Publication No. FHWA-PD-92-041

C•ase Study No. 1

Reasons Why Bicycling And Walking Are And Are Not Being Used More Extensively As Travel Modes

U.S. Department
of Transportation
Federal Highway Administration

National Bicycling And Walking Study

FHWA NATIONAL BICYCLING & WALKING STUDY

CASE STUDY #1

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

It is generally acknowledged that bicycling and walking are not as widely used for practical transportation as they could be. The purpose of this report is to examine the factors which encourage and restrain people from treating bicycling or walking as practical travel modes.

The body of this report focuses on exploring and analyzing, first separately and then jointly, the two functional dimensions of demand for non-motorized travel:

1. The factors which influence the individual decision to bicycle or walk for utilitarian trips. Evidence is derived largely from mode choice surveys and studies of travel behavior.

2. Environmental and infrastructural factors which vary significantly from place to place and thereby affect aggregate usage of these travel modes. Data collected from twenty cities across the country is the basis for this section.

Key Findings: Bicycling

Individual factors: Age is the most significant demographic variable; virtually every survey demonstrates that bicycling becomes less popular with age, especially utilitarian bicycling. Bicycle trips are generally taken for recreation or for errands, with bicycle commuting much less prevalent. The main incentives motivating bicycle usage are exercise and enjoyment, with some evidence that environmental concerns are also a factor. The main disincentives to bicycle are concerns over traffic safety, lack of routes, and weather. However , if bicycle *commuting* is the subject, then distance to the work place, followed by safety, and the absence of shower and parking facilities are the main impediments. These concerns take on added significance when considered in light of the major reasons the automobile is the preferred commute mode: Travel time, convenience, and the need of a car for work or other reasons., Policies to stimulate mode shifts to bicycling will have to address both the objections to bicycling and the advantages associated with driving or public transit. Consequently, no single improvement can be expected to attract all potential bicycle commuters to cycle, suggesting that an integrated approach will be necessary to maximize such mode shifts.

Environmental Factors: Levels of bicycle commuting in twenty cities were compared across a number of objective physical, environmental, and infrastructural features. The most significant variable appears to be the dominating presence of a university. These cities have considerably higher rates of bicycling than other cities. In fact, no other factor correlates so consistently with high levels of bicycle commuting. Commute distance and primary bicycling facilities also appear to be connected with high levels bicycle commuting, though the relationship is far from perfect. Cities with a higher proportion of the population commuting five miles or less tend to have more bicycle commuters, though when university towns are removed from this group, the relationship is somewhat weaker. Considerably more important is the ratio of bikeways to road mileage. Even when university towns are excluded from consideration, cities with higher levels of bicycle commuting have on average 70% more bikeways per roadway mile and six times more bike lanes per arterial mile. Given the considerable difference in the levels of bicycle commuting between the two groups, the presence of on-road facilities looms large.

Other factors were also considered. Land use favoring compact development can shrink trip distances and thereby make bicycling a viable option. However, higher density can also mean greater traffic congestion on streets, making road space scarce for cyclists. Thus high density without a network of safe bicycling facilities may fail to stimulate bicycle trips. Cities with higher levels of bicycling tend to be laid out as grids, but not all such cities have high rates of bicycling, suggesting that lay-out is probably more of a impediment than an incentive. Policies affecting the attractiveness of other travel modes appear to influence the decision to bicycle,but these may be most effective in the guise of a disincentive, such as high parking rates. Climate does not seem to be correlated with interest in bicycling except as a seasonal and daily variable in the decision to bicycle.

Implications: Attitudes toward the bicycle are generally positive, and a majority recognize its virtues, but choice of it as a travel mode lags far behind stated preferences in favor of it. Part of this stems from the failure of most communities to address the major impediment to utilitarian cycling - distance and safety. Trip distance is a function of land use history and our reliance on the automobile, and thus represents a structural barrier to increased utilitarian cycling. Poor traffic safety and lack of routes for bicyclists can be overcome with sensitive design and is thus amenable to engineering solutions. Yet even in cities that are perceived as bicycle friendly, the level of bicycle commuting varies significantly, and with the exception of university towns, generally plays a limited role in the transportation system. This suggests that the effectiveness of improvements in the bicycling environment will depend heavily on local conditions and variables.

Key Findings: Walking

Limited information on this subject shows that walking is much more prevalent than bicycling, whether we are speaking of recreational or utilitarian purposes. However, fewer studies have focused on walking, which severely hamper evaluation of it as a travel mode.

Individual Factors: Walkers, like bicyclists, are largely motivated by exercise and enjoyment. Some utilitarian walking appears to be motivated by its relative convenience to other options. This is especially true for short errands, particularly in CBDs and other high density districts. Just as with bicycling, distance is the most widely cited reason for not walking more often. Other reasons include the hassle of carrying things, time limitations, and fear of crime. None of these secondary causes are as powerful a disincentive to walk as traffic safety is to bicyclists. Few individuals identify inadequate facilities as a reason for not walking more often. Limited evidence suggests that better facilities and more attractive places to walk would encourage more walking, but it is unclear whether this pertains to both recreational and utilitarian alike.

Aggregate Levels of Walking: Like bicycling, levels of walking vary from place to place. Evidence indicates that walking among urban residents living in high density districts is far more prevalent than among suburbanites, and that a much higher proportion of short trips (less than one mile) are walked in CBDs than in the suburbs. It should be noted, however, that suburbs and outlying areas often lack sidewalks, though cause and effect has not been established. Indications are that the relative convenience of other modes affects reliance on walking.

Implications: Though distance and travel time prevent many trips from being walked, clearly much more walking is possible given that many short trips are not walked. Making such trips feasible and pleasant - by the addition and maintenance Of sidewalks, crosswalks, greenery, and

landscaping should generate more walking, but how much more is uncertain.

Overall Recommendations

- Current markets for bicycling have not been adequately tapped. More effort should be expended in targeting specific demographic markets; for instance, all university towns and university districts in larger cities should be able-to achieve very high levels of bicycle usage.

- Removing perceptions of danger and lack of good routes are fundamental to tapping the existing potential of bicycling. If bicycling facilities are designed to allay safety concerns and are linked in such a way that access matches the Access motorists have come to expect, then utilitarian bicycling will increase.

- Bicycling and walking must be made as convenient as possible in order to attract trips away from motorized travel modes. That means bicycle and pedestrian "friendliness" must be fully incorporated into all aspects of urban design in the short run. In the long run, that means emphasizing compact land use and development.

- The low cost of operating a car underscores the perceived convenience of choosing it as a travel mode, thereby making it an easy choice for short trips that could easily be accomplished by bicycle or on foot. Non-motorized travel will remain severely under-utilized so long as the full social cost of driving is not paid by the driver. Making bicycling and walking more appealing is unlikely to generate a substantial shift to non-motorized travel modes as long as society continues to promote "auto-friendly" features which encourage distances between trip generators to grow.

- Considerably more remains to be learned about bicycling and walking before their full potential can be assessed. Almost nothing is known about walking habits and precious little about utilitarian bicycle trips which are not commute-related.

INTRODUCTION

It is generally acknowledged that non-motorized travel modes are not being used as extensively as they could be. Today it is reported there are at least 70 million adult bicycle riders, [1] or about 42% of the adult population. But bicycling, and to a lesser extent, walking, are viewed primarily as recreational activities. Yet for bicycle trips under five miles and walking trips of less than two miles, these are highly efficient, inexpensive modes of travel. The reasons why relatively few people choose to bicycle and walk on utilitarian and recreational trips are the subject of this report.

PURPOSE

This report discusses current levels of bicycling and walking for utilitarian and recreational purposes and assesses the potential for increased usage. Part and parcel of this will be an exploration of the major demand constraints on non-motorized forms of travel. The following issues will be addressed explicitly and implicitly through the various sections of the report:

- The chief factors influencing the decision to bicycle or walk;
- The effect of facilities, environment, and commute distances on levels of bicycle commuting;
- Whether public policy can cultivate higher levels of purposeful bicycling and walking;
- Whether enough is known about bicycling and walking habits to accurately predict levels of usage under different conditions.

SCOPE AND ORGANIZATION

This report will proceed from the level of the individual, first focusing on factors, both subjective and objective, that may influence individuals to choose or avoid nonmotorized transportation. In the course of this chapter, national and regional survey data will be reviewed and compared. Then the impact of the urban environment, commute distances, and infrastructure on aggregate levels of bicycling and walking in a number of cities will be examined. The section that follows will offer some insight into how these disparate personal and objective factors can be weighed in considering the role of public policy in encouraging non-motorized travel. The final sections will examine available data on bicycling and walking and review a

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[1] Bicycling Magazine, April 1991, p.44

few of the current analytic approaches to assessing the market for utilitarian cycling.

It will quickly become obvious that the majority of the discussion in this report centers on bicycling. This is due not only to the severe limitation on available walking data, but the virtual absence of analytic material oh why people walk. For the most part, walking will be folded into the discussion of non-motorized transportation even though the emphasis is on bicycling; when data allows otherwise, walking will be treated separately.

CHAPTER 1: THE INDIVIDUAL CHOICE TO BICYCLE OR WALK

Much of the bicycle literature which has emerged in the past two decades focuses on analyzing the factors which both stimulate and inhibit the growth of bicycling and walking as transportation options. In order to gain perspective on the subject and lay the groundwork for the data cited in subsequent sections, this chapter will begin with a brief review of the major factors which may affect the individual decision to bicycle or walk. A clear understanding of these factors is an essential prerequisite for designing policies which can tap latent demand for non-motorized travel.

The factors that influence an individuals travel mode choice can be classified under two major headings:

1. Subjective factors which have less to do with measurable conditions than with personal perception and interpretation of one's needs.
2. Objective, physical factors which exist for everyone, though they may not be weighed equally by everyone.

As will be evident, the distinction between objective and subjective at times can be murky, but it may be a useful division when considering policy options to remove barriers to non-motorized travel.

A. PERSONAL AND SUBJECTIVE FACTORS[2]

Distance: Although a measurable "objective" quality, individuals determine for themselves what distance is suitable for bicycling or walking and when it is a barrier to non-motorized travel. Individual differences may stem from physical condition, attitudes toward exercise, misperceptions of distance, as well as the kind of trip for which non-motorized travel is chosen. Individual variations aside, it is probably safe to assume that, all else equal, the farther one is from a destination, the less likely one is to prefer bicycling or walking. This well-established relationship has made distance a commonly used yardstick for defining a base market for non-motorized transportation. Defining such a market assumes average trip lengths are known. Ohrn (1976) argued that most purposeful bicycle trips would be less than two miles. Robinson (1981) corroborated this in finding that 90% of work trips taken by bicycle were 2 miles or less, as were 84% of other utilitarian trips. These findings in turn are supported more recently by a.

