-motorized and pedestrian-centered transit and others cater almost exclusively to the automobile?

• How can these barriers be overcome?

**Thesis Goal**

The main goal of this thesis is to formulate an explanation for the difficulties the author experienced planning bicycle infrastructure while interning for Bicicleteros del Tropico de Cancer in San Luis Potosí, Mexico. This thesis identifies which factors influence the decision-making process in favor or against sustainable transportation policies.

This thesis also analyzes the current situation in the City of San Luis Potosí that is experiencing rapid urbanization, congestion, air quality problems, and increasing incidences of fatal accidents involving cyclists and motorists. In addition, this thesis develops feasible policy prescriptions to mitigate the multi-faceted problems facing San Luis Potosí and recommends the possible policy changes that could foster sustainable transportation in the form of bicycles and its related infrastructure.

**Methodology**

The case study approach was chosen as an appropriate method through which to gain insight into the research question. This approach was chosen over other research methods because as Yin explains, case studies have a distinctive advantage when a ‘how’
or ‘why’ question is being asked about a contemporary set of events, over which the investigator has no control” (Yin, 2003, p.9). Indeed, this thesis will look at contemporary events in two different cities with the goal of identifying why some communities successfully incorporate cycling as a viable form of transportation while other communities do not.

The thesis research included a concise review of the literature pertaining to the current state of the debate of sustainable transportation, particularly focusing on the role of the bicycle. In addition, the existing literature describing the link between transportation and the environment, equity, and environmental justice issues was examined.

From there, case studies were compiled using multiple sources of evidence to test the proposition that in many communities, economic conditions, cultural and class stereotypes, and political factors influence the choice of mode of transportation by examining what is being done in Cambridge, Massachusetts, USA; and San Luis Potosí, Mexico. Interviews of local people, bicycle advocacy organizations, community planners, and local government officials on their view of the issue of bicycling as a form of transportation were used to gauge where differences lie and determine the current state of the debate. Interviews of Rosalie Anders and Cara Seiderman of the City of Cambridge Department of Community Development provided an inside view of the planning process and policies regarding pedestrian and bicycle facilities. Ms. Anders and Ms. Seiderman also provided background information regarding key factors that have led to the City’s current level of bicycle-friendliness.
A survey was administered by the author and members of the local bicycle advocacy group, Bicicleteros del Tropico de Cancer to a cross-section of the residents of the City of San Luis Potosí over the span of four days in various locations in the downtown. The purpose of the survey was to gain insight into the cycling habits and views of Potosinos, such as the primary purposes of cycling, level of personal security regarding cycling in the City, and barriers to using bicycles as a method of transportation. Demographics of participants were recorded to understand the impacts of age and gender on cycling views.

While interning in San Luis Potosí, the author worked in close contact with members of the Bicicleteros del Tropico de Cancer as well as the Chief of the Sports Department and Planning Department officials, which provided valuable insight into the planning process of a medium-sized Mexican city.

A large component of research for this thesis involved a thorough review of local, regional, state, and federal policies, plans, and legislation pertaining to the use of the bicycle as a mode of transportation which included evaluating and assessing the current policies in place regarding infrastructure, incentive programs, and the promotion of non-motorized transport. Key plans reviewed were the local, regional, and state development plans of San Luis Potosí, as well as the Cambridge Open Space and Recreation Plan. In addition, the official websites of the City of Cambridge, Commonwealth of Massachusetts, and the United States Department of Transportation provided for the comprehensive review of legislation, laws, and ordinances which affect pedestrian and bicycle infrastructure. In addition, design guidelines regarding bicycle infrastructure were reviewed to develop the recommendations section of this thesis. Design guidelines
and recommendations that were reviewed include those of MassHighway, American Association of State Highway Transportation Officials (AASHTO), the City of Chicago, and the City of Toronto.
Chapter Two

The Problem: Equity, Environment, and Everything Else

An automobile-centric transportation system has produced a myriad of problems worldwide. For one, it is damaging to the natural environment with exhaust emissions, dependence on non-renewable oil, the legacy of lead gasoline, and the reduction in pervious surface with its effects on hydrology to name just a few.

Secondly, a car-centered society is harmful to public health. People drive everywhere, not just solely due to laziness, but because in many cities the inefficient planning of communities and inadequate public transportation or cycling infrastructure forces them into their cars. In turn, people are no longer engaging in simple activities such as walking or riding a bike as a part of everyday living. This lack of physical activity is causing many automobile dependent individuals to become overweight and to suffer from associated health problems such as heart disease and diabetes. The picture becomes even grimmer when one considers that those that do get outside and walk may suffer from the poor air quality generated from cars causing respiratory problems such as asthma.

Finally, communities that depend on the personal car as the primary form of transport are not equitable places to live. Cars are expensive to buy, maintain, insure, and to fuel. People of lower incomes cannot always afford to have their own cars, which in turn limits their opportunities for employment and choice of where to live, raise a family, and send their children to school.

In order to offer an organized discussion of the problems associated with an automobile-centric society, these issues have been broken down into Social Equity Issues,
Public Health Issues, and Environmental Issues. It must be noted that these problems overlap and it is somehow artificial to categorize them as such. For example, upon a closer examination it becomes obvious that lower income people tend to live in areas with inadequate public transportation, which reduces their mobility and opportunities (a social equity issue). In low income neighborhoods, the usual associated poor air quality (an environmental issue) leads to a higher incident of asthma (a public health issue) and lack of economic investment leads to a higher crime rate (a social equity issue) because shops and businesses close early and there are no eyes on the street to deter crime.

Social Equity Issues

People have places to go, so why does it seem that it’s hardest to get there for those of lower income groups?

Transit Racism

The concept behind transit racism is that communities of color are generally not adequately served by public transportation. The routes offered may not be convenient and the modes are inferior, slow, and dirty. In addition to the poor state of public transportation, federally subsidized transportation construction and infrastructure projects have generally been large thruways with quickly moving traffic coursing through neighborhoods. The result is a catalyst to urban sprawl with the physical isolation of residents from their places of business, the disruption of stable communities, displacement of local businesses, traffic congestion, and increased hazard risks to the community including pollution and traffic accidents (Bullard, 2004). In Asphalt Nation, Jane Holtz Kay quotes Douglas Foy of the Conservation Law Foundation as he described
tacit car welfare: “A poor Roxbury mother taking mass transit at rush hour pays 80 percent of her costs for a few miles in the inner city. A stockbroker driving his BMW to the suburbs at that peak of congestion pays only 20 percent” (Kay, 1997, p. 117). The combination creates an inhospitable environment to cyclists and pedestrians that is even more important due to the inadequacies of the public transportation system.

A particularly glaring example of disenfranchised public transport users is in Roxbury, a neighborhood in Boston comprised of mainly African American and Latino residents. Although densely populated and a historic location of rail-based transit, there is no train that serves the community. In 1987 the elevated Orange Line of the Massachusetts Bay Transit Authority (MBTA) was razed and rerouted below grade through Jamaica Plain to Forest Hills. The MBTA promised the community a “better or equal replacement service” in exchange for this removal, but they were given the dirty and noisy # 49 bus instead.

In 2002, the MBTA launched Phase I of the Silver Line, which is still indeed a bus, but not quite Bus Rapid Transit. The Silver Line vehicles are articulated, low floor, and run on compressed natural gas (CNG) which have cleaner emissions, a welcome change from the black plumes of diesel exhaust, but still is not a quick and efficient route into Boston where many of the residents work and run errands. True BRT uses dedicated lanes and has traffic light preemption, which frees up the vehicles from automobile traffic and long delays. The Silver Line along Washington Street into Dudley Square in Roxbury does not have either one of these key characteristics.
**Lifeless Streets**

Traditionally, the public streets were a social gathering place. A place where neighbors chatted, children played, and friends were made. Then the automobile came and took over and now many streets are no place people congregate. This loss of community space is damaging to the social fabric of neighborhoods.

In place of these social gatherings, we are left with rivers of steel enclosed cages flowing through the streets, the occupants rarely having to interact with other people. A false sense of bravado and anonymity are felt by these people and when interactions do occur they are usually characterized by impatience and anger manifested in blaring horns and unkind hand gestures.

**Safety**

The loss of lively communities also can become a safety issue. Safe communities exist where neighbors know each other and keep an eye on the comings and goings of the community. Lively communities create an inhospitable environment for trouble-makers and would-be thieves who favor the cover of night and averted eyes to commit crimes. Pedestrian-centered communities consist of mixed-use development where people can easily walk or cycle to accomplish most of their daily needs. Communities that don’t shut down and close up shop at five o’clock are safer at night.

**Public Health Issues**

**Obesity**

In western countries, particularly the United States, obesity is becoming an alarming problem. The latest data from the Center of Disease Control (CDC) National
Center for Health Statistics shows that 30 percent of U.S. adults 20 years of age and older are obese and that the percentage of young people who are overweight has more than tripled since 1980. Among children and teens aged 6–19 years, 16 percent are considered overweight (CDC, 2006). According to CDC’s Behavioral Risk Factor Surveillance System, 55 percent of Massachusetts adults are obese and 24 percent of Massachusetts high school students are obese or at risk to become obese (CDC, 2006). The obesity epidemic stemming from sedentary lifestyles is directly linked to numerous chronic health problems such as diabetes and heart disease, the nation’s number one killer (CDC, 2006). Lack of exercise, even everyday walking, due to sprawl and over-reliance on the automobile is to blame as walking and cycling have been replaced by the automobile for all but the shortest distances.

Increased physical activity, especially biking and walking, can often prevent heart disease as well as diabetes, stroke, hypertension, and depression. According to the Surgeon General’s Report on Physical Activity and Health, the main message is that Americans can substantially improve their health and quality of life by including moderate amounts of physical activity in their daily lives (1996). The physical activity gained by simply incorporating cycling as a mode of transportation for short trips instead of driving a car can provide health benefits achievable for most Americans, including those who may dislike or have been discouraged by vigorous exercise programs.

According to the 2005 survey conducted by Men's Fitness magazine, the “fattest city” where the most sedentary Americans live is Houston, Texas where pedestrian-friendly infrastructure such as sidewalks and downtowns are nonexistent. Denver, Colorado holds the title of the “thinnest city” which is no surprise as downtown Denver
boasts a mile long pedestrian mall in addition to the many multi-use paths that wind through the city.

**Environmental Issues**

The current trend in transportation options is leading to serious environmental damages in almost all forms, including air and water pollution, climate change, destruction of natural habitats, and erosion. As automobiles get larger and less fuel efficient, there is an increased demand on nonrenewable resources and increased emissions leading to climate change. Bigger automobiles lead to more pavement and impervious surfaces to accommodate wider roads and bigger parking lots.

**Air Pollution**

Over-reliance on personal automobiles for short distance trips that could be easily and more efficiently made using public transport options or by cycling greatly contributes to air pollution. Carbon monoxide (CO) emissions lead to the formation of ozone causing smog and poor breathing conditions. Children are particularly vulnerable to poor air quality and everyday breathing in of small particulate matter from automobile emissions is a frequent trigger of asthma. Asthma kills about 4,000 people a year and was estimated to cost 4.2 billion dollars in medical care and lost time from school and work in 2002 (CDC, 2005). Asthma is the leading chronic illness of children in the United States and the leading cause of school absenteeism due to chronic illness (CDC, 2005).

Asthma is a major environmental justice issue as urban environments often have high levels of outdoor pollution and poor housing conditions, which frequently are
associated with increased levels of indoor pollution. Disproportionate numbers of people of color and people from low income households live in these areas, and thus may be exposed to higher than average levels of air pollution, both indoors and outside. These exposures, along with other factor such as inadequate health care, may explain why roughly two to three times as many African Americans as Caucasians die from asthma. Asthma also affects children disproportionately: five times more children than adults die from asthma each year (EPA, 2006).

Climate Change

Perhaps the most controversial environmental problem and how the world should deal with it, is the issue of climate change. Public opinion spans the spectrum from skeptics who insist it does not exist, fatalists who say “just deal with it”, and progressive environmentalists who believe that catastrophic disasters can be averted if we change our way of existence. The Carbon dioxide (CO₂) generated from the world’s energy consumption is largely to blame for climate change. In the United States energy consumption is divided fairly equally among the three sectors of buildings, transportation, and industry. Among energy consumption from transportation, personal cars account for over 60 percent (US Department of State, 2003). Every second, America’s automobiles travel 60,000 miles, using 3,000 gallons of petroleum products, while adding 60,000 pounds of carbon dioxide in the atmosphere (Kay, 1997).

Water Pollution

Automobiles also affect the quality of water. Roadways and parking facilities make up a large percentage of impervious surfaces, which contribute to stormwater pollution. Following rain or snow melting events, stormwater flows over the ground. In
natural landscapes, those with vegetated land, this stormwater runoff seeps into the ground or is lost to evapotranspiration. The vegetative surfaces slow the flow of water, filter out sediments, and can either break down or trap pollutants (Mass DEP, 2004). In urbanized areas where a high level of impervious surface cover exists due to paving, the stormwater runoff flows over the land and into nearby lakes, streams, and wetlands.

Impervious surfaces in urbanized areas include streets, parking lots, and rooftops. Current zoning regulations in many communities exacerbate the problem of impervious surfaces with mandated and unnecessarily large minimum pavement width requirements for roads and inflexibility regarding paving materials that may be used.

Water flowing over these impervious surfaces flows at a greater speed and volume. In addition to the transport of pollutants, the increased water flow from the land directly into waterways greatly increases flooding (Center for Watershed Protection, 2005). Office development in the Alewife floodplain, combined with the area's past industrial uses, has increased storm water runoff and depleted flood storage capacity (City of Cambridge, 2005a).

Automobiles in particular contribute pollutants such as antifreeze, oil, and metals such as copper, cadmium, chromium, lead, and zinc, as well as salt from roadways (Center for Watershed Protection, 2005). These pollutants all contribute to the poisoning of aquatic life. In turn, animals and humans who eat these fish can become poisoned themselves.
Sprawl Links Them All

This thesis is not asserting that it is the automobile that is the root of all the terrible environmental, social, and public health problems. Rather it is poor, automobile-centric planning that has catered largely to the automobile that is to blame. The modern phenomenon of low density, spread out communities, in which people commute great distances to their workplace or to grocery shop is known as Sprawl. This unplanned development contributes to the loss of green space and increases driving distances leading to the scores of environmental ills.
Chapter Three

What is Sustainable Transport?

What is Sustainability?

The concept of sustainability or sustainable development has been around since the 1972 United Nations Conference on the Human Environment in Stockholm. The definition used most widely originates from “Our Common Future” published by the United Nations (UN) World Commission on Environment and Development (WCED) which reads:

*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs* (WCED, 1987, p. 43).

The world began recognizing that environmental problems were a global concern in the early 1970s with the 1972 Stockholm Conference. It was here that 113 nations pledged to begin to clean up the environment and acknowledged that problems of air pollution, water pollution, and chemical contamination do not recognize borders (Newman and Kenworthy, 1999).

The beginning of the paradigm shift in which global environmental problems started to be viewed through the lens of economic development began at the 1992 UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brasil. This conference addressed the growing concerns of nations in the South that believed that
“sustainable development” was anti-development, unjust, and a way to keep them in poverty.

A Sustainability Timeline has been outlined below to summarize the major milestones in bringing the concept of sustainability to global attention:


- Environment is put on the global political agenda.
- 113 nations pledged to begin to clean up the environment.
- Acknowledged that the problems of air pollution, water pollution, and chemical contamination do not recognize borders.
- Acknowledged that environmental degradation had to be handled on a global scale.

1983- The UN Established the World Commission on Environment and Development

- This independent body was headed by Gro Harlem Brundtland, Prime Minister of Norway.
- Goal was to resolve the conflict with Third World countries who viewed “sustainability” as anti development.

1987- Commission Published Our Common Future (the Brundtland Report)

- Brought the term “sustainable development” into common usage.
- Re-examines the critical environment and development problems on the planet and to formulate realistic proposals to solve them.
1992 Earth Summit, Rio de Janeiro, Brasil

- Sustainable development viewed as the answer to solve the global problems of environmental degradation and economic development of the poor.
- Environment put on the global economic agenda.

1997- “Rio plus 5” Earth Summit, New York City, United States

- Follow up to Rio to assess the progress of the agenda.

2002- World Summit on Sustainable Development, Johannesburg, South Africa

- Renewed commitment to the implementation of the outcomes of the Rio Conference.
- Served as a forum for debate on practical ways to achieve progress.

The underlying themes of “Our Common Future” can be distilled into several principles that must be followed to ensure global sustainable development.

- **Affluent countries must reduce consumption**

  The goal of global sustainable development requires that those affluent countries adopt life-styles within the planet’s ecological means in their use of energy. The average person in a developed country uses more than 80 times as much energy as someone in sub-Saharan Africa and as these poor countries develop they inevitably will increase their energy consumption. The planet cannot sustain a growing population living at such levels of inefficiency, which increases the pressure on the world’s resources. The new era of economic growth must be less energy intensive than the past and energy efficiency policies must be at the forefront of national energy strategies for sustainable development.
Global cooperation in the management of the “Commons”

The issues affecting the environment are global in nature and do not respect national boundaries. Carbon dioxide emissions create a greenhouse warming effect and the release of Chlorofluorocarbons (CFCs) into the atmosphere depletes the ozone layer that is needed to deflect the solar rays and prevent global warming. Hazardous waste discharged into waterways affect communities downstream and pollutes their drinking water. Loss of biodiversity interrupts the food chain causing species extinction resulting in plagues and potential loss of medicines to cure disease. All countries must work to reduce their emissions of greenhouse gases as well as reduce pollution into “global commons” such as waterways.

Reduction of poverty is imperative

“A world in which poverty is endemic will always be prone to ecological and other catastrophes” (WCED, 1987, p. 8). This statement is supported by evidence provided in the report that shows that poverty is one of many factors that contributes to the degradation of the environment. It describes the problem of present day communities still based on subsistence agriculture in which the populations grow rapidly as children are sources of labor and security. The environment is suffering because in the past high death rates used to control population, but now this unchecked growth leads to the clearing of more forest and overgrazing to sustain these large populations. Economic development can only break this cycle.
• **Meeting the “Urban Challenge”**

The planet is increasingly urbanized and governments must make the investments to ensure that the infrastructure keeps pace with the exploding populations. Access to clean water, sanitation, and transportation are imperative.

• **Local initiatives are key**

Sustainable development cannot only be discussed at global conferences amongst high level officials. The principles of sustainable development have to be implemented at the local level in ways that respect the local culture.

**Sustainable Transportation Systems**

Sustainable transportation systems are those that are more energy efficient, convenient, and contribute to a higher quality of life. Sustainable transportation embraces multi-modalism in which different motorized and non-motorized transportation modes complement each other instead of competing with each other.

**Bus Rapid Transit**

Bus Rapid Transit (BRT) is a form of public transport that is gaining popularity in cities all over the world. Key characteristics of BRT are dedicated travel lanes, traffic light preemption, low floored, articulated vehicles, and rail-like stations and frequency. Many BRT vehicles use compressed natural gas (CNG), which burns cleaner than diesel and regular gasoline (FTA, 2004). Many cities favor BRT systems due to its low cost of implementation and associated infrastructure. Since the vehicles are buses with rubber tires, there is no need to lay track work that is very exacting and expensive. The lack of tracks also provides flexibility with route designs, giving planners ease in adding or
altering routes in response to rider demand. Notable BRT systems are in Curitiba, Brasil and Bogotá, Colombia where BRT has contributed to fewer congestion problems (Miyamoto, 2004).

**Heavy Rail**

Heavy Rail is characterized by high-speed, passenger rail cars operating singly or in trains of two or more cars on fixed rails in separate rights-of-way from which all other vehicular and foot traffic is excluded (FTA, 2005). The cars are propelled along the track via an electrified third rail. An example of heavy rail in Cambridge, Massachusetts is the MBTA’s Red Line.

**Light Rail Transit**

Light Rail Transit (LRT) could be described as the happy medium between Heavy Rail and Bus Rapid Transit. An example of LRT in Cambridge, Massachusetts is the Green Line that begins at Lechmere Station. By definition, LRT is a system of electrically propelled passenger vehicles with steel wheels that are propelled along a track constructed of steel rails. The propulsion power is drawn from overhead wires by means of a pantograph and returned to the electrical substations through the rails. In addition, the Light Rail Vehicles (LRVs) are capable of negotiating curves as sharp as 25 meters (82 feet) in order to traverse city streets (FTA, 2005).

![Figure 1: Example of Light Rail Transit](image)
Like a bus system, LRT has lower infrastructure costs associated with its ability to share the street with vehicular traffic and pedestrians. It is also the most flexible of rail options. As opposed to heavy rail systems, LRT vehicles can travel among automobiles along embedded tracking on the same streets, or in segregated ways underground through tunnels, at-grade, or above grade along elevated structures. In addition, LRT has the benefits of Heavy Rail in that it provides a more comfortable ride to the passenger and provides a feeling of investment in the community and permanence because once tangible tracking has been laid, the mode of transport will stay in existence for some time.