[2] Several of the general insights into mode choice in this section are traceable to Cy Ulberg's summary work for the Washington State DOT, "Psychological Aspects of Mode Choice." (1989).

Boulder, Colorado survey (1990) which found the mean bicycle trip was 2.1 miles. Other evidence suggests commute trips may be longer. Forester (1984) concluded that the average one-way bicycle commute trip was 4.7 miles. Deakin (1985), citing earlier works, stated that the average bicycle commuter traveled between 5 and 6 miles, but that the mean length for all bicycle trips was between 1 and 2 miles.

Traffic Safety: Most surveys report that traffic safety is the major factor deterring individuals from bicycle commuting (see page 19, "Deterrents to Cycling"). The issue, however, is a matter of perception as much as reality: Those who regularly cycle in traffic are not as fearful as non- riders.[3] But its importance cannot be diminished. Even the experienced cyclist chooses routes carefully, almost always considering traffic patterns, road conditions, and bikeway configurations first - the key ingredients in rating the safety of the route.

Traffic safety also is an important concern for some pedestrians, particularly children and older persons, though the extent to which such perceptions curtail walking trips remains unknown.

Convenience: Though not easily defined, convenience is regularly cited in travel surveys as a major factor in mode choice. It may well be a catch all for comfort, reliability, time spent traveling, or ease of access. or it may simply express the forces of inertia, or represent a rationale for ones current preference. Convenience was cited by many respondents as a factor in mode choice in recent surveys in Seattle, Palo Alto, and Tucson. At the same time, bicycle commuting is sometimes described as inconvenient, though that is seldom the primary reason for not cycling. Robinson found that motorists perceive the bicycle as much less convenient for errands than bicyclists do, suggesting that riding experience influences perceptions of the bicycle's convenience.

Cost: Though cost is cited as a reason for bicycling in many surveys in the last fifteen years, its importance as a factor is uncertain (see page 18, "Incentives for Cycling"). General mode choice surveys show that cost is rarely the chief factor in the decision. Research has shown that most drivers overlook or miscalculate a number of key components when estimating the cost of driving, suggesting that few people bother to carefully account for their transportation Costs.[4] moreover, the cost of operating a car remains relatively inexpensive for the individual, providing little

[3] Attitude Study for the Portland Metropolitan Bicycling Encouragement Program, Columbia Research Center, Vancouver, WA, 1982. Active bicyclists were found to be only half as likely as potential riders to cite danger as a reason for not bicycle commuting.

[4] Ulberg, p.20.

impetus for people to make careful cost comparisons with other modes. Indeed, if economic considerations really were a prime factor in mode choice, then one would expect much higher rates of walking and bicycling, since travel costs are near zero for walking and extremely low for cycling: a recent estimate put the cost of bicycling at roughly $0.05 per mile [5] as compared with $0.35 to $0.45 per mile for an automobiles[6]

Valuation of time: Travel time is of major concern to commuters, according to most surveys. Thus one who values time above all else might not perceive bicycling or walking as viable options. Everett (1983) argued that for most working people the perceived loss of time associated with bicycle commuting outweighs the savings derived from the low cost of operating a bicycle. As with cost, travel time is not always correctly calculated. The common perception is that bicycling involves sacrificing time, but this is not necessarily the case, given that bicycles are usually able to avoid or maneuver around traffic congestion which normally delays motorists. Just as direct travel costs often are discounted, potential time savings associated with nonmotorized travel are often ignored. For example, cycling or walking to work could reduce the need to devote free time to aerobic exercise.

Valuation of exercise: Data cited in the pages ahead reveals that exercise is one of the primary attractions of bicycling and walking. Therefore, it stands to reason that as the value one places on exercise increases, so should interest in cycling and walking. This premise led Everett (1974) to make attitude toward exercise a key component in determining the costs of bicycle commuting: for those who consider exercise important, the time costs associated with bicycle commuting were set at zero. However, a caveat is in order. Since exercise comes in many forms, it does not follow that utilitarian bicycling will be the chosen form merely because exercise is highly valued. If the perceived disadvantages of bicycling outweigh the perceived fitness benefits, then other forms of exercise would be preferred.

Walking is widely considered the most gentle form of aerobic exercise, which may explain why it is the most popular sport in America and one in which people of all ages participate. Data from Seattle and Ontario show that most everyone recognizes the health benefits of walking.

Physical condition: Some people, especially middle-aged and older people, believe they are physically incapable of bicycling and therefore dismiss it as a viable transportation option regardless of other benefits ascribed

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[5] Estimate provided by the Bicycle Federation of America.
[6] Your Driving Costs, American Automobile Association (AAA), 1991.'

to it. This may help account for the fact that cycling. declines steadily after the age of forty.

Family Circumstances: The transportation mode chosen by many individuals may be circumscribed by family needs, such as dropping off children at school, household errands conveniently done during the commute, the number of available vehicles, etc. If both parents work outside the home, carpooling is facilitated. Bicycle commuting simply may not be practical, even if one is inclined to favor this as a commute mode. on the other hand, if one drives and handles the Chores, the other is free to bicycle. Limited evidence suggests that adults with dependents are less likely to rely on bicycling for utilitarian trips, [7] though data on this subject is far too meagre to draw any strong conclusions.

Habits: Inertia exerts a powerful influence over daily habits, and travel is no exception. Without some very compelling reason, few are likely to change their mode of travel. Some psychologists believe that attitudes and perceptions are molded by behavior, rather than the other 'way around; thus habits may be self-reinforcing. Robinson noted that actual rates of purposeful bicycling lag well behind the proportion of those who profess to prefer it; similarly, surveys in Portland and Seattle show strong levels of abstract support for utilitarian bicycling, but modest levels of actual usage for such trips.

Attitudes & Values: Those who regularly use the bicycle for purposeful transportation may be driven to do so by a set of values not shared by the majority. Exactly what these values are is unclear, since studies systematically examining value differences between motorists and non-motorists are absent from the literature. A stronger identification with public concerns may account for some of these attitudes. For example, survey data from cities in the Pacific Northwest suggest that a high degree of environmental awareness is correlated with utilitarian bicycling (see page 18, "Incentives for Cycling"). It should be noted, however, that such sentiments are seldom cited as the primary reason for bicycling. Limited evidence suggests the same may be true for pedestrians: less than 1% of respondents in a recent Seattle survey identified environmental concerns as the primary reason for walking.

Peer Group Acceptance: While evidence shows that recreational bicycling is widespread, utilitarian bicycling is deemed inappropriate among certain professions and social

7 Kocur, G., Hyman, W., & Aunet, B., "Wisconsin Work Mode-Choice Models Based on Functional Measurement and Disaggregate Behavioral Data," Transportation Research Record 895, 1982. The authors discovered in the course of conducting focus groups on bicycle travel that many women would under no circumstances take up bicycle commuting due to errands and child reading.

sets. Some people dismiss the bicycle as a toy. Though evidence for this is largely anecdotal, the oft-mentioned claim that "dress requirements" eliminate the bicycle commuting option is essentially a rationale for conforming to group norms. Much work remains in determining the effect of peer group travel habits on individual mode choice.

B. OBJECTIVE FACTORS

1. Environmental

Climate: Though weather is regularly mentioned in bicycle surveys as a factor in the decision to bicycle or walk, it is best viewed as a seasonal or day-to-day factor in travel decisions. Pinsof (1982) noted that weather was often mentioned spontaneously when transit users were asked about frequency of bicycling to a station. Both Ohrn (1974) and Hanson (1974) concluded that weather is a greater deterrent for fixed schedule journeys, such as the work commute, than for discretionary trips. Evidence suggests that precipitation is probably the most important climatic factor [8] Buckley (1982) found substantially more cyclists out when the weather was partly sunny than when it was foggy with light rain. Daily bicycle counts on the West Seattle Bridge over the course of two years (1990 - 1991) showed steep declines in ridership during the rainy season. It seems virtually certain that fewer bicycle trips will be made during inclement weather. Therefore, all else being equal, localities with milder, dryer climates should be able to generate more bicycling trips over the course of a year. However, there is no evidence that climate circumscribes the overall market potential for bicycling.

Data collected three years ago in Ontario, Canada suggests that weather also may be a deterrent for some pedestrians.[9] More than one-third of Ontarians stated that when the temperature is above 300 centigrade (860 F), they do not walk, and about 40% reported they will not walk when the temperature gets below -20 C (-40 F). Precipitation is an even greater impediment to walking: About 70% said that hard rain prevents them from walking; 40% said that heavy snow has the same effect. However, in a recent Seattle survey only about 9% identified weather as a reason for not walking more often.[10]

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[8] Ashley, C., & Bannister, C. "Cycling to Work from Wards in a Metropolitan Area," Traffic Engineering and Control, June 1989. In this study, precipitation - defined as the number of days in a year with at least 2.5mm of rainfall-showed a significant correlation with levels of cycling. A decade earlier, in its Bicycling and Air Quality Information Document, the EPA concluded that precipitation was a more important variable than temperature.
[9] Hawthome, W., Why Ontarians Walk, Why Ontarians Don I Walk More: A Study into the Walking Habits of Ontarians (Energy Probe), Toronto, 1989.
[10] Unlike the Ontario survey, Seattle residents were not asked specifically about the effect of weather on their walking habits, but generally about reasons for not walking more often.

Topography: Intuition tells us that hills are a potential deterrent to cycling, particularly utilitarian cycling, for the following reasons: Because climbing hills is more strenuous than pedaling on flat terrain, riders must be in better physical condition; moreover, hilly terrain can leave the rider in a relatively sweaty state, lessening the appeal of bicycle commuting for some people. Though serious research on this topic is extremely limited, a study of metropolitan commuter cycling in England revealed a strong negative correlation between hilliness of the district and the level of bicycle commuting.[11]

2. Infrastructural Features

Presence of Bicycle Facilities & Traffic Conditions: Numerous studies in the past twenty years have asserted that the inclusion of bicycle-friendly features on or along major through streets is of extreme importance in creating functional bicycling routes for utilitarian trips.[12] Hence the design And location of bikeways will significantly affect subjective perceptions of safety (as will the provision of such supporting facilities as traffic signals cued-by bicycles, proper lighting, smooth railroad crossings, and suitable drainage grates).