*Alternative Fueled /Hybrid Technology*

Alternative fuel sources such as biodiesel are getting a lot more attention as are hybrid cars. They have experienced a huge increase in popularity in the past year due to sky-rocketing gas prices. Almost all automakers are producing hybrid cars to follow this trend and backlash against SUVs. Hybrid technology utilizes a propulsion system powered by a gasoline engine and electric motors, increasing fuel efficiency (FTA, 2005).

In addition to cars, cities such as Tampa, Florida are investing in hybrid-electric buses that are powered by both a small diesel engine and electric motors, increasing fuel efficiency by 20 percent and reducing emissions. In addition to operating more efficiently and being environmentally friendly, the new hybrid-electric buses provide a much quieter ride than traditional buses while enhancing power for smoother and faster acceleration (FTA, 2005).
**Human Powered/Non-motorized Transport**

The focus of this thesis is on the personal non-motorized transport mode of the bicycle. It should be noted that other non-motorized modes exist, such as human-powered rickshaws, which are prevalent in India and Asia as a form of public transportation.

**Transit Oriented Development/New Urbanism**

The urban planning principle of Transit Oriented Development (TOD) is the encouragement of dense, mixed-use development around transportation nodes. This type of development allows for people to be able to cycle and walk within their communities and to the central transportation node, whether it is a train or bus station, which would then take them to destinations of further distances.

This is not a new concept as traditionally cities have always evolved in this manner. Up until the 1860s in Europe and the New World, cities have always been walkable, characterized by dense, mixed land use, and most destinations reachable by foot in less than half an hour. In the 1860s these walkable cities began to change with increased population and industrial development. In turn, these cities expanded outwards as trains and trams allowed for faster travel. Trains created subcities at railway stations, while linear development occurred along tram routes. In both cases, this new expanded development was still characterized by dense, mixed-use development (Newman and Kenworthy, 1999).
However, around the time of WWII, the increase of automobile use, supplemented by buses, allowed for development to occur in any direction. Low density housing became feasible and as a reaction to the increased industrialization, the cities and towns implemented zoning regulations that separated residential development from commercial and industrial development. (Newman and Kenworthy, 1999). This further increased traveling distances making the car more necessary than ever.

Closely aligned with TOD, the concept of “New Urbanism” is about bringing back walkable and bikeable communities. By updating city and town zoning regulations to allow for mixed use and more dense development, urban infill can occur instead of inducing sprawling development. The denser communities then become favorable to public transportation as proximity of residences to transit stations allows for people to walk or cycle to the catchment area.
Chapter Four

The Solution: The Bicycle

The solution to these myriad problems lies in the simple bicycle. The bicycle produces no pollution aside from what was used to manufacture it. Bicycling is an excellent way to exercise doing everyday activities such as commuting to work or school and taking a quick trip to the corner store for a few ingredients. Bicycling is also an inexpensive way to get around on one’s own schedule.

Brief History of the Bicycle

It is hard to pin down the “inventor” of the bicycle. The modern bicycle is the product of trials and errors of many people from many countries. According to Jim McGurn, author of On Your Bicycle: An Illustrated History of Cycling, the notebooks of Leonardo Da Vinci contained drawings of ball-bearings, gearing systems, continuous drive-chains, freewheels, and band-brakes. However claims that he put them all together to form the bicycle have been proven to be unfounded (1999).

Between the years of 1650 and 1800, viewed mostly as novelties with no real transportation purposes, human-powered “horse-less carriages” or “gentlemen’s pleasure carriages” could be seen around Italy and France. However, from the mid 1800s, inventors strove to develop a hand or foot propelled carriage for more successful utilitarian purposes (McGurn, 1999).
A giant leap was made toward the development of the modern bicycle in the remote forests of Central Germany. The so-called “father of the bicycle” Baron von Drais, Master of the Forests in the Dutchy of Baden, invented the *Running Machine* which consisted of a wooden body above two wooden wheels set in a line and was ridden by scooting along by pushing one’s feet against the ground while steering the front wheel (Perry, 1995). Drais patented his machine in 1818 in Baden, and then later in France. However, as his machine was fairly simple, it was widely copied on a large scale as he failed to take out patents in all of the independent states of Germany or the patents were ignored altogether (McGurn, 1999).

The chain driven bicycle was first invented in the late nineteenth century and soon became commonplace for the industrial working class and was introduced into colonial societies (Lowe, 1989). The first real wheel-drive appears to have been invented around 1839 by Kirkpatrick Macmillan, a blacksmith-mechanic from Scotland who made no attempts at patenting or marketing it and many copies were made (Perry, 1995). In 1842 similar to Macmillan’s, Alexandre Lefebvre of France designed a more refined model and in 1861 brought the velocipede with him when he emigrated to California where he continued to make velocipedes without ever achieving fame (McGurn, 1999). His original machine survived and was rediscovered and researched by Andrew Ritchie who wrote of his account in *Boneshaker* in 1975 (McGurn, 1999).

**Modern Day Bicycle Usage**

Today “pedal power” brings mobility to the most remote villages and the most bustling metropolises. However, today the post war boom in automobile use has
contributed to its mass decline as a form of transport. Indeed, only China and a few Western European countries collect transportation data that count bicycles as a form of transportation (McGurn, 1999). The advent of the personal automobile and associated car-oriented urban planning around World War II led to a decline in popularity, but has since been experiencing a revival as more often federal, state, and local transportation policy makers are supporting non-motorized transport such as cycling.

**Economic Efficiency of Cycling vs. Cars**

There is an obvious disconnect between economic efficiency and choice of travel mode. Since car owners pay for the costs of operating cars in a piece meal fashion, the majority do not realize the actual cumulative costs. After the hurricane season of 2005, the surge in fuel prices seems to have brought the high costs of automobile travel to the average person’s attention now that filling up is more expensive than ever. Couple this high cost of fuel with the average commuting distance, congestion (and associated idling), high costs of parking and insurance, and the car ceases to be a bargain.

According to American Automobile Association (AAA), the cost to operate an average automobile for one year is nearly $8,000 US dollars \(^3\) (Pedestrian and Bicycle Information Center, 2006). In Massachusetts that is over 15% of median household income, nationwide that is over 22% of median income (US Census Bureau, 2000). According to the League of American Bicyclists, the average cost to operate an average bicycle for one year is just over $100 US dollars (Pedestrian and Bicycle Information Center, 2006).

If you take into account external costs, such as national health costs, the car

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\(^3\) Based on 15,000 annual miles, includes insurance, license, registration, taxes, depreciation and finance charge.
becomes even less attractive. Obesity doesn’t come cheap; the cost of health problems associated with obesity (just one of several diseases directly linked to a sedentary lifestyle) in the United States in 2000 was estimated at $117 billion US dollars (CDC, 2005). A possible strategy to get people out of their cars is to highlight the hidden costs of automobile travel.

According to the United States Department of Transportation’s (USDOT) National Bicycling and Walking Study, cycling is often the fastest mode of transportation from door to door for distances up to six miles in the urban cores (1994). The bicycle in the United States has the potential to play a greater role in everyday transportation as more than one-quarter of all trips in the United States are still less than a mile and almost one half are three miles or less or approximately a 15-20 minute bike ride (Clarke, 2002). If more people cycled for short distance commutes, the resulting eliminated traffic congestion would in turn reduce noise and smog.

Another benefit of fewer cars on the road is the reduced need for vehicle parking. According the Toronto Bike Plan-Shifting Gears, ten bicycles can be parked in the space required for a single automobile (2001).

**Bicycle Infrastructure**

Bicycle Infrastructure refers to any facilities that are dedicated to non-motorized vehicles or exclusively to the bicycle. These facilities include bicycle

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*Figure 3: Typical Bike Lane*
lanes, shared use paths, bicycle parking, bicycle signage, and other related infrastructure that facilitates the operation of a bicycle. For simplification throughout this thesis, bicycle lanes, bicycle paths, and shared use paths are collectively referred to as “bikeways”. Descriptions of these different types of bikeways are summarized below.

**Bicycle Lanes**

Bicycle lanes are one-way facilities that carry bicycle traffic in the same direction as the adjacent motor vehicle traffic. Bicycle lanes are used to delineate available road space for preferential use by bicyclists and motorists and to provide for more predictable movements by the different modes.

Bicycle lane markings can increase a bicyclist’s confidence in cars not veering into their path. In addition, passing motorists are less likely to swerve to the left out of their lane to avoid bicyclists on their right. In urban areas bicycle lanes are considered the preferred method for bicycle accommodation. In some cases, bicycle lanes are not even needed or desirable due to low-traffic conditions.

Bicycle lanes are most commonly implemented in urban and suburban settings. Frequently, bicycle lanes are found in combination with on-street parking, raised curbs, and sidewalks. The minimum width for bicycle lanes is four feet when the bicycle lane is adjacent to the edge of pavement; however, five-foot bicycle lanes are preferred for most

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conditions. Contraflow bicycle lanes may be appropriate on one-way streets to increase cyclists’ connectivity.

*Shoulder Use/Wide Curbs*

Much like bicycle lanes, paved shoulders provide space for bicycling outside of the travel lanes. One difference between shoulders and bicycle lanes is that shoulders are usually used for bicycle accommodation in rural and suburban low-density areas where on-street parking, curbs, and sidewalks are rarely encountered. In these locations, shoulders may provide shared accommodation for pedestrians and bicyclists. Another difference between shoulders and bicycle lanes is that the width of shoulders is usually determined through an assessment of combined pedestrian, bicycle, and motor vehicle needs. Additionally, shoulders do not typically include bicycle lane pavement markings.

*Shared Use Paths*\(^5\)

Shared use paths are facilities on exclusive right-of-ways with minimal crossings by motor vehicles. Shared use paths serve as complementary off-road transportation routes for bicyclists; however their presence does not eliminate the need to accommodate bicyclists within a roadway.

Provision of shared-use paths is particularly suited to high-speed, high-volume roadways where the characteristics of traffic flow, roadway geometry, and traffic control are incompatible with bicycle use, except for advanced cyclists. Similarly, shared-use paths can provide a bicycling route parallel to freeways, where bicycling is prohibited. Shared-use paths are also an option in areas of limited right of way or where environmental or cultural resources limit the width of a roadway and a nearby pathway is

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\(^5\) The Minuteman Bikeway in Cambridge is an example of a mixed-use path. A photograph of this bikeway appears in the Chapter 5.
available. Finally, shared use paths can provide recreational amenities in waterfront areas or near other attractions. Whether bicycle infrastructure plays a role in creating behavioral change is investigated in several studies. According to the 2002 *National Survey of Pedestrian and Bicyclist Attitudes and Behaviors* conducted jointly by the USDOT’s Bureau of Transportation Statistics (BTS) and the National Highway Traffic Safety Administration (NHTSA), bicyclists riding in areas without bikeways are nearly twice as likely to feel endangered (mostly by motorists) as are bicyclists with bikeways, and more than four times as likely to be dissatisfied with how their community is designed for making bicycling safe (2002). Others believe that the improvement of motorists’ behavior is a more important factor that the provision of bicycle infrastructure in the encouragement of people to take up cycling (Tolley, 1997).