Access & Linkage: In virtually every city in the country, even those with a reasonably sophisticated system of bicycle facilities, certain districts are very difficult, if not impossible, to reach by bicycle. Tunnels, bottlenecks, and bridges can make safe passage extremely risky or impossible, often restricting travel options between important centers. Yet all of these barriers can be overcome with sensitive designs. Equally important is route linkage. Many wonderful bicycle facilities exist around the country, but rare is the city with a network of bicycle facilities as fully linked as is the typical network of streets available to motorists across the country. In most cities bicycle facilities are either concentrated in a few areas or spread across the region with no formal links between them. Fragmented bikeway systems constitute a serious impediment to utilitarian bicycling.

Transportation alternatives: The decision to bicycle or walk must be viewed within the context of a given region's transportation picture and the choices available to an individual. In some cases bicycling or walking are two of several possible ways to reach a destination. For others, however, subjective choice may very well be a product of absolute choice: in many areas of the country where

[11] Ashley,, p.301.
[12] Everett (1983), Lott (1978), Robinson (1981), Kocur (1982) all maintain that the provision of bicycle facilities, especially bicycle lanes, probably is a major factor in stimulating utilitarian bicycling.

population densities are low, driving is the only option for utilitarian trips since distances are great and public transit systems, if existing at all, generally provide limited service. Perhaps more importantly, a very high proportion of Americans own or have access to cars. With a fair degree of consistency, studies have shown that access to an automobile is highly correlated with the choice of it as a travel mode. This suggests that the limited reliance on non-motorized travel may have less to do with negative perceptions of these modes than with the ever-widening availability of cars: studies now indicate that there are 1.1 vehicles for each licensed driver in the U.S.[13]

C. FACTORS SPECIFIC TO WALKING

Most of the factors outlined above also hold true for walking. Distance is almost certainly the key factor limiting utilitarian trips, perhaps even more so than for bicycling because it is a much slower travel mode. (Walkers can cover 3 or 4 miles in an hour at an moderate pace whereas average bicyclists pedal at a rate of 10-12 mph). Though distance is a subjective factor in mode choice, evidence indicates that walking trips are predominantly short. When asked what they considered the maximum distance suitable for walking on errands, 40% of Seattle residents reported one mile or less and 70% reported two miles or less, with the mean being 2.1 miles.[14] ontarians were asked how many minutes they would be willing to walk on errands and to work. The average for both trips was a bit over twenty minutes, which translates to about 1.25 miles. Through measurement of actual trips, Robinson found that 80% of walking trips were under I mile and 94% were under 2 miles, which more or less corroborates the Ontario findings. This variance between actual and predicted behavior could stem from one of the following explanations: 1) Willingness to walk X miles (or minutes) on paper in no way determines which trips a person will actually decide to walk; 2) People tend to overestimate the mileage they are willing to walk, or actually miscalculate the distance they do walk, believing it to be farther than it really is.

Both climate and topography affect walkers in essentially the same way they affect bicyclists, though rain perhaps is easier to cope with as a pedestrian. Access to other modes (especially a car) creates a similar disincentive to walk. On the other hand, by comparison with bicyclists, traffic safety is a localized barrier. Still, survey data suggests that certain aspects of the pedestrian environment may affect the decision to walk:

[13] "1990 Nationwide Personal Transportation Study, The Urban Transportation Monitor, Sept. 1991.
[14] The standard deviation was 1.8 miles, indicating the wide range of responses.

Presence of sidewalks: Suburban areas and neighborhoods on the edge of cities often lack sidewalks. Not surprisingly, walking appears to be less common there than in central cities, even though many utility trips in suburbs are short enough to be handled on foot. [15] Limited survey data indicates that the presence and quality of sidewalks is of concern to some people, though the extent to which this affects the individual motivation to walk is unknown.

Traffic Signals and Pedestrian crossings: Absence of crossings on major arterials or poorly timed signals can impede access for some pedestrians. Wide roads combined with high traffic speeds, heavy vehicle volumes, and free right turns can be impossible to cross, particularly for children and the elderly.

Availability and Presence of Services: In cities with populations greater than one-hundred thousand, it is not uncommon to live at least a half-mile from a supermarket or pharmacy. Such distances tend to grow as one moves away from the city center. Zoning which separates commerce from residential districts makes even the most basic shopping relatively long, and thereby less likely to be done on foot. Mixed zoning and higher density shrink distances between residential neighborhoods and services, thereby enhancing the feasibility of walking.

Street Lighting: In many urban neighborhoods, crime is a powerful disincentive to walking, particularly for women. Better lighting is viewed as a way to bolster security; the reduction of crime would be even better.

Attractive Places to Walk: The slow pace of walking allows one to take in much more of the surrounding environment. Thus features which are appealing to the senses will make walking a more attractive option: Park trails, greenery, landscaping, water, expansive views, architectural diversity, historic preservation, and a concentration of activities (e.g. open-air markets) have been identified in survey s as helping to make walking appealing.

[15] A comparison of suburban and inner city neighborhoods by the Chicago Area Transportation Study illuminates this point clearly; though data is limited, it is almost conventional wisdom for many urban transportation planners and analysts.

D. CURRENT LEVELS OF BICYCLE USAGE: WHAT SURVEYS REVEAL

Before exploring further into the reasons non-motorized forms are chosen or avoided, current usage from an individual standpoint must be examined by focusing on some basic issues: demographics of riders and walkers, trip purposes, and perceptions of each mode. In doing so, some of the survey data collected in the past fifteen or so years from various areas of the country will be discussed.

1. Who Bicycles?

America has millions of bicyclists. Exactly how many depends on whether one is measuring bicycle ownership or frequency with which people ride. Estimates for adult cyclists range from 48 million (BIA, 1990) to 70 million (Bicycling Magazine 1991). At least two demographic variables appear to be correlated with bicycle usage: Sex and age.

% of All Adult Cyclists by Sex of Respondent

	Harris Poll	BIA	NPTS 1990	FHWA RD-80[16]	Portland	Santa Barbara	Vancou-verBC	Phoe-nix	Se-aftle	Boul-der
Male	57%	45%	75%	67%	55%	62%	70%	56%	54%	68%
Female	43%	55%	25%	33%	45%	38%	30%	44%	46%	32%

% of All Adult Bicycle Commuters by Sex of Respondent

	Harris Poll	Seattle	Portland
Male	60%	52%	76%
Female	40%	48%	24%

In all but one survey male riders outnumber females, whether we are speaking of riding for recreation or transportation. The difference is even greater if we are specifically talking about bicycle commuting. The cause of this disparity is unknown, leaving room for speculation.

[18] Barton - Aschman Assoc., Feasibility of Demand Incentives for Non-Motorized Travel, Final Report No.FHWA/RD-80/048, Washington, D.C. Federal Highway Administration, U.S Department of Transportation, 1981.

Age:

% of All Adult Cyclists By Age of Respondent [17]

Age Group	Harris	Age Group	Seattle	Boulder
18-29	39% (67%)	16-25	12%	43%
30-39	26% (24%)	26-35	30%	22%
40-49	17% (5%)	36-45	30%	13%
50-64	11% (5%)	46-55	13%	10%
		66-65	6%	6%
		65 & older	7%	7%

A rather intuitive pattern emerges with respect to age and frequency of bicycling: it declines. It should be noted that the decline is not necessarily steady from the age of 18; some evidence shows that cycling becomes more popular for those in their mid-twenties. Nonetheless, in all cases at least two-thirds of cyclists were under the age of 45; the age bias for bicycle commuters is even more pronounced, the decline being precipitous after the age of 45. These results hold true whether the data was collected in the 1970's or in 1991.

Income:

Income data are a bit more difficult to interpret because they are not easily separated from age and education. Data 'from the Harris Poll suggests a fairly strong correlation between income and work trips made by bicycle, as does the somewhat more aggregated data from the Portland study.

% Commuted By Bicycle in Previous Month By Income: 1991 Harris Poll

$7,500 or less	$7,501-$15,000	$15,001-$2p,000	$25,001-$35,000	$35,001-$50,000	$50,001 & Over
23.1%	14%	5.7%	6.7%	1.1%	7.2%

Portland Attitude Study (1982)

Income Level	% Active Riders
Less than $25,000	69%
More than $25,000	31%

As expected, it appears that lower income groups bicycle more than higher income people. The only surprise is that those in the highest income class surveyed for the Harris

[17] Each of the surveys had a slightly different approach to defining what constitutes a bicyclist, ranging from bicycle ownership to some specified riding frequency. Parenthesized figures in Harris Poll are specific to bicycle commuting. Seattle figures represent bike ownership.

Poll should be such avid cyclists. There are several possible explanations for this: one is that members of this income group are better educated, and thus recognize the merits of cycling from a physical fitness perspective; another may simply be that high income households are better equipped to cycle: They probably own more and better bicycles, providing an incentive to ride. Indeed, the same poll showed that those in the $50,000 and up income bracket were more likely than any other income group to have ridden a bicycle in the previous month, regardless of the purpose. This suggests that the confounding effects of several variables must be taken into account. A recent analysis of travel behavior based on data drawn from several large transportation surveys in Orange County, California did just that - and showed that virtually no correlation at all exists between bicycle commuting and household income.[18]

2. Bicycle Trip Purposes

In order to realistically gauge the potential for bicycle commuting across the entire population, it is essential to consider the purpose of bicycle trips taken by active cyclists and then examine the reasons the bicycle is chosen for such trips.

% of Active Bicyclists By Trip Purpose

Purpose	Harris Poll	NPTS[19]	Phoenix	Port land	Seattle	Pennsyl vania[20]	Madison
Work	7.0%	10%	11%	12.2%	14.3%	6%	N/A
School	N/A	14%	N/A	2.8%	N/A	6%	N/A
Utility[21]	N/A	20%	54%	26.1%	24.1%	18%	23%
Recreation	75.8%	55%	84%	95.6%	90.8%	70%	63%

By and large, the data provide unambiguous evidence that bicycling is overwhelmingly considered a recreational pursuit. Only one point needs clarification. The

[18] McKeever, Quon, and Valdez, "Market-Based Strategies for Increasing the Use of Alternate Mode Commutes" presented at TRB 70th Annual Meeting, 1991.

[19] National Personal Transportation Survey, 1990. The figures represent the relative proportion of all trips, rather than the percentage of cyclists using the bicycle for the listed purposes, which explains why recreational bicycling appears less popular.

[20] The figures for Pennsylvania were drawn from the EPAs 1979 *Bicycling and Air Quality Information Document*, which cited a study from this location. The data is from the mid-1970's.

[21] 'Utility' is defined here as any trip that is neither a commute nor a pleasure trip, with the exception of Madison. In this case, it refers to all bicycling for transportation. Unfortunately, the Madison data was limited to three categories: Transportation, recreation, or both; thus commute trips are lumped together with other utilitarian trips. Other data cited in the next chapter suggests that a fairly high percentage of utility trips are commute trips to work or school. The NPTS figure for 'utility' is the sum of the percentage of trips taken for shopping and family business.

Pennsylvania data unlike the other regional data, were drawn from a statewide sample of bicyclists, which therefore includes small towns and rural areas. Though this data was collected about 15 years earlier, the proportion of commuter cyclists is very close to the level found in the recent national Harris Poll.

Though bicycle usage for utilitarian trips is far less prevalent than recreational riding, data drawn from the above cited Portland Survey suggests that the bicycle is nonetheless perceived as much more than just a recreational vehicle, hinting at a much broader potential:

% of Active Cyclists Using Bicycle for the Following Purposes vs. % of All Respondents Deeming the Bicycle Appropriate For Such Trips [22]

Purpose	Bicycle Use: Active Cyclists	Believe Appropriate for Bicycle: All Respondents
Work	12.2%	87.6%
School	2.8%	95.6%
Utility	26.1%	82.5%
Recreation	95.6%	99.5%
Shopping	N/A	49.7%

Though active cyclists do not use the bicycle primarily as a commuter vehicle, the overwhelming majority of survey respondents (which includes many non-cyclists) regard the bicycle as a commuter vehicle. In fact, with the exception of shopping,[23] the bicycle is considered suitable for most purposes by nearly all the respondents. Indeed, support for bicycling appeared particularly strong in the recently completed Seattle survey. Seventy-four percent of all respondents agreed that more should be done to encourage bicycling. This highlights a curious tendency suggested in many attitudinal studies of alternative transportation: **High levels of abstract support for cycling belie the fact that in most places, only a small minority choose to use a bicycle for transportation on anything resembling a regular basis.** Indeed, one group of researchers asserts that "of all modes, the bicycle is the only one for which preference is consistently greater than choice. This is true regardless of the current level of bicycle use, or the purpose of the trip."[24] The nature of this discrepancy is the next subject to be considered.

[22] Attitude Study for the Portland Metropolitan Bicycling Encouragement Program, pp.12&26.
[23] The author attributes the lower level of support to The difficulty in carrying packages." Ibid., p.11. [24] Robinson, p.50.

3. Incentives (Reasons) for Cycling

An integral part of most mode choice surveys is ascertaining why people choose the transportation modes they do. In the case of bicycles, the reasons cited by active cyclists for choosing to bicycle, regardless of purpose, bear heavily on whether or not they would also consider bicycle commuting. The table below purports to show what influences the decision to bicycle.[25]

% Indicating the Following Reasons Influencing Decision to Cycle

Reason	Portland	Eugene	Vancouver	Tempe	Seattle
Exercise	72%	71%	85%	30%	42%
Enjoyment	58%	49%	83%	37%	6%
Environment	52%	41%	N/A	5%	15%
Cost savings	37%	45%	54%	12%	2%

For the most part, the reasons cited in this table corroborate the data on trip purposes discussed above: recreation (i.e., exercise and enjoyment) once again comes out on top of the reasons bicyclists choose to cycle. Cost savings is mentioned frequently in several cities which seems odd given that most riding is for recreational, rather than practical purposes. Assuming that economics is not necessarily the prime motivator of mode choice, then it stands to reason that under current conditions, economics is unlikely to motivate a great many people to take up bicycle commuting. This being the case, utilitarian bicycling probably will have to be perceived as a form of recreation before it achieves widespread popularity.

4. Factors Influencing the Choice of a Commute Mode

Are the reasons that bicyclists use this travel mode the same as those which motivate non-bicyclists to choose their modes? Direct comparisons are virtually absent from the literature, but it is important to review the considerations that dominate mode choice in general. By doing so we can get some idea whether the positive features associated with the bicycle in any way match what people expect from a travel mode. Since most travel data surrounds the work commute, that will be the focus of this brief digression.

A handful of surveys reviewed for this report asked respondents what factors they considered in choosing a commute mode. Although the numbers are not strictly

25 The language used in each of these surveys varied slightly, so for simplicity's sake I have collapsed some of the reasons into broader categories. For example, 'energy' and 'pollution' have been joined under 'environment'. The data for Eugene and Tempe were taken from the previously cited EPA document; the data for Vancouver was drawn from "Cycling and Cyclists in Vancouver," and the Portland numbers are from the previously cited study.

comparable due to differences in survey methodology, a few patterns are evident across surveys:[26],

Reasons for Choosing Commute Mode

Factor	Tucson	Seattle	Orange County, CA	Palo Alto
Travel Time	17.4%	13%	49%	
Convenience	11%	40%	42%[27]	44%
Work Schedule	14.7%	7%@		
Need car for work	8.8%	14%	26%	11%
Need car - other	10.8%	7.8%	46%	
No one to carpool with	14%	4.6%		
Cost	8.7%	9.7%	25%	8%
No alternative	3.2%	5.8%	11%	33%
Distance	3%	3.5%		
Exercise; health	1.1%	3.5%		
Environmental concerns	1.4%	4.3%	9%	4%

Several important trends are indicated by the above table. The first to note is that those things most widely associated with bicycling --- exercise, recreation, And environmental protection are far from the minds of most commuters. Conversely, the things which inspire commuters in their mode selection - travel time, convenience, the need for a car during the day - are not advantages ordinarily associated with bicycles. Cost - a factor clearly favoring the bicycle - is mentioned by less than 10% of respondents in three of the four sources cited above, suggesting it is of secondary importance in the selection of a commute mode.

5. Deterrents to Cycling

Major barriers exist which deter the great majority of people, including active cyclists, from using the bicycle as a regular means of transportation. Many of these barriers have been identified through numerous surveys over the last fifteen years; the data again and again point to the same concerns. Below are some of the major barriers identified across different surveys when all respondents are asked to name, or select from a given list, the factors which influence their decision not to bicycle: [28]

[26] The terminology used in the response categories varied slightly between surveys, but was easily aggregated for this table. The Palo Alto survey apparently allowed respondents only one reason, which explains the paucity of categories and the fact that they add up to 1 00%. It should be noted that the responses listed here only are the most common ones. Sources are as follows: Tuscon:"Travel Reduction Program Validation Study," (Behavior Research Center, Phoenix) 1991; Seattle: "Seattle Engineering Department Bicycle and Walking Phone Survey," 1991; Palo Alto: "Staff Report on the Downtown Transportation Coordination Program," 1988.

[27] In "Market-Based Strategies...... the closest category to 'convenience' was phrased "not having to depend on others."

[28] One may reasonably question the statistical comparability of this data, but the purpose merely is to observe the trends. Though the factors listed in this table vary slightly from survey to survey in terms of language, they comfortably fit into the categories as I term them.

% of All Respondents Citing Factor as Influential in Decision Not To Cycle[29]

Factor	Boston	Gainesville	Portland	Vancouver
Traffic safety	53%	73%	55%	35%
Adverse weather	86%	90%	52%	51%
Inadequate parking	65%	22%	29%	23%
Too slow	N/A	45%	35%	N/A
Road conditions	52%	N/A	36%	24%

Not unexpectedly, the concerns surround perceived physical limitations of the bicycle and the inadequacy of facilities. These are the most common complaints among bicyclists in general. But when active bicyclists are asked specifically about bicycle commuting, some new elements emerge. Several surveys asked respondents why they don't ride a bicycle to work. [30]

% Active Bicyclists Citing Following Reasons For Not Bicycle Commuting

REASON	Phoenix	Seattle	Portland	Orange Couty
Too far to ride	31%	41%	21%	45%
Too dangerous	19%	22%	12%	N/A
Lack of facilities[31]	17%	15%	12%	N/A
Need car for work	14%	8%	N/A	7%
Inconvenient	6%	8%	17%	4%
Weather	N/A	11%	7%	N/A

Asking directly about barriers to bicycle commuting as opposed to bicycling in general brings out a new --- and crucial - factor: distance.
Faced with riding a fixed distance, under time constraints and work requirements, with road conditions far from ideal for the majority, most riders opt out of bicycle commuting.

The above survey responses by no means comprise a complete catalogue of all factors cited in the various surveys, but

[29] Data sources: Boston Area Bicycle Project (Central Transportation Planning Staff, Boston); Gainsville, 'The Second Most Frequent Mode of Transportation", Planning, Design, and Implementation of Bicycle and Pedestrian Facilities. (Caine and Siegel). These two sources were cited in EPA's Bicycling and Air Quality Document. Portland: Attitude Study .. Encouragement Program; Vancouver, Cycling & Cyclists in Vancouver.

[30] In three of the four surveys, the questions were open ended and phrased almost identically, making the results moderately comparable. In the fourth (Orange County), all respondents were asked their reasons for not wanting to consider various alternate commute modes. Caution, however, must be taken in comparing the actual reported percentages from surveys conducted under different circumstances and via different methods. Once again, this table is indicative of trends and no more. 31 This includes showers, parking, bicycle and related equipment, and proper routes. In the case of Portland, the response 'too sweaty" was treated as a call for shower facilities.

they are the most common by far. Other items sometimes cited include:

- -Too much physical exertion
- -Fear of crime
- -Lack of bicycle routes
- -Inconsiderate drivers
- -Inability to bring bicycle on bus

All in all, available survey data point to one clear fact: with a few notable exceptions, bicycle commuting continues to play a minor role in the commuter transportation scheme. Only 1 in 60 Americans use bicycles to get to work.[32]

6. Inducements to Bicycle Commuting: Survey Results

A somewhat different approach has also been employed to find out why bicycles are not more widely used as transportation. Rather than being asked to identify the barriers to increased cycling, respondents are asked (or asked to select from a list) what improvements would encourage them to ride a bicycle to work. It is well worthwhile to compare the results from several recent surveys:

Bicycling Magazine Harris Poll[33]

Improvement	Active Riders	% All Adults
Safe Bike Lanes	49%	20%
Financial Incentives	44.5%	18
Showers & Storage	43.5%	17%
Rise in Gas Prices	38%	15%

[32] Bicycling Magazine, April 1991, #44

[33] The question, asked only of active cyclists who had ridden a bike in the last year, but had not commuted during the previous month, read: "Do you think you would sometimes commute to work by bicycle if there were...?" The column on left shows percent of actual respondents; on the fight is the projected figure for the entire population.