*Bicycling* magazine report that a 1992 Harris Poll indicates that one out of 60 adults occasionally rides a bicycle to work and that 21% of adults would commute by bicycle if safe bike lanes were available (Pena, 1992).
Chapter Five

Case Studies

Reason for Case Choices

Two cities, the Mexican city of San Luis Potosi, the capital of the state of the same name, and the American city of Cambridge, Massachusetts were chosen for use as case studies as they illustrate two different levels of development in bicycle infrastructure. The original intent was to include the Dutch city of Amsterdam as a third case study as the City is widely known for its bicycle-friendly environment with its miles of bikeways with their own signage and traffic signals. Those riding bicycles span all age groups and economic classes as Dutch culture views the bicycle as ‘an extension of walking’ and not as an inferior mode of transit (Seiderman, 2005).

However, the author’s lack of Dutch language skill proved to be an insurmountable barrier when navigating Dutch websites for primary sources of information on current policies and looking for possible interviewees. However, while conducting the other two case studies, it became apparent that the general opinion is that Amsterdam is regarded as “almost like another planet” and that their culture was almost too different (or perhaps more advanced) for their policies to be applied in the United States or Mexico.

In contrast, Cambridge, Massachusetts is a work in progress. Backed by legislation and progressive political leaders, bicycle infrastructure is a priority in the City’s development. Synergy and communication between the different departments ensure that opportunities for expanding bikeways and installing parking facilities are not
missed. It is not a perfect city for cycling, but taking small steps to becoming more accommodating to the cyclist.

San Luis Potosí represents the city that has little to no facilities for bicycles and caters to the automobile almost exclusively. Although there is language in planning documents and reports issued by the local government, materializing these plans have yet to occur. Accidents with cyclists and automobiles are high, public transit is poor, and many members of the population rely on bicycles as their primary mode of transit.
Case Study #1: San Luis Potosí

The City of San Luis Potosí dates back to the 1500s and is the capital of the state of the same name occupying 557 square miles with a population of 670,532 inhabitants (Gobierno del Estado de San Luis Potosí, 2005). Situated at an elevation of 6,157 feet, the City is arid and temperate year round. Founded in 1592, it is historically a mining town producing gold, silver, copper, and lead. Its abundance of minerals lead the Spanish to name the City after Potosí, Bolivia, a very rich silver mining town the Spanish hoped San Luis Potosí could grow to become.

The City is historically significant for its involvement in the shaping of modern Mexico. San Luis Potosí was the seat of the national government under President Benito Juárez in 1863 and again in 1867. While here in 1854, Gonzales Bocanegra wrote the Mexican national anthem. In addition, the Plan of San Luis Potosí was drafted by Francisco Madero while he was imprisoned in the City by his opponent, dictator Porfirio Diaz. This document called for the nullification of the election of 1910 and upon

Figure 5: Pedestrian Mall in San Luis Potosí

Source: Fillis
Mexicans to take up arms against the government setting the stage for the Revolution of 1910 (Gobierno del Estado de San Luis Potosí, 2005).

Today, a growing, sprawling city, San Luis Potosí no longer depends on mining as its principal economic activity, but rather the economy is largely driven from industry which includes breweries, textile mills, tanneries, flour mills, smelters, and furniture factories (Gobierno del Estado de San Luis Potosí, 2003). The City is home to several universities, museums, and historical churches. Narrow streets connecting large plazas bordered by large gothic churches, trees, and fountains characterize the well-preserved historic downtown of the City. The downtown is exceptionally friendly for the pedestrian on foot with the many pedestrian malls lined with restaurants and shops. The historic downtown is one giant social gathering place where teenagers congregate, couples stroll, and street performers attract large crowds. The downtown is surrounded by modern, sprawling development comprised of large, wide highways filled with automobiles and trucks, housing developments, and industrial factories.

**Public Transportation**

The public transportation system in San Luis Potosí is a bus system. Some buses on main routes are newer and operate on fixed, designated stops. Other buses are older and in disrepair which sluggishly rattle through circuitous routes picking up and dropping off passengers in random locations. These secondary routes are very inefficient and painfully slow. None of the City buses operate on a schedule. During busy commuting hours, traffic is at a standstill creating an environment with very poor air quality as bus emissions accumulate.
The poor suffer the most because they live on the periphery of the City where the level of service and areas served are unorganized and inefficient. For the poor urban public transportation user, the multiple transfers equal trip costs that are often more than 20 percent of their incomes (Pokorney, 2001). According to Agustin Villegas, “60 percent of Potosinos live in poverty, of which 40 percent live in extreme poverty and do not have access to the use of cars or urban buses. This limits their ability to improve their already scarce economic resources. The only transportation alternative is the bicycle, but everyday it is more dangerous to use them” (Villegas, 2005).

**Being a Cyclist in San Luis Potosí**

Although the historic downtown is exceptionally friendly for the pedestrian with the many pedestrian malls, the current state of bicycle facilities and infrastructure is poor to nonexistent. There are no maintained designated bicycle lanes on the roads and few secure places to lock up bikes. Bicycles are even prohibited from being ridden on the pedestrian rights-of-way. New road construction features wide, multi-lane highways that are difficult to cross and speed limits are rarely to never enforced.

There is a small recreational cycling community in San Luis Potosí. Within the City there are many large parks with many recreational opportunities. There are many ball fields, running tracks, and bicycling lanes. On an early morning or late afternoon visit to one of these many parks, it is common to see a fair amount of bicyclists from the spandex-clad on road bikes to families riding in groups for pleasure. However, the majority of these bicyclists arrive at the parks via car, carrying the bicycles in the trunk or
in the bed of their pick up truck. Recreational cycling is confined to the park boundaries, perhaps the only safe haven away from traffic.

It is a different kind of bicycle user that is observed on the City streets, from the traffic-clogged arterial roads to busy, fast highways on the outskirts of the City. The majority of those utilizing the bicycle as their primary form of transportation are poor workers traversing the City from the colonias to the outlying factories and other workplaces.

These are the many residents who travel by bicycle daily. The overwhelming majority are young to middle-aged men who wear no helmets and are not educated in safe cycling techniques as they often cycle against traffic and down one-way streets and weave amongst cars.

This combination of high numbers of bicycle users and a hostile cycling environment creates a dangerous environment where accidents between automobiles and pedestrians and cyclists often result in fatalities. Bicycle advocacy groups, such as Bicicleteros de Tropico del Cancer, are particularly concerned with the high occurrence of accidents resulting in death or severe injury as a result of poor cycling facilities.
According to the official figures provided by the City of San Luis Potosi, during the year 2005, there were reported 240 cyclists involved in accidents with motor vehicles, of which 26 died (Villegas, 2006).

Inventory of Bicycle Infrastructure

- **Parque Tangamanga** has a network of paved and unpaved bicycle paths for recreational use.

- **Calle Periferico**—old bikeway in disrepair and as seen in Figure 8 not closed off to vehicular traffic despite signage that reads, “solo ciclistas” (only cyclists).

- A few scattered quasi-shared use paths along railroad tracks and in medians

Survey Results

A one-page survey was administered in various locations in the City to obtain a diversified cross-section of participants\(^6\). The survey locations were chosen for their large concentrations of pedestrian traffic. The four chosen sites included two different

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\(^6\) A copy of the survey translated into English can be found in Appendix A.
plazas (Fundadores and San Sebastian), the bus depot, and a neighborhood on the eastern side of the City. Over the course of four days, the survey administrators approached the respondents and either read aloud the questions and completed the survey for the respondent or allowed the respondent to fill out the survey on their own.

The purpose of the survey was to take a temperature reading of behavior and opinion regarding cycling, in particular as a mode of transportation. Key information sought was feeling of security, purpose and frequency of trips on bicycle, as well as identify some of the barriers against and motivators for increased cycling. Gender and age were noted to identify if there existed any trends in bicycling behavior.

One of the first questions asked in the survey was whether or not the individual owned their own bicycle. Of the 256 total respondents, 59 percent answered they did own a bicycle. However, ownership varies greatly between men and women as 69 percent of males respondents indicated that they owned their own bicycle while only 36 percent of women said that they owned their own bicycle.
One of the purposes of this survey was to determine the modes of transportation that are used most frequently in San Luis Potosí. The majority of respondents (46%) reported that their primary mode of transportation is the public bus system. The second highest used mode of transportation was the personal automobile with 25 percent of users reporting it as their primary mode of transportation. The bicycle was third with 19 percent of total respondents reporting it as their primary mode of transportation.

These percentages change slightly when broken down into gender. The percentage male respondents who reported using the bus as a primary mode of transportation fell to 31 percent, while use of the personal automobile increased as the
primary mode of 29 percent of male respondents. The bicycle is also used more by men with 21 percent of male respondents reporting cycling as their primary mode of transportation.

Figure 11: Percentage of Transportation Mode Use of Total Respondents

Source: Fillis

Figure 12: Percentage of Transportation Mode Use: Male Respondents

Source: Fillis
Another main purpose for the survey was to understand why Potosinos were not better utilizing the bicycle as a form of primary transportation. Respondents were given a list of possible barriers to cycling in the City and asked to indicate which of these barriers were reasons for them not to cycle in the City.

Of the total respondents, 34 percent cited that “the lack of respect given to cyclists from motorists” was the primary reason for not cycling (more) in the City. Breaking down the respondents by gender it is clear that this factor is a more significant deterrent for women (47%) than for men (29%).

**Figure 13: Reason For Not Cycling (More or Ever): Total Respondents**

![Reason for Not Cycling Pie Chart]

Source: Fillis
Figure 14: Reason For Not Cycling (More or Ever): Female Respondents

Source: Fillis

Figure 15: Reason For Not Cycling (More or Ever): Male Respondents

Source: Fillis
One of the most promising outcomes of the survey was that 83 percent of respondents said that they would cycle more in the City if there were bicycle lanes. This is an indicator that any cultural bias against using the bicycle as a viable mode of transportation can be overcome with the implementation of bicycle infrastructure. The presence of a bikeway would be a visible indication that cycling as a form of transportation is normal and encouraged. In addition, bikeways would also encourage safer cycling habits with arrows and other markings indicating the direction in which cyclists should ride and crossing locations. Finally and crucially, bikeways would also show motorists that bikes belong on the road and promote safer driving habits in respect to cyclists.
Figure 17: Percentage of Respondents Who Would Cycle More If There Were Bike Lanes/Paths

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>83%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Source: Fillis

Moving Backward: Towards a Car-Dominated City

In San Luis Potosí, automobile ownership is on the rise. According to the statistics in the 2004 Plan Municipal de Desarrollo (Municipal Development Plan), personal automobile ownership increased by over 47 percent from 1992 and 2000. Population is increasing only by 28 percent. Of the year 2000 population, just over half (56%) are of economically productive age, a three percent increase from 1990 statistics in which 53 percent of the population were of economically productive age (City of San
These statistics indicate car ownership is increasing at a much faster rate than those reaching driving age.