Regional Surveys

Improvement	Davis	Seattle	New York[34]
Safer Routes[35]	11.7%	41%	1%
Shower Facilities	9.4%	5%	3.1%
Improved parking	11.9%	4%	0.9%
All above improvements made	N/A	N/A	28.3%
Nothing could encourage	37%	37%	72.7%

The Harris Poll furnishes the most optimistic assessment of commuter bicycling. Even economic incentives could produce a shift to bicycle commuting, suggesting it is a much more powerful factor than other mode-choice studies reveal. That each of these improvements standing alone could produce such large shifts to commuter cycling casts doubt on the effectiveness of this survey methodology in simulating the mode choice process. (see Chapter IV)

A fair degree of correspondence exists between the commonly identified barriers to bicycling and the improvements which are cited in all of these surveys. But the proportion of bicyclists who say that infrastructural improvements such as bike lanes, secure parking, and shower facilities at work might inspire them to bicycle commute varies sharply by survey and region. Safer bicycle facilities or routes provides an interesting comparison by region. The results of the Seattle survey most closely echo the Harris Poll, suggesting that the lack of safer bicycle facilities is holding back growth in commuter bicycling. For Davis, where bike lanes are a well-established feature of the street system and bicycle commuting is a widely accepted commute mode, safer routes would lead to a notable, but not staggering increase in bicycle commuting, since most of those likely to bicycle commute are probably doing so already. In New York, on the other hand, the quality of the bikeway alone is of importance to very few people. Indeed, no single feature seems to inspire interest among those working in Manhattan, though when combined into a package, a sizable portion of the sample found bicycle commuting enticing. Still, New Yorkers were by far the likeliest to say that nothing could encourage them to bicycle commute.

Another section from the Seattle survey provides more evidence that people believe inadequate facilities are the key impediment to expanding ridership. When respondents

[34] The data is derived from a Manhattan employers' survey which was part of a study called "Improving Manhattan Traffic and Air Quality Conditions. "It is not clear from the survey description whether this question was posed of all respondents or only those who own bicycles. Judging from the data, one suspects the former. In the Davis and Seattle surveys, this question is reserved for bicyclists who do not bicycle commute.

[35] As the alternatives or responses were slightly different for each city, this includes all road/bikeway improvements pertaining to safety.

(bicyclist and non-bicyclist alike) are asked to rank three sets of policy options in order of importance, improved facilities easily comes out on top:

Importance of Policy Options to Increase Bicycling

Policy Option	Most important	2nd	3rd
Expand/Improve Facilities	67%	17%	16%
Educate Cyclists & Motorists	21%	45%	34%
Enforce bicycling traffic laws	19%	35%	46%

Assuming the notion that facilities will affect ridership is correct, a significant question emerges. Would any one of these major improvements alone increase ridership at any level approaching what the surveys suggest, or are they best considered as an integrated package? The Manhattan survey responses certainly suggest that they be viewed as a package of improvements. Indeed, the improvements listed above have the appearance of a well-coordinated program. For example, what good would it do to build safer bicycle routes designed to increase commuter cycling without increasing and improving bicycle parking facilities? Or does it make sense to require shower facilities in office buildings unless bikeways can safely bring workers to the building? Why struggle to find a secure place to store one's bike when an employer provides inexpensive or free parking for a car? The obvious conclusion is that **no single improvement will be sufficient to attract all potential bicycle commuters to cycle, and that some sort of integrated approach is the best bet for stimulating mode shifts. Moreover, the relative importance of various improvements will depend heavily on local conditions and variables**.

This "package" approach was explored in a major study completed in 1981 for Federal Highway Administration.[36] The goal was to determine what type of demand incentives would stimulate mode shifts to either bicycling or walking. Over four thousand surveys were returned from the five widely disparate cities chosen for the study. The central purpose was to measure the change in preference for walking or cycling in response to the hypothetical implementation of four different scenarios or strategies, which are as follows:

- **Provision of improved bicycle and pedestrian facilities**: This would include bike lanes, sidewalks and ancillary facilities.
- **Implementation of a "congestion fee:**" This would discourage vehicular traffic in downtown areas during peak periods; flexible work hours were also tested concurrently with the fee strategy.

36 Robinson et.al. Feasibility..for Non-Motorized Travel, FHWA/RD-80/048

- Compact land use: Encouragement of self-contained development where trip generators are in close proximity to each other and separate facilities for non-motorized travel. Lowered speed limits and a reduction of parking space were included in a variation on this strategy.
- Increased fuel prices: This was tested alone as well as in conjunction with the other strategies.

The respondent was asked to read a statement explaining each scenario and then rank the four modes under consideration (auto, bike, transit, and walk). The findings are quite revealing. Below is the list of strategies in order of greatest impact on the preference to cycle:

Strategy	**Cycling to work**	**Cycling to shop or for personal business**
Compact land use	33%	29%
Improved Bicycle Facilities	18%	21%
Congestion fee	16%	19%
Fuel price increase	14%	13%
Preference Levels at time of survey	7%	7%

The concept of compact land use easily produced the greatest shift in preference from the automobile to bicycling (and walking). Facilities alone would stimulate a much smaller shift, supporting the supposition that cycling must be integrated into the environment in a more pervasive fashion for it to become a significant travel mode. The fact that the two economic levers appear to promote the smallest mode shift corroborates the view that financial disincentives alone will only have a limited impact on the switch to nonmotorized travel modes. It is particularly noteworthy that the fuel price increase scenario produces a level of commuter cycling almost identical with that found in the national Harris Poll (15%), conducted ten years after this study. Coincidentally, both surveys were conducted shortly after major increases in the price of oil due to events in the Mideast. One would suspect that in the wake of these events respondents would be more likely to consider bicycle use as a serious transportation option than in ordinary (i.e., cheap gas) times. That suggests the projected mode switch attributable to higher fuel prices may be either
1) fairly accurate, given that events had already placed fuel prices at the forefront of the collective conscious, or
2) too high, for approximately the same reason -- fears of a serious oil shortage may find more people *considering* alternate modes of travel than would the mere threat of higher gas taxes. Nonetheless, it is noteworthy that similar hypothetical situations in surveys a decade apart produced nearly identical results.

According to the authors, the compact land-use scenario contained two complementary elements which explain the substantial shift in preferences: 1) Acceptable distances for bicycling, and 2) bicycle facilities separated from motorized traffic. The latter fully supports the numerous survey findings that identify traffic safety as the leading barrier to greater bicycle use; in this regard, the policy implications are straightforward. The former, however, suggests that certain geographic realities may interfere with the widespread acceptance of bicycling as a means of .transportation. That will be the subject of Chapter II in which the state of cycling across the country will be explored.

E. WALKING & THE INDIVIDUAL: PURPOSE, BARRIERS, & INCENTIVES

In general, very little is known about the walking habits of individual Americans, particularly walking for transportational purposes. However, recent surveys conducted in Ontario, Canada and Seattle[37] have uncovered some interesting patterns. Key findings from both surveys are worth reviewing:

1. Trip Purpose

% of Respondents Who Walk for Following Trip Purposes

Trip Purpose	Seattle	Toronto	Ottawa
Recreation	78%	91%	91%
Errands	81%	47.1%	48.7%
Daily commute	6.7%,	8.1%	11.4%

Walking Frequency by Trip Purpose: % of Respondents
(Seattle only)

Trip Purpose	Seldom	Occasionally	Often
Recreation	13%	36%	50%
Errand	13%	36%	51%

Clearly, walking is a recreational activity many Seattleites and Ontarians enjoy. If there is any surprise here, it is the high level of utilitarian walking reported. An overwhelming majority of Seattleites claim to walk on errands, whereas less than 10% of all survey respondents do so by bicycling; similarly the percent of those walking to work is more than twice that of bicycle commuting. Ontarians show a similar preference for walking over bicycling.

[37] The "Seattle Bicycling and Walking Survey" consisted o phone interviews with 301 randomly selected respondents; the data in Why Ontarians Walk, Why Ontarians Don't Walk was derived from a written questionnaire randomly mailed to residents of Toronto, Ottawa, and Thunderbay, Ontario. Only 321 surveys were completed; thus, the sample is self-selecting, suggesting a possible bias.

2. Reasons for Walking

% Respondents Identifying Following Reasons for Walking[38]

Reason	Seattle	Toronto	Ottawa
Exercise, health	63%	23%	29%
Enjoyment	39%	'20%	24%
Close to destination	15%	N/A	N/A
Avoid driving hassle	11%	12%	18%
Avoid transit hassle	N/A	9%	14%
Save on transportation expenses	N/A	6%	13%
Save on parking expenses	N/A	7%	11%

Just as with bicycling, exercise and enjoyment are the two primary reasons for walking, regardless of the trip purpose. Other reasons identified are highly practical and seem to suggest that disincentives and costs associated with driving can inspire some individuals to walk. Indeed, the Ontario walking study found that 25% of Toronto residents and 35% of Ottawans claimed that their walking habits are influenced by the cost of other modes and that these people are more likely to walk to work. Though this appears to contradict evidence cited earlier that cost is not a major factor in mode choice, it may simply be that local variations in transportation options and related policies can affect the strength of this relationship.

3. Reasons for not Walking

Much can also be learned by examining the reasons people choose not to walk. As the table below indicates, some of the same impediments were identified both by Seattleites and Ontarians.

[38] In Seattle, this question was asked of all walkers, regardless of purpose. In Ontario this was asked only of those who walk to work. This helps explain some of the variation in the response categories.

% Identifying Reason for not Walking

Reasons for not walking	Seattle	Toronto	Ottawa[39]
Distance	33%	47% (45%)	56% (43%)
Too slow; takes too long	14%	12% (26%)	14% (24%)
Weather	8.7%		
Dislike walking; lazy	6.4%		
Difficult to carry things	5.7%	50%	48%
Inconvenient	5.7%		
Fear of crime	3.3%		
No time	2.0%		
Darkness	1.7%		
No sidewalks	1.3%		

Paralleling attitudes toward bicycle commuting, distance is identified by a majority in ontario and a sizable minority in Seattle as the primary reason for not walking more often.[40] The primacy of distance in the choice of walking as a travel mode is also corroborated by Robinson. Walking like bicycling, receives the most attention when associated with shorter distances as in the compact land use strategy:

% Preferring to Walk Under Various Scenarios

Strategy	Walking to work	Walking to shop or on personal business
Compact land use	34%	45%
Improved Walking Facilities	30%	33%
Congestion fee	18%	28%
Fuel price increase	16%	25%
Preference Levels at time of survey	14%	18%

This study also concluded that major enhancements in walking facilities would also change the preferences of a great many people in favor of walking. But what constitutes "improved" walking facilities? The scenario presented to respondents included: Pedestrian pathways, improved sidewalks, better lighting, and pedestrian-oriented traffic signals. It also included improved landscaping and stands along the walkways. In other words, the walking environment would be enhanced.

The Ontario study indirectly addressed this same question by asking respondents to rate the degree to which they liked or

[39] Parenthesized figures pertain specifically to work commute; other data from Ontario specifically pertain to non-commute utilitarian trips, which may explain the high proportion identifying the limitations of walking and carrying things. Equally significant, Ontarians were given a written list of items to choose from; Seattleites were asked an open-ended question on the phone.

[40] Distance was also the main reason identified by McKeever, Quon, and Valdez in "Market-Based Strategies...." As in Ontario, 45% of southern Californians identified distance as the main reason for not walking to work.

disliked aspects of the pedestrian environment. The following were identified as the most likeable features (listed in order of popularity):

- Trees and landscaping
- Parks, open space
- Quiet streets and sidewalks
- Shade on hot days
- Historic buildings/neighborhoods
- Safety from crime
- Benches, places to rest

As a group, these features are entirely compatible with the scenario developed by Robinson, suggesting that an integrated set of improvements might encourage more walking.

ontarians also identified several unappealing qualities in the pedestrian environment (listed in order of importance):

- Air pollution/car exhaust
- Litter and garbage
- Dangerous street crossings
- Traffic noise
- Poorly maintained sidewalks
- Skateboarders on sidewalks
- Panhandlers
- Cyclists on sidewalks

Both the appealing and unappealing qualities of walking identified by Ontarians hint at the importance placed on green, clean, and safe environments for walking, and the negative role played by the automobile in this equation. Still, the extent to which any of these negative qualities actually prevents walking trips is unknown.

A slightly different picture emerges when Seattleites were asked (without any choices suggested) what would encourage people (not just themselves) to walk more often.[41] The results reveal a mix of social and environmental concerns:

[41] The exact wording of this question read: 'What, if anything, can or should be done to encourage more walking?"

% Believing Following Changes Would Increase Walking

Suggested action	% of Respondents
Reduce crime/safer streets	19%
Education; awareness of health benefits	15%
More sidewalks	14%
Improve street crossings	8%
More trails, paths, places to walk	5%
Better street lighting	4%
Enforcing pedestrian laws	3%
Nothing more should be done	29%

In considering public policy aspects of walking, respondents identified a range of specific improvements, yet not a single response besides "nothing more should be done" got more than a 25% response rate. This can be interpreted in a couple of ways:

- Walking is not something people think or talk about very often. Hence, views expressed are little more than off-the-cuff remarks. Lacking the organization-or "culture" of cyclists, a conventional wisdom has not yet emerged.

- No compelling issue is associated with walking, as, for example, traffic safety is with bicycling. The exception to this may be fear of crime, which when combined with an obviously related issue street lighting -- was mentioned by more than 20% of respondents,, a solid majority of whom were women.

Interestingly, only a couple of respondents mentioned promoting shorter distances between trip generators as a means to stimulate more walking. Yet while few people thought of this as a way to increase aggregate levels of walking, a great number identified distance as a personal reason for not walking. This suggests that people do not view distance as something that can be consciously shaped through policy initiatives. Yet when offered a scenario which eliminates distance as a disincentive, as in the Robinson study, the preference for walking increases dramatically. Indeed, the Ontario study found that 77% of Toronto residents would like to live within walking distance of work.

Summary

Walking appears to be a more common activity than bicycling. Limited survey data suggests that there are more than twice as many utilitarian walkers as there are bicyclists.

Walkers, like bicyclists, are primarily motivated by exercise and health, regardless of trip purpose Although some walkers claimed they walk to avoid driving, environmental benefits to society were seldom mentioned by walkers. Distance and travel time appear to be the main deterrents to higher levels of utilitarian walking, though a number of environmental factors seem to dampen enthusiasm for walking. on the whole, walkers, unlike bicyclists, do not see themselves as a class of travelers denied sufficient facilities to enjoy themselves. Although a number of people thought certain enhancements to the pedestrian environment might induce more walking or make it more appealing, few identified the lack of such amenities as a personal disincentive for walking more often.

CHAPTER II. AGGREGATE LEVELS OF BICYCLING & WALKING IN SELECTED CITIES

Individual perceptions of bicycling and walking are only a part of the picture. Levels of non-motorized travel vary, often sharply, from city to city, and from section to section within a city as well. We can reasonably assume that demand for non-motorized travel in a given area is shaped by something more than just individual preferences. Thus the focus will now switch to examining whether environmental and infrastructural features affect aggregate levels of bicycling and walking. This is an essential step in determining what kind of public policy decisions can affect a change in current transportation patterns, and how such policies should be prioritized.

The core of this chapter will be devoted to comparing data collected from twenty cities across the nation.[42] The data ranges from standard items such as area size and population to infrastructural elements relevant to the bicycling environment. This section will also include a look at commute distances. Key variables will be charted against the reported levels of bicycle commuting and walking to ascertain whether any sort of correlation is detectable.

A caveat is in order: the data were collected under a host of such widely divergent circumstances and methods that the numbers must be used with extreme caution .[43] This is particularly true regarding reported mode splits, especially for walking and bicycling, and in some instances, commute distances. Therefore, it must be stressed that these comparisons are at best indicative of a few trends and possible correlations between certain variables.
Quantitative conclusions are most assuredly not the purpose of this section.

[42] The number of cities in each chart varies because some cities were unable to provide all the data requested.

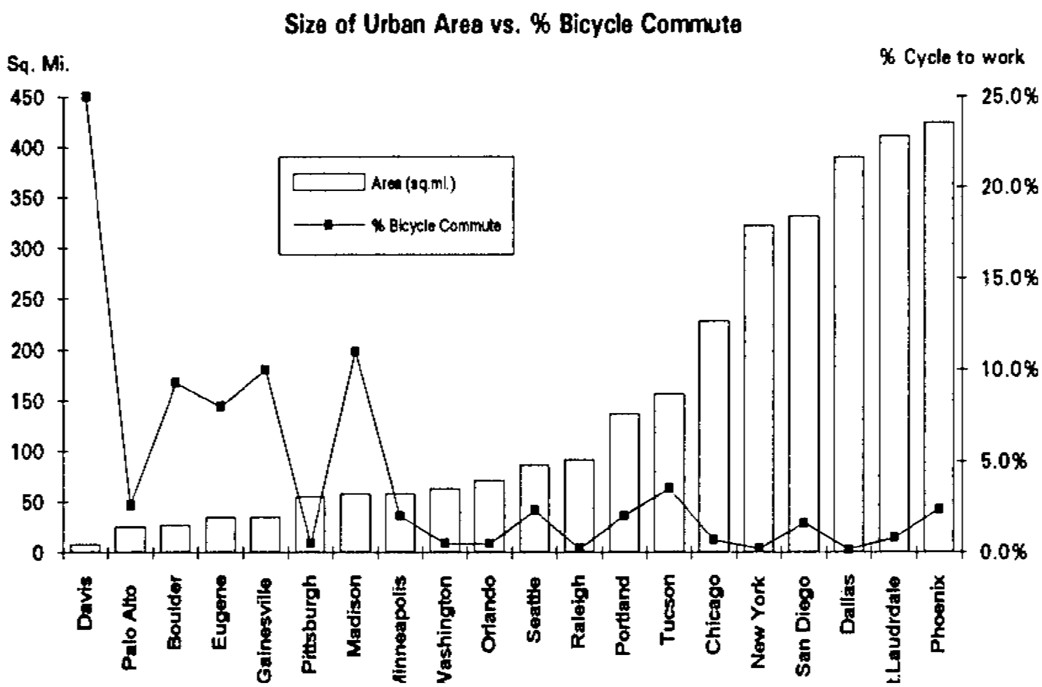
[43] Innumerable difficulties were encountered while assembling the data for this chapter. The main problem is that the quality of the data varies so much. For example, even such concrete variables as area size posed problems. A city like Orlando is actually one political sub-division among a group; alone it is of modest size, but in fts proper context it is part of a metropolis. However, the information needed for these comparisons was impossible to collect at the metropolitan level; similar problems were encountered in determining the relevant geographic boundaries of Tucson... The commute distances provided by cites were derived from such disparate sources as commuter surveys, computer models, or extrapolations from CBD employers'surveys. A few bicycle commuting figures are hardly more than seat-of-the-pants estimates. Some cities were unable to provide a precise breakdown on street mileage. Furthermore, even defining some of the categories for comparison proved difficult to pin down --local variations exist for such terms as "bikeway," "bikelane," and "arterial". Even mode splits may not be standardized - in some cases it was calculated by number of users regardless of frequency and in others by percent of all trips.

In this chapter, walking will be treated separately from bicycling. Though they share certain attributes, the effect of infrastructure on walking is of a very different sort than for bicycling.