To meet the needs of the increase in cars, road construction is the top priority for the state government. In the last two years, $200 million US dollars were spent on the construction of Boulevard San Luis, which is the urban section of Carretera 57, a highway that stretches towards Laredo. Despite pressure by bicycle advocacy groups on all three levels of government, this road is comprised of 12-16 lanes and does not include bicycle lanes although everyday 3,000 cyclists use this route to travel to the industrial zones for their jobs (Villegas, 2006).

The governor of San Luis Potosí, C. Octavio Pedroza Gaitlin, spent over $2 million US dollars on the Bocanegra interchange and just announced the construction of an elaborate bridge in the affluent Lomas district at a cost of $15 million US dollars. The governor declared there would be no pedestrian or cyclist infrastructure incorporated because it is too ‘onerous’ (Villegas, 2006).

**Plans for Bicycle Infrastructure in the Future?**

City, state, and federal laws and regulations were reviewed for any reference to bicycling. The public transportation law of the State of San Luis Potosí (Ley de Transporte Publico del Estado de San Luis Potosí) makes no reference to bicycles nor to the role that bicycles could play in multi-modalism (Gobierno del Estado de San Luis Potosí, 2003.) In the Ley de Transito y Vialidad (Transit and Public Ways Law) the bicycle is recognized as a class of vehicle and that it is to obey the rules of the road that
pertain to motorized vehicles (Gobierno del Estado de San Luis Potosí, 1996). It also makes clear that pedestrians are to be given the right of way when crossing streets, but that they are to obey traffic signals and stay on sidewalks. However there is no mention of any associated infrastructure for exclusive use for the operation of bicycles. There is also no mention of cycling infrastructure in the state laws pertaining to the municipalities.

The Secretaria de Comunicaciones y Transportes, the federal government agency that handles transportation, mentions the bicycle in the Reglamento de Transito en Carreteras Federales (Regulation of Federal Highways). This regulation recognizes the bicycle as a vehicle and has all the rights and responsibilities as other vehicles on the road. However Chapter 3, Article 155 states that if there is a bicycle lane, the cyclist must use it and not ride in the street, therefore this regulation does not grant the same rights to cyclists as to motorists (Secretaria de Comunicaciones y Transportes, 2003). Also, this regulation creates a safety hazard as the condition of the few bikeways in Mexico are inadequate and poorly maintained, which is dangerous for cyclists forced to use them.

The City, regional, and state development plans were reviewed for policy objectives that encouraged the promotion of bicycling as a form of transportation. The Strategic Central Population Development Plan (Plan de Desarrollo Urbano del Centro Poblacion Estrategico) includes a section on the planning of bicycle lanes while the State and City Plans do not, and does touch upon the associate problems of vehicular congestion and accidents and the inadequacies of the public transportation systems.

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In the United States, cyclists are not obligated to use bikeways and have the freedom to operate alongside automobiles in the public roads.
**Plan Municipal de Desarrollo**

The most recent Plan Municipal de Desarrollo 2004-2006 recognizes the issues that are arising from the rapidly growing city and details the growing vehicular congestion and accidents, deforestation, air and water pollution. The identified solutions to the transportation problems entail widening arterial roads and building new super-highways, improving drivers’ education, and the acquisition of speed detection radar equipment. There is a brief mention given to public transit, in that studies need to be done to determine transit-user needs. There is no mention given to reducing dependency on automobiles and other forms of motorized transport through encouraging cycling and walking.

There is a lengthy discussion of the promotion of sports for improving the health of youths, but no connection is ever made to increasing walking and cycling to achieve these goals. Nor is any connection made between the pollution problems and reducing the amount of personal automobiles on the road.

**Plan de Desarrollo Urbano del Centro de Poblacion Estrategico**

This Strategic Regional Plan was completed in August, 2003. It covers the two main municipalities in the State of San Luis Potosí, the capital, San Luis Potosí, and the adjacent municipality of Soledad de Graciano Sanchez.

The Transportation section of the Plan discusses the increase in the number of vehicles circulating in the City. Goals outlined in the Plan are to build more roads and to
widen existing roads, not just adding additional lanes, but the widening of the lanes as well.

There is a brief section on “special transportation” which includes mention of designated bus and bike lanes. The Plan makes special mention that the bike lanes would be for the promotion of the bicycle as an alternative or complementary form of transportation not just for recreation or sport. The purpose of bike lanes would be to improve the safety of the cyclists who traverse busy roads and to encourage safer cycling behavior by discouraging cycling against the direction of traffic and zig-zagging through traffic lanes. The Plan recommends that more study is needed to determine the demand for such bike lanes and the appropriate roads in which to implement them.

The establishment of bikeways and sidewalks is given cursory mention as a solution to the lack of parking in the historic downtown. The underlying goal is that if access to the downtown from outlying parking areas were more pedestrian-friendly, driving into the center (without enough parking) would not be necessary (2003).

*Plan Estatal de Desarrollo*

The State Development Plan makes a cursory mention to the inadequacies of public transportation. It recognizes that public transit users are not satisfied with the level of service offered. It mentions that a major problem is that the fares do not coincide with the operating costs. The Plan states that it is necessary to revise and improve regulation of fare collection and to reduce the number of free rides granted (2004).
The National Perspective

Mexico is a primarily urban country. Urban centers account for 75 percent of the total population and 63 percent of Mexico’s poor live in cities (Cruz and Freire, 2001). With the majority of the country’s poor population living in cities, it is no surprise that poverty is a primarily urban problem.

Traditionally, Mexico has been governed by a very centralized form of government. This began to change when Mexico began the decentralization process in 1983, giving the local governments much more autonomy and power over spending based on their needs (Ward, 1998). Since local conditions are better managed on the local level, the newfound power of the local government will be better able to address local cycling needs and perhaps chip away at urban poverty problems. The federal government should establish only national urban transport goals, while regional and local governments should be entitled to define their own transport and traffic policies (Vasconcellos, 2001).

Physical Barriers to Bike Infrastructure

Aside from the policies and conditions that discourage cycling in San Luis Potosí, there are many design constraints that make planning bicycle lanes difficult. The narrow, cobblestone streets in the historic downtown are barely wide enough for a car to pass through and accommodate a narrow strip of sidewalk just wide enough for one person. Often one has to walk in the street to pass a slower walker or to get around the many parked cars on the sidewalk, as the majority of streets do not have room for on street parking.
The wider, newer streets outside of the City center are often wide enough to accommodate a striped lane or a grade-separated cycle way without having to eliminate on street parking or reduce traffic lanes. However, the inconsistency of building set backs inhibit many grade separated cycle ways of a uniform width. Another physical constraint is the presence of street trees that are planted close to the curb or in the median. Although a few trees could be removed to accommodate bicycle infrastructure, it should be avoided if possible as the urban flora provides a great benefit to the City in the forms of shade, cooling, carbon dioxide sequestration, and aesthetic appeal.
Case Study #2: Cambridge

Background

Cambridge, Massachusetts is located across the Charles River across from Boston. Cambridge is widely regarded as one of the most pedestrian-friendly communities in the state and the nation. The City is compact and dense with 100,000 people and 120,000 working in its 6.2 square miles (Seiderman, 2005). Home to Harvard University and the Massachusetts Institute of Technology (MIT), many students from all over the country and the world come to Cambridge to study. It is just not practical for the majority to own their own car.

In turn, public transportation is efficient with a subway and bus system. The Massachusetts Bay Transportation Authority (MBTA) operates both rail and bus service within the City. The Green Line has one stop in Cambridge (Lechmere), while the Red Line runs through the entire length of the City (with stops at Kendall/MIT, Central Square, Harvard Square, Porter Square, Davis Square in Somerville, and Alewife). There is also a commuter rail station in Porter Square with service to points west as far as Fitchburg.

Numerous bus lines run throughout the City, including the recently implemented CT1 and CT2, cross-town busses that are part of the early phases of the MBTA’s plan to create a more comprehensive urban-ring transit system (City of Cambridge, 2005a). The

Figure 18: Minuteman Trail Bikeway

Source: Minuteman Bikeway Website
City, through its Environmental Program, is also actively encouraging other techniques including shuttle buses, car and vanpools and bicycle use.

Cambridge is a very walkable city with its diverse mix of retail and residential space all on top of each other, making walking and bicycling the most convenient way to get around. Traveling by car is a rather frustrating experience with limited parking and circuitous streets confusing for drivers.

*Evolution of a Bicycle-Friendly City*

There are several fortuitous reasons why Cambridge has evolved in this manner. First, Cambridge was founded before the advent of the automobile and was not designed to cater to automobiles. Streets are narrow and weave around the City in a seemingly disorderly fashion. In addition, an important piece of legislation, the Vehicle Reduction Ordinance was passed in 1992 creating a basis for the program (Anders, 2005). This ordinance was created because the City did not meet the 1990 Federal Clean Air standards and the City needed to take action to improve air quality by reducing the number of vehicles traveling through the City. This ordinance mandated the creation of pedestrian and bicycle plans which encourages cycling in the City and to focus the attention of the City on the needs of pedestrians (Seiderman, 2005).

*Coordination*

Another tremendous reason that bicycle facilities are able to come into existence is because the interdepartmental communication makes it easier to plan for them. In fact, there is an interdepartmental transportation committee that meets monthly to augment project coordination (Seiderman, 2005). This means that when public works is planning
to repave a road, they automatically check to see if a pedestrian plan is underway or if cycle lanes need to be striped. This creates a more efficient planning and project environment where multiple projects can be implemented simultaneously and the costs defrayed across multiple departments. Roads do not need to be blocked and torn up twice when once is sufficient.

Inventory of Bicycle Infrastructure in Cambridge

Minuteman Trail-Bikeway

Completed in 1992 by the Commonwealth of Massachusetts on an inactive railroad, the aptly named Minuteman Bikeway passes through the historic area where the American Revolution began in April 1775. The eleven-mile asphalt bikeway is one of the most popular and successful rail-trails in the United States due in part that it is utilized each day for both recreation and transportation. Connecting to the Alewife “T” Station in Cambridge, the bikeway provides an easy way for bicyclists and pedestrians to travel to subway and bus lines, serving to reduce automobile traffic in the area. The bikeway is collectively managed and maintained by the four communities it passes through: Bedford, Lexington, Arlington, and Cambridge (Minuteman Bikeway Website, 2006).

Memorial Drive

This major thoroughfare along the Charles River closes to automobile traffic on Sundays during the warmer months of the year. In addition, there is multi-use path that follows the length of the river parallel to the road.
**Bike Lanes**

Along Massachusetts Avenue and around the Kendall Square/Massachusetts Institute of Technology campus there are striped bike lanes incorporated into the streetscape. In certain areas that are considered high conflict areas between motorists and cyclists, the lanes are marked in blue to indicate that extra precautionary measures should be taken when traveling through these sections.

**Bicycle-Friendly Policy**

**Transportation Demand Management (TDM) Ordinance**

Incentives in the form of financial breaks and increasing the convenience factor of using alternative commuting options is often necessary to illicit a change of behavior. The purpose of the TDM Ordinance is to slow the rate of growth in traffic congestion by reducing the use of single occupant vehicles within the City. To achieve this end, this ordinance requires large employers to create (and pay for) Transportation Demand Management Plans in order to achieve certain transportation mode splits among their employees. These plans may incorporate the use of a variety of strategies, but most plans include at least a few of the following programs (City of Cambridge, 2005b):

- Transit and vanpool subsidies
- Pre-tax deduction of transit and vanpool fares
- Carpool and vanpool matching service
- Shower and locker facilities for bicyclists and walkers
- Bicycle parking
- Carpool and vanpool parking
• Employee shuttle
• Emergency Ride Home (ERH) program
• Commuter information center (bulletin board, web page, brochure table)
• Employee Transportation Coordinator (ETC)
• Flexible or alternative work hours
• Telecommuting program

Traffic Calming Program

Physical design features, such as pinch points, round-abouts, and chicaneries are incorporated into roadway improvements that slow traffic and make streets safer for pedestrians and bicyclists.

Climate Protection Plan.

This plan, promoted by ICLEI – Local Governments for Sustainability, a Toronto headquartered not for profit, is being developed by a task force in order to determine how much greenhouse gas pollution is produced in the City, in domestic, commercial, transportation and industrial sectors, and to discuss possible reduction measures. The draft plan recommends a target of a twenty percent reduction from 1990 levels. In order to reach this target, the following transportation actions will be required:

• A reduction in single-occupancy vehicle commuting, improved facilities for walking and biking,
• Reduced motor vehicle travel with promotion and education programs,
• Reduced motor vehicle emissions,
• The promotion of transit improvements.
Citizen Input

The City of Cambridge has both a bicycle and a pedestrian committee that give residents an opportunity to become involved in transportation planning. The Cambridge Bicycle Committee was established by City Council in 1991 and is made up of a variety of stakeholders including community members who take an active interest in bicycling issues in Cambridge, as well as City staff from the Community Development Department, the Department of Traffic, Parking, and Transportation, the Police Department, and the Department of Public Works (City of Cambridge, 2005b).

The goal of the Bicycle Committee is to improve conditions for bicyclists in the City of Cambridge and promote bicycling as a means of transportation. Activities of the Committee include:

- Reviewing City plans for road construction;
- Commenting on pending bicycle-related ordinances;
- Organizing and participating in public events;
- Creating materials to encourage bicycling in the City, and
- Working with other bicycling organizations at the local, state, and national level.

The Importance and Role of Citizen Groups to Effect Change

Local cycling advocacy groups have played a large role in furthering bicycle-friendly policies on the local level. In addition to creating political pressure and raising awareness of the issues affecting cyclists, they also take on the role of an information clearing house, educating policy-makers on best management practices. When cycling infrastructure proponents are invited to sit at the same decision-making table with policy-makers they can work to build consensus and further their policy agenda.
One such cycling advocacy group that has played a large role in the advancement of cycling infrastructure is the Massachusetts Bicycle Coalition. Commonly referred to as Massbike, their purpose is to:

Promote the bicycle as a safe, healthful, enjoyable, efficient, and environmentally sound means of transportation, to seek to establish an atmosphere which enhances those desirable qualities of bicycle transportation, and to serve and protect the interests of the bicycling public. The primary means of achieving these goals is the education of bicyclists and motorists as to safe riding skills, good driving habits with regard to bicyclists, and the rules of the road. MassBike shall also advance its purposes through the sponsorship of public events, through the dissemination of information to the public, through cooperative activities with other organizations, through encouragement of favorable actions by government and private industry, through publicity of the benefits of cycling, and through other suitable means (Massachusetts Bicycle Coalition).

Some of MassBike’s main achievements include working with MassHighway to redesign state's official roadway design manual to ensure it is more bicycle-friendly, the successful lobbying of the MBTA to increase hours bikes are allowed on the subway, and install additional bicycle racks on buses.

State Policies

In addition to City policies and programs that encourage the implementation of cycling infrastructure, the Commonwealth of Massachusetts has several laws that relate to the promotion of cycling infrastructure.

*The Massachusetts Bicycle/Pedestrian Access Law*- Chapter 90E-Section 2A:

An act relative to bicycle and pedestrian access in construction of public ways.

Massachusetts is one of three states\(^8\) to have a state law requiring the state department of transportation\(^9\) to accommodate bicycles and pedestrians into the design

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\(^8\) The other two states with similar requirements are Oregon and Rhode Island.
and construction of every project. Sponsored by Representative Anne Paulsen (D-Belmont), it is sometimes referred to as the "Paulsen Bill" and was approved on May 20, 1996. The law reads as follows:

*Chapter 90E of the General Laws is hereby amended by inserting after section 2, as appearing in the 1994 Official Edition, the following section- --*

*Section 2A. The commissioner [of the Massachusetts Highway Department] shall make all reasonable provisions for the accommodation of bicycle and pedestrian traffic in the planning, design, and construction, reconstruction or maintenance of any project undertaken by the department. Such provisions that are unreasonable shall include, but not be limited to, those which the commissioner, after appropriate review by the bicycle program coordinator determines would be contrary to acceptable standards of public safety, degrade environmental quality or conflict with existing rights of way"* (General Laws of the Commonwealth of Massachusetts)¹⁰

This bill was followed up by two Mass Highway Engineering Directives¹¹:

- **Mass Highway Engineering Directive 97-004, dated 7/1/97**
  
  Titled "*In Response to MGL Chapter 87 Acts of 1996 - Bicycle and Pedestrian Accommodation*", this directive outlines the state's position on "reasonable" bicycle accommodations.

- **Mass Highway Policy Directive P-97-001, dated 6/16/97**
  
  Titled "*Bicycle Route Signing - State Highways*", this directive applies to situations where bicycle routes are being considered on state highways.¹²

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⁹ In Massachusetts, the State DOT is called the Massachusetts Highway Department.
¹⁰ The entire text of Chapter 85 and 90E are reprinted on the MassBike website.
¹¹ A directive is a written communication that prescribes or establishes policy, organization, methods, procedures, requirements, guidelines, or delegations of authority (FHWA).
¹² These directives are available at http://www.massbike.org/bikelaw/mhdsign.htm
**Chapter 90E section 3, Bikeways: Funding; expenditures; federal funds**

This legislation lays the groundwork for funding mechanisms for local bicycle infrastructure.

*The commissioner shall expend for the purpose of assisting counties, cities and towns to construct bikeways for commuter or recreational use, and for the construction of unique regional bikeways and bicycle parking facilities, such funds as are appropriated or authorized by the general court for such purpose, and payment shall be made to the county or city or town upon application to the commissioner on the basis of criteria established by him.*

**The Massachusetts Statewide Bicycle Transportation Plan**

This Plan completed in 1998 includes the following statement:

*The vision of the Statewide Bicycle Transportation Plan is recognition of the bicycle as a viable means of transportation and reasonable accommodation of the needs of bicyclists in policies, programs and projects. Greater recognition and accommodation of the needs of bicyclists will lead to a more balanced transportation system with greater modal choice and improvements in bicycle safety. Such actions will enhance the environment and quality of life in the Commonwealth, and improve personal mobility.*

**The Massachusetts Energy Plan**

One of the goals of the Massachusetts Energy Plan is to "Increase Efficiency and Diversity in Transportation Energy Use." To achieve this goal the Plan includes a recommended action to "Encourage the Increased Use of Bicycling and Walking as Long-Term Alternatives to the Private Automobile":

*Walking and bicycling represent viable alternatives for short trips if the infrastructure exists to support and encourage non-motorized travel. Especially in suburban work, shopping and even residential settings, the land use and supporting urban design is too often oriented to support only automobile travel. Buildings surrounded by large parking lots are the current norm. Department of Energy Resources (DOER) will work with transportation and municipal agencies to provide a variety of infrastructure facilities and amenities that will promote the use of bicycling and walking and to encourage designated bicycle routes to bus,*
train and carpooling terminals. This will include evaluating the use of abandoned railroad beds as potential bikeway facilities.

Federal Policies

Through its several branches and agencies, the federal government has clearly articulated the mandate to promote bicycling in the United States. The federal government has made significant advances in its view towards cycling promotion as a viable mode of transportation. It wasn’t long ago in the 1970s that during the energy crisis, Peter M. Flanagan, an assistant to the president, made the comment, “the United States is not going back to the cold, the dark, and the bicycle” (Balshone, 1975).

The first major step to encourage non-motorized transportation was the 1991 US Department of Transportation Appropriations Act, in which the Secretary of Transportation was directed to conduct The National Bicycling and Walking Study that included "a plan for the increased use and enhanced safety of [bicycling]." The report presents a plan of action for activities at the federal, state and local levels for meeting the goals of doubling the current percentage of trips made by bicycle and by walking and reducing the injuries and deaths to bicyclists and pedestrians by 10 percent. Since this first study there have been two follow-up studies, a five-year and ten-year update to monitor the progress towards achieving these goals.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)

ISTEA affirmed the value of bicycling in the transportation system. Among other things, it requires 10 % of federal transportation funds be used for "enhancement
activities," which include bicycle and pedestrian facilities. The reauthorization of this legislation, the Transportation Equity Act (TEA21) was passed in 1998. It is even stronger in its support and encouragement of bicycling in the transportation system. Bicycle projects are broadly eligible for funding from most of the major federal-aid highway, transit, safety and other programs. Bicycle projects must be "principally for transportation, rather than recreation, purposes." Special provisions also protect cyclists and other non-motorized users; for example, projects may not have an adverse impact on the safety of non-motorized transportation (FHWA, 2006).

SAFETEA-LU


In SAFETEA-LU, metropolitan and statewide transportation planning processes are continued, but changes are made in the planning process for surface transportation\(^\text{13}\). Some of these changes add flexibility while others add new requirements such as the expanded consultation requirements for State and Metropolitan Planning Organizations (MPO). These require state and regional transportation plans to address environmental

\(^{13}\) Surface transportation means all elements of the intermodal transportation system, exclusive of aviation. For the purposes of TE eligibility, surface transportation includes water as surface transportation and includes as eligible activities related features such as canals, lighthouses, and docks or piers connecting to ferry operations, as long as the proposed enhancement otherwise meets the basic eligibility criteria (www.fhwa.dot.gov)
mitigation, improved performance, multimodal capacity, and enhancement activities; tribal, bicycle, pedestrian, and disabled interests are to be represented (FHWA, 2006).

SAFETEA-LU includes changes in the definition of the TE activities established in TEA-21. It continues to include the provision in 23 U.S.C. 133(d)(2) requiring 10 percent of the Surface Transportation Funds be set-aside and be only available for TE activities, but expands funding to non-construction activities such as direct educational expenses for surface transportation workforce development, training, and education, provided the activity specifically benefits eligible TE activities. The FHWA website outlines the following qualifying TE activities provided in 23 U.S.C. 101(a)(35) as eligible for TEA funding:

- Provision of facilities for pedestrians and bicycles.
- Provision of safety and educational activities for pedestrians and bicyclists.
- Acquisition of scenic easements and scenic or historic sites
- Scenic or historic highway programs (including the provision of tourist and welcome center facilities).
- Landscaping and other scenic beautification.
- Historic preservation.
- Rehabilitation and operation of historic transportation buildings, structures, or facilities (including historic railroad facilities and canals).
- Preservation of abandoned railway corridors (including the conversion and use of the corridors for pedestrian or bicycle trails).
- Inventory, control, and removal of outdoor advertising.
• Archaeological planning and research.

• Environmental mitigation
  o To address water pollution due to highway runoff; or
  o Reduce vehicle-caused wildlife mortality while maintaining habitat connectivity.

• Establishment of transportation museums.


Conserve by Bicycling Program

The “Conserve by Bicycling Program” was established within the Department of Transportation a program in 2003 to establish pilot projects throughout the country that are designed to conserve energy resources by encouraging the use of bicycles in place of motor vehicles. Goals of the program are the incorporate the use education and marketing to convert motor vehicle trips to bicycle trips and document project results and energy savings.

In addition, an Energy and Bicycling Research Study is to be conducted to report on the results of each of the pilot programs’ success in converting motor vehicle trips to bicycle trips. The study will also determine the type and duration of motor vehicle trips that people in the United States may feasibly make by bicycle, the associated energy savings that would result, and factors that would encourage more motor vehicle trips to be replaced with bicycle trips.

The Bicycle and Pedestrian Program of the FHWA’s Office of Human and Natural Environment, promotes bicycle and pedestrian transportation accessibility, use,
and safety. Each State has a Bicycle and Pedestrian Coordinator in its State Department of Transportation to promote and facilitate the increased use of nonmotorized transportation, including developing facilities for the use of pedestrians and bicyclists and public educational, promotional, and safety programs for using such facilities. The FHWA Bicycle and Program issues guidance and is responsible for overseeing that requirements in legislation are understood and met by the States and other implementing agencies (FHWA, 2006).

Case Analyses

Looking at these two case studies, there are many similarities and differences. Both cities are relatively flat, each house universities, have at least one active cycling advocacy organization, and bicycle infrastructure/cycling/public transportation receives some mention in the master plans. The main differences however appear to be political will on the part of decision-makers, cultural differences, and density of the cities. It is not surprising to see that the city covering the largest area and lowest density has the worst bicycle infrastructure. San Luis Potosí covers an area greater than Los Angeles.

One advantage Cambridge has over San Luis Potosí is that it has federal and state regulations requiring them to at least take into account cyclists and pedestrian needs. However, to get to this point, there was a tremendous amount of effort on the part of bicycling advocacy groups putting pressure on policy-makers to improve the conditions for cyclists. San Luis Potosí can take these lessons from Cambridge and build up their support base and strive to make more inroads into local government to have their voices heard. They should strive to partner and not spar with local government to improve
conditions for cyclists. These partnerships are even more important for efforts on the local level as the decentralization process in Mexico continues allowing local governments more autonomy on decision-making regarding how they spend transportation funding.

With or without legislative mandates, support on the part of the policy-makers greatly facilitates the implementation of cycling infrastructure. However, getting this support is not an easy process and takes time and effort. Rosalie Anders sums it up well, “Sometimes people have to retire or die for new people to get in office and change policy” (Anders, 2005).

On the national level, the two countries are experiencing different trends in the number of passenger cars per 1,000 people. Using data provided by World Development Indicators database, a table and graphical representation provide a snap shot of these trends. In addition to data from Mexico and the USA, data from the Netherlands was included to roughly see if a relationship between the individual country’s level of “cycling friendliness” was associated with the number of passenger cars per 1,000 population.

This data shows that in all three countries between 1980 and 1990, the number of passenger cars per 1,000 people is increasing with Mexico experiencing steepest rate of increase of 38 percent, with the Netherlands at 15 percent, and the US at 7 percent. However, from 1990 to 1999, the number of passenger cars per 1,000 in the USA actually drops 16 percent while it continues to increase slightly in the Netherlands at just over 4 percent, and the highest increase of 26 percent occurring in Mexico. Mexico’s rapid increase in percentage of cars on the road presents many problems as the existing road
network can barely keep pace. This rapid growth also puts constraints on the planning process, as thoughtful and comprehensive planning could suffer from a rush to meet the demand of traffic.

Table 1: Number of Passenger Cars per 1,000 people¹⁴

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico</td>
<td>59.670</td>
<td>82.18</td>
<td>103.2</td>
</tr>
<tr>
<td>Netherlands</td>
<td>321.55</td>
<td>368.45</td>
<td>384</td>
</tr>
<tr>
<td>USA</td>
<td>535.70</td>
<td>573.28</td>
<td>480.6</td>
</tr>
</tbody>
</table>

Figure 18: Passenger Cars per 1,000 People

¹⁴ Table 1 and Figure 18 created by Fillis using Data from World Development Indicators. 1999 was the most recent data available for all three countries on the World Development Indicators database.
Chapter Six

Conclusions and Recommendations

Examining the two case studies, it is apparent there are many factors that contribute to the evolution of a bicycle-friendly city. This is not to say that it is impossible to reverse the damage of an automobile-centrically planned community. As economic, political, and cultural shifts occur, it is inevitable that alternative forms of transport will assume a larger role in the way people move around.

On the outset of this thesis, the goal was to answer the research question “what are the motivations for and the barriers to the implementation of bicycling infrastructure?” To answer this question, the social, political, and cultural factors, as well as the theory of transport culture were examined for their role in creating a hostile environment for bicycle infrastructure planning. The findings of this thesis support that these barriers can be overcome with the implementation of bicycle infrastructure and a safe cycling environment.

Of course it is easier for communities like Cambridge that are fortunate (or lucky) to have political decision makers who are advocates of cycling. Bicycle advocates such as Bicicleteros del Tropico de Cancer in San Luis Potosí, need to increase and more sharply focus their lobbying efforts of political leaders to try to get a greater voice in the planning process. Only when bicycle advocates put pressure on the decision makers, will there be change.
Importance of Planning

Communities that are bicycle and pedestrian-friendly place a high priority on planning methods and policy-making that favor alternative transportation. The role of successful land use and transportation planning in establishing good multi-modal service is often underestimated. As Walkable Communities director Dan Burden points out, "Engineers must react to whatever is given them. And when planning is poor, their job becomes that much harder" (Walkable Communities, 2006).

Interdepartmental communication to ensure that bicycle and pedestrian needs are considered in every project is key to successful and efficient bicycle infrastructure planning. In addition, public input is essential from those representing different interests to incorporate consensus building in the approach to solving transportation problems. Local citizens understand their needs better than policy-makers and the planning process should better utilize local knowledge.

Policy and Planning Prescriptions

There are many different policies that need to be developed to enhance the bicycle and pedestrian friendliness of any city. These policies should be considered for adoption by San Luis Potosí. If these policies do not come from within by forward thinking decision makers, pressure from citizen’s groups will be very important in having bicycle and pedestrian concerns heard. The policies that should be considered include infrastructure improvements as well as programs that make cycling safer and more desirable.
**Formation of a Bicycle Committee**

One of the most important first steps for San Luis Potosí towards becoming a bicycling-friendly city, is to establish a bicycle committee. This committee should be made up of members of various different city departments including transportation, police, sports, planning, public works, engineering, environmental protection, bicycle advocates, and elected officials. This committee should meet monthly to review construction and road plans for opportunities and threats to cyclists. In addition, this group can work on drafting bicycle-friendly ordinances and work to implement bicycle infrastructure.

**Infrastructure Improvements**

The creation of a safe cycling environment is very important to increase the number of people who use the bicycle as a form of transportation. Research in the United States has shown that where investment in bicycle facilities has occurred, rates of trip making by bicycle are significantly higher than the national average. It is therefore reasonable to assume that some percentage of personal trips now being done via motor vehicle could be shifted to non-motorized modes if proper facilities were provided (Morris, 2003). The results of the survey administered in San Luis Potosí indicate that 83 percent of respondents would cycle more if there were bicycle infrastructure in the City.

Bicycle ways, the provision of adequate and secure parking for bicycles, and increased signage of the presence of the bike lanes can create a safer cycling environment by alerting drivers of the presence of cyclists on the road. Signage also can increase the number of cyclists as these signs increase the comfort level of cyclists as they feel that
drivers are aware that they are sharing the road with them. According to the San Luis Potosí survey results, the largest barrier (34%) to cycling in the City was the perception that motorists did not respect the presence of cyclists on the roads. The presence of bikeways and signage would send a clear message to motorists that cyclists belong on the roads.

**Pavement Marking**

Motorists, pedestrians and bicyclists benefit from pavement markings that clearly define travel lanes, crosswalks, shoulder and other roadway characteristics. When a travel corridor is well defined with the proper pavement markings, the users of that corridor have a clear understanding of their responsibilities. The pavement marking policy for San Luis Potosí should be reviewed for clarity and consistency and be updated as necessary. A maintenance component regarding all pavement markings should be included in these policies.

**Shoulder Striping for Rural Roads**

The white stripe on the rural roadway shoulder that marks the edge of the travel lane offers the opportunity to provide added space for a cyclist to operate. Over the years travel lanes have tended to expand with each resurfacing and the white stripe that marks the edge of the pavement has followed right along resulting in travel lanes that are unnecessarily wide. Limiting travel lanes to 11 1/2 - 12 feet can end up providing 2-3 feet of pavement to the outside of the edge stripe. This is a significant amount of space that can be used by bikers (MassHighway, 2006). The City of San Luis Potosí should consider adopting this practice on the peripheral roads that feed into the City.
**Traffic Calming**

The overall objective of traffic calming is to reduce the negative effects of motor vehicles while improving conditions for other modes. Traffic calming projects can enhance safety and maintain access for cyclists. Bicyclist safety is enhanced because the goal of these projects is to slow motor vehicles down. This decreases the speed differential between cars and bicycles, which enhances the comfort level of cyclists. Access for bicycles is maintained and the neighborhood environment is improved when roadways are restored to their intended function.

On the other hand, traffic calming measures such as road narrowing can place bicycles and motor vehicles in closer proximity than is comfortable. Therefore, traffic calming policy should be sensitive to the needs of cyclists and consider these unique requirements during the design phase of new roadways as well as prior to rehabilitating existing road segments. The bicycle amenities of roads that have not been built and those of roadways about to be redone are easiest to get changed during the earliest stages of the design phase.

As in the whole of Mexico, the City of San Luis Potosí has in place many speed bumps and “topes” to slow down motorists near populated areas. However, these are hazardous to cyclists as bicycle tires can easily be caught between topes and cause accidents. The City should instead use the more modern traffic calming techniques being employed by Cambridge.

Ultimately, a plan to achieve traffic reduction will need to be put in place as the number of automobiles on the City streets continue to increase in San Luis Potosí. San
Luis Potosí should adopt an ordinance similar to Cambridge’s Traffic Reduction Ordinance which aims to decrease the amount of cars in the City, not just slow them down. Ways to reduce traffic include increasing the costs of operating a vehicle within the city limits by eliminating free parking or in the case of London, instituting a congestion charge in which motorists must pay to drive into the City.

**Provide Intermodal Access and End-of-Trip Facilities**

According to the Federal Transit Administration’s publication *Bicycles and Transit: A Partnership that Works*, “linking bicycles and transit together is a win-win proposition… bicycles and public transportation can help establish more livable communities” (FTA, 1999). Bicycle-friendly transit provides benefits to both cyclists and public transportation providers.

For cyclists, it provides increased options for travel and allows the opportunity to make longer trips. In addition, where physical conditions prevent a continuous bicycle trip, public transportation can provide a link to previously inaccessible destinations. One of the many benefits for public transportation providers is that improved bicycle access expands transit ridership. Use of mass transit is limited by the potential catchment area of each route and its stations or stops. Distances to transit stops that may be too far to walk may be within range of a short bicycle trip. By making it easier for bicyclists to get to and use transit, it is possible to increase the capture area and, as a result, to benefit both (FTA, 1999). State and Municipal transit authorities for San Luis Potosí should investigate ways to encourage the combined use of transit and bicycles in order to increase its transit capture area. In the United States, many transit agencies can apply for funds administered by the Federal Highway Administration such as the Transportation
Enhancements program and Congestion Mitigation and Air Quality Improvement (CMAQ) program to pay for bike racks on buses and other bicycle-friendly improvement projects (FTA, 2006). Similar funding mechanisms should be created in Mexico.

The provision of secure parking for bicycles at transit stops and stations is less expensive than providing parking for automobiles. In Bicycle Parking, a publication of the Santa Clara Valley Bicycle Association, a quote by Darryl Skrabak succinctly describes the barrier to cycling as a result of the lack of bike parking,

> Perhaps the greatest impediment to urban bicycle use is a dearth of secure bicycle parking and storage. A bicycle might provide ideal city transport, but it is no good if, at one’s destination, the bike isn’t welcome inside, but can’t be left outside due to the risk of theft. This unhappy situation is met nearly everyplace: the post office, libraries, shops, stores, shopping centers, museums, etc. These places might as well hang out ‘bicyclists unwelcome’ signs (Fletcher, 1983, in Perry, 1995, p.265).

San Luis Potosí should perform an inventory in order to determine if bike racks or other bicycle parking facilities exist at strategic locations such as places of employment, as well as at parks and other recreational facilities. The Massachusetts Highway Project Development and Design Guide recommends that bicycle parking be located where they are convenient to the users and where they will not interfere with pedestrian and vehicular traffic. The general guidelines are that the appropriate number of spaces needed should be assessed with respect to the associated building or land use. Typical inverted “U” systems are preferred, but any similar rack that enables the frame and one or both wheels to be secured, preventing the bike from tipping over and that the rack should be anchored so that it cannot be stolen with bikes attached (MassHighway, 2006).

In addition to the provision of improved access to transit stations and parking for cyclists, there is also need for incentives to be put in place by workplaces, stores,
libraries, and other destinations. People would be more willing to ride a bike to work if there were convenient facilities equipped with showers, lockers, and changing rooms at their workplace. This would encourage cycling and facilitate its use as a viable mode of transportation.

The following recommendations, although not specifically identified in the case studies as official programs, should be a part of any city’s efforts to become more bike-friendly.

**Bicycle and Pedestrian-Friendly Roadway Programs**

Programs to eliminate existing physical barriers to cycling should be developed (or maintained) that focus on enhancing safety and improving access for bikers and walkers. These programs need to pay special attention to road maintenance and debris removal crucial to cyclists as well as providing bicycle and pedestrian access to intersections and bridges, as well as to roadways.

**Street Sweeping**

Debris that ends up on roads tends to accumulate on the shoulders, where bicycles are typically operated. Roadway shoulders should be kept free of debris through regular street sweeping.

**Shoulder Repair**

The roadway shoulder is where bicycles are generally ridden and it is also where roadway pavement typically begins to deteriorate first. Hazards such as cracks, potholes and crumbling pavement, that a motorist might not even notice, can have a devastating impact on cyclists. By the time a roadway is resurfaced, the shoulders have long since become dangerous to cyclists. It is therefore critical that roadway shoulders be repaired
more frequently than travel lanes when necessary. It is recommended that San Luis Potosí should develop pavement repair reporting procedures designed specifically to include cyclists.

**Bicycle-Friendly Grates**

Catch basin grates are usually located in the shoulder where bicycles travel. Older grates are unsafe for bicycles because they can easily catch a wheel and cause an accident. San Luis Potosí should begin to replace old style grates with bicycle-friendly grates.

**Eliminate Physical Barriers**

Bicycling and walking tend to be short distance travel modes, which means barriers such as rivers and highways that force a one, or two-mile detour can discourage many non-motorized trips. Other barriers include the lack of road connections between housing developments or cul-de-sacs. These barriers can be easily remedied by requiring connections between these land uses that are reserved for non-motorized travel only.

In San Luis Potosí there are several pedestrian crossings for major roads, but the majority incorporates several sets of stairs and are not ideal for crossing with a bicycle. It is recommended that San Luis Potosí develop bicycle-friendly crossings of major barriers, including the rivers and highways. Additionally, the City should require connections between housing developments, cul-de-sacs, and commercial properties that are reserved for non-motorized travel.

**Bridge and Underpass Improvement Program**

Bridges and underpasses are important because they provide crossing points of
major barriers such as rivers and highways. Underpasses are not particularly bicycle or pedestrian friendly because of abutment walls that are close to the travel lanes, as well as poor lighting and drainage create security concerns (City of Toronto, 2001). Overpasses and bridges can be narrow, with no accommodation for non-motorized travel. The general policy should be to provide bike lanes and sidewalks on bridges and in underpasses even if they are not part of the designated bicycle network. If this isn’t possible then travel lanes should be striped as narrowly as possible to provide more room for cyclists and walkers. Improved lighting and drainage should be included in any underpass reconstruction project.

Behavioral Change

Incentives

Incentives are important in facilitating behavioral change. Very few individuals elect to take the hard route when given other options that are easier, more convenient, and affordable. In addition to providing parking and showers to encourage cycling as a form of transportation to the workplace, school, and other daily destinations, financial incentives may make the biggest impact. Not to overlook the financial savings inherent in choosing cycling over driving a car discussed earlier in this thesis, employers can provide transit subsidies or other financial bonuses such as cash in lieu of parking passes or additional paid time off in exchange for cycling to work.

Lead by Example

Leading by example can be a powerful incentive to illicit behavioral change. Many people do not commute to work on bicycles because they fear traffic and think
riding to work would be too sweaty, unprofessional, or difficult (Pena, 1992). To change these assumptions employers should sponsor “bike to work” days and encourage upper management to bike to work and use public transit. This is especially important in San Luis Potosí in which the culture harbors bias against cycling for class-conscious reasons.

**The Last Word**

In conclusion, it appears that bicycle-friendly communities emerge from a combination of factors. Political will is an important factor, but the will of citizens is also very important. It is entirely possible for San Luis Potosí to embrace the bicycle as a viable mode of transportation as the seeds exist and just need to be carefully cultivated.

As Mexico continues to decentralize and local government moves in the direction of making their own transportation decisions, the efforts of local bicycle advocacy groups such as Bicicleteros del Tropico del Cancer can make more progress towards effecting change on the local level. They should partner with their local governments to work to strengthen the existing language in the Development Plans and to create local laws and programs that facilitate the development of bikeways.

There should be no doubt about the success of bikeways in San Luis Potosí if they are implemented. Potosinos have expressed that they will cycle more if there were safe cycling facilities. Not only will the bikeways reduce congestion, improve air quality, and create a healthier society, it will save the lives of the urban poor that must traverse the streets by bicycle daily.
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Appendix A

San Luis Potosí Bicycling Survey (English Translation)

1- Female O Male O Age ______ Occupation _______________________

2- Where is your town/city of residence?
___________________________________________

3- Do you own a bicycle? Yes O No O

4- What mode of transportation do you use?
Walk O Bicycle O Bus O Subway O Car O
How long does it take to get to work/school? ________________

5- Have you ever suffered a traffic accident? Yes O No O

6- How many days a week do you ride a bicycle?
Never O 1 - 3 days O 4-6 days O daily O

7- what are the principle reasons you use a bicycle?
Transportation to work O recreation/exercise O
Visit friends/family O shopping/errands O
Other reasons ________________ I do not use bicycles O

8- how do/would you feel about riding in the city?
Very secure O secure O insecure O

9- what are the reasons that inhibit you from bicycling?
I don’t have a bicycle O Auto drivers do not respect cyclists O
I don’t know how to ride a bicycle/physical impairment O
Weather (rain/cold/snow/heat) O Lack of bike lanes O
Bike was stolen O Lack of designated bicycle parking areas O prestige O
Preference for other modes of transportation O

10- Would you cycle (more) if there were......?
- Bike path/lanes Yes O No O- parking/locking facilities Yes O No O
- Better law to protect pedestrians and cyclists Yes O No O

11- Other comments? ____________________________________________