A. FEATURES AFFECTING AGGREGATE LEVELS OF BICYCLE COMMUTING

1. Size of Urban Area[44]

Among the cities surveyed, cities with very high levels (over 5%) of commuter bicycling all are small (population less than 250,000), but not all small cities have high levels of bicycling. That obviously suggests that area size alone is not an independent variable. The chart below shows the relationship between levels of commuter bicycling and area size:



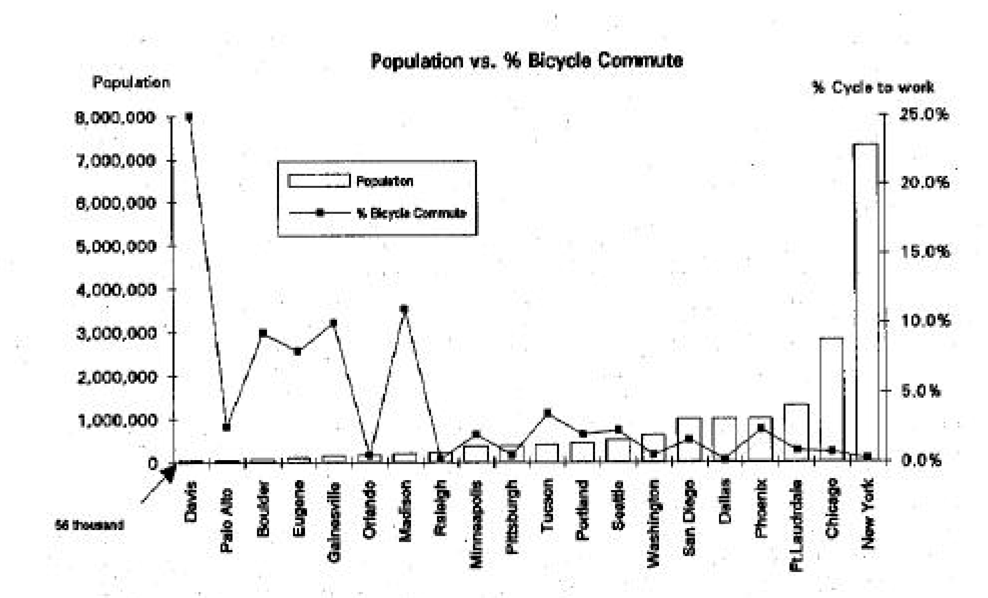
Essentially, the chart can be broken into two sections. The section from Davis to Madison represents geographically

[44] Many of the urban areas included here are composed of countless political subdivisions, which made data collection almost impossible. Many of the officials I spoke with could not easily define the borders of the metropolitan area in which the city was located. Therefore, data is derived from the city proper in an but one instance (Ft. Lauderdale-Broward County). The problem is that leaves off a large segment of area (and a sizeable portion of the population) which is contiguous to and just as urbanized as the city
proper, particularly in the case of non-university cities. A city like Orlando is referred to as medium-sized city when in fact R is one part of a large, burgeoning metropolis. Thus in terms of bicycling, it may be unrepresentative of medium-sized cities. In general, using the city proper rather than the metropolitan area as the subject of comparison probably biases the data toward relatively higher levels of bicycling and walking, since non-motorized travel is widely felt to be less popular in suburban areas. However, inclusion of suburbs probably would not change the findings in any substantial way. Given the problems in assembling the data, I have chosen to opt for consistency even at the risk of a few misperceptions.

small cities with high levels of bicycling (with the obvious exception of Pittsburgh). To the tight of this, commuter bicycling is at much lower levels, with averages perhaps slightly higher between Washington D.C. and Tucson than between Chicago and Phoenix. However, given this minute difference, a much larger sample of American cities would be needed to conclude that the level of commuter cycling is higher in medium-sized cities than in large metropolises, all else held constant. Intuitively, area size should matter because travel distances on average are bound to be greater. But as we shall see in a moment, evidence for this is not the least bit compelling.

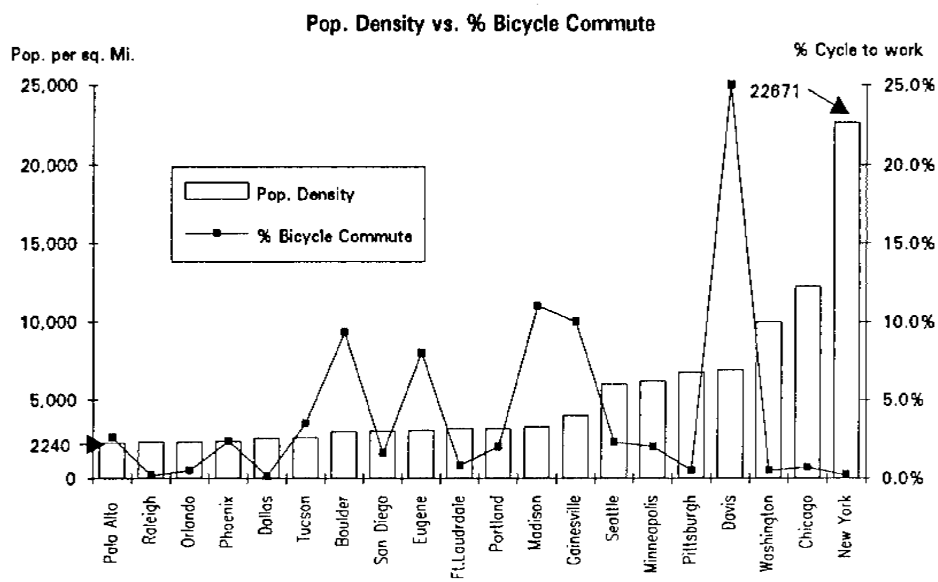
2. Population

Population very closely parallels the effect of geographical size in its relation to levels of commuter cycling, except that on average there appears to be a greater difference between large (1 million and over) and medium-sized cities, particularly as populations move well over the 2 million mark. (This tendency would be further heightened if area-wide population of Washington D.C. were included rather than the city itself).



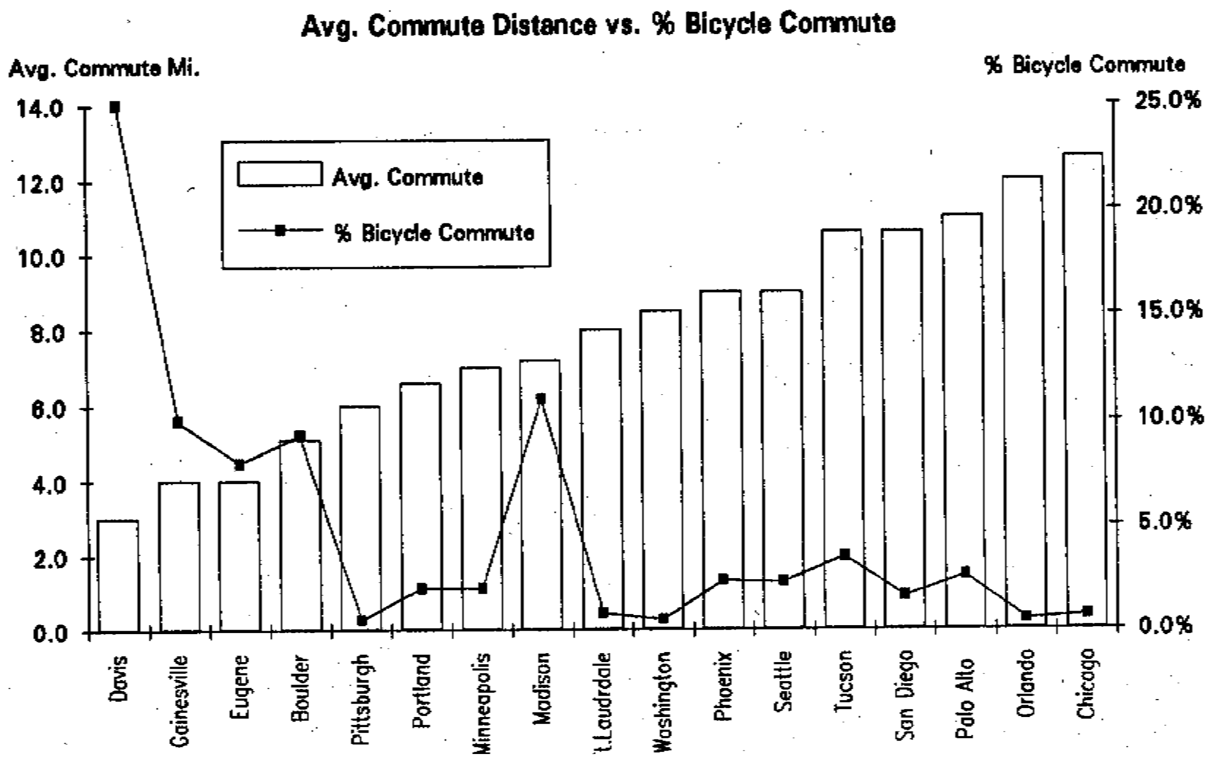
3. Population Density

Many observers would argue that higher density is conducive to non-motorized transportation. On the other hand, more densely populated cities are more likely to have more crowded roads, which bicyclists generally view as a threat to safety. In this chart any relationship at all is difficult to discern:



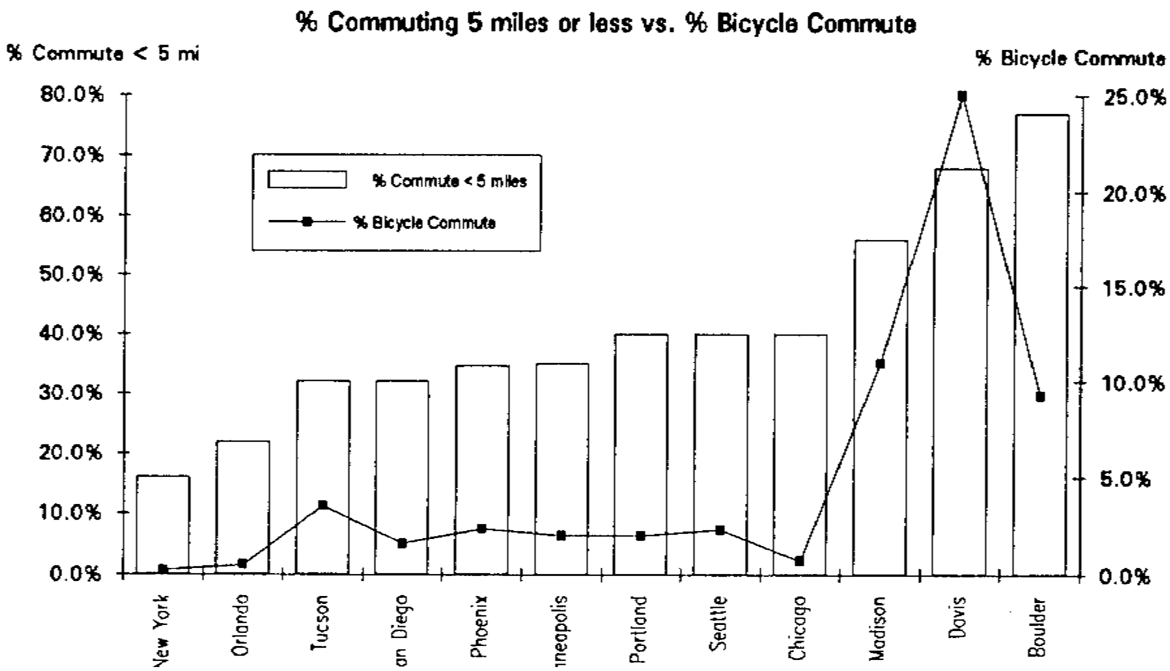
4. Commuting Distances

According to the survey data cited in the last chapter, distance appears to be the key variable in the individual choice to bicycle commute. If this is true, then cities with shorter commutes on average should show greater levels of bicycle commuting:

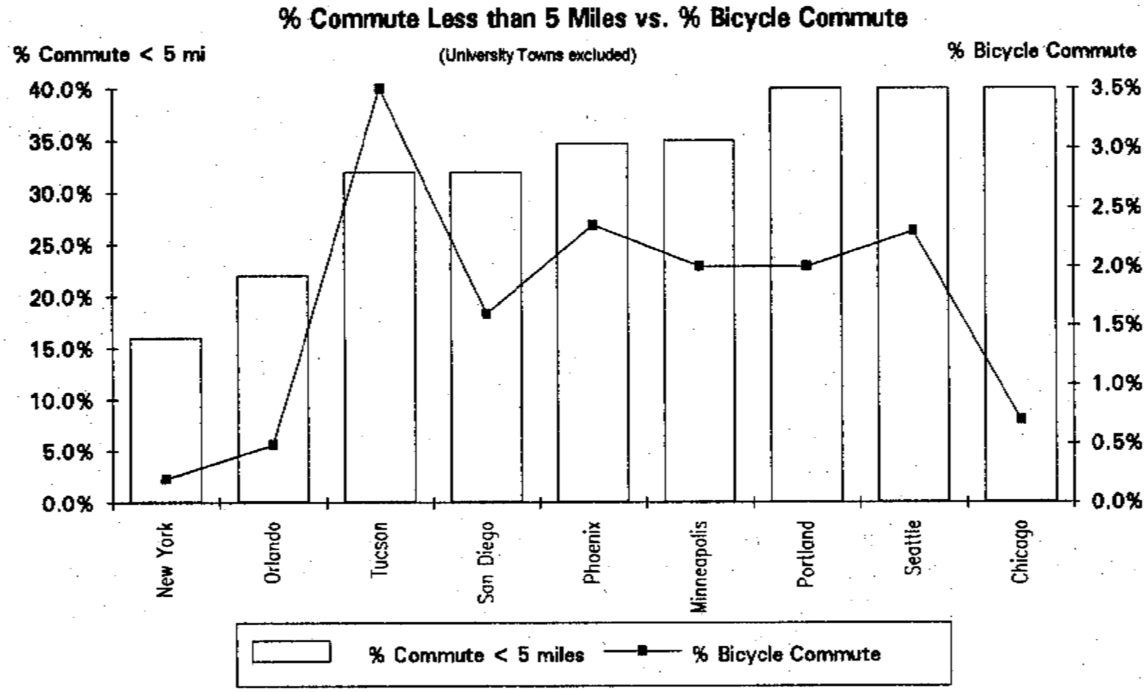

Avg. Commute Distance vs. % Bicycle Commute
Avg. Commute Mi.
% Bicycle Commute
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Avg. Commute
% Bicycle Commute
Davis
Gainesville
Eugene
Boulder
Pittsburgh
Portland
Minneapolis
Madison
t.Laudrdale
Washington
Phoenix
Seattle
Tucson
San Diego
Palo Alto
Orlando
Chicago

A mild inverse relationship exists between commute distance and bicycle commuting - but again if university towns are removed, this relationship all but disappears.

An alternate way to consider commute distance and bicycling is to focus on that portion of the population which lives within five miles of the daily destination, a figure widely accepted as a probable outer limit for the ordinary adult rider. Theoretically', cities with a higher proportion of such commuters should have more bicycle commuting, all else being equal:


% Commuting 5 miles or less vs. % Bicycle Commute
% Commute < 5 mi
% Bicycle Commute
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
% Commute < 5 miles
% Bicycle Commute
New York
Orlando
Tucson
San Diego
Phoenix
Minneapolis
Portland
Seattle
Chicago
Madison
Davis
Boulder

The first thing that should be noted is that the number of commuters in all of the above cities who commute less than 5 miles is far greater than the number who actually bicycle commute. Indeed, only in Davis does the proportion of bicycle commuters reach a mere one-third of all commuters who live within five miles of the work place. otherwise, this chart mirrors the effect of average commute on the level of bicycle commuting: The three university towns in this chart have by far the highest proportion of commuters traveling five miles or less as well as the highest levels of bicycle commuting. Once removed from the comparison, the relationship between these variables appears a bit different:



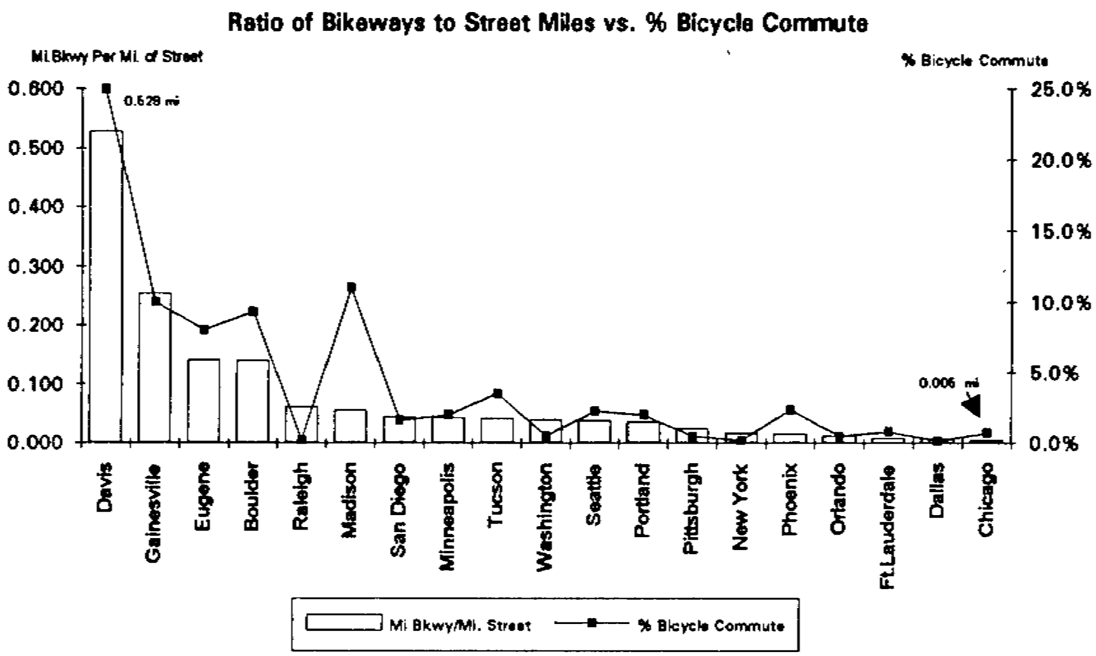
It is important to note that for all but two of the remaining cities the proportion of commuters traveling five miles or less is relatively flat, and that the two cities with the lowest proportion of bicycle commuters also are the two with distinctly lower proportions of commuters traveling less than five miles. Though the paucity of data precludes any strong conclusions, the data suggests that cities with less than 20% of the population commuting five miles or less are unlikely to produce levels of bicycle commuting comparable to cities in which 35% or more of the population commutes less than five miles.

5. Bikeways & Bicycle Commuting

If any infrastructural amenity should affect the level of utilitarian cycling, the quality and extent of bikewayS[45] should be it. This is because the nature and location of bikeways will have the greatest impact on perceived traffic safety, cited most often as the reason bicyclists avoid bicycle commuting. But bikeways cannot be treated as a feature independent of the city in which they are located; thus simply comparing their mileage would be of little value. Rather, the presence of bikeways relative to roadways is the more apt comparison, since such a ratio reveals the importance assigned to bicycling facilities with respect to the transportation infrastructure designed primarily for

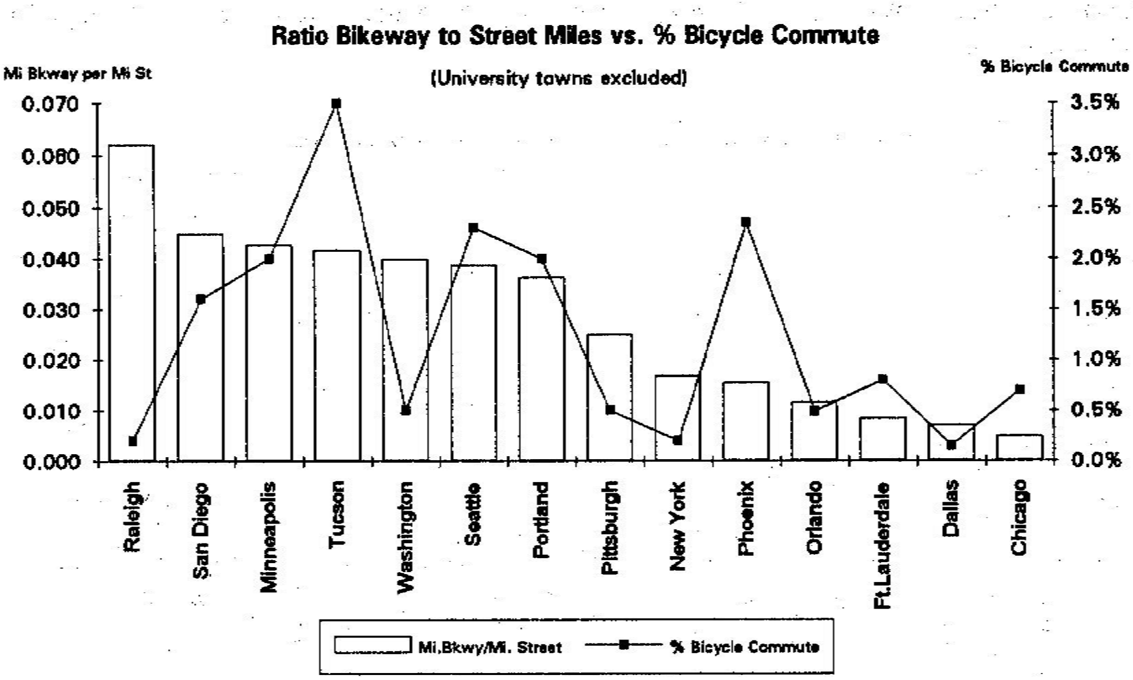
[45] For the purpose of this report, "bikeways" will be limited to separated paths (not necessarily dedicated) and bike lanes. Because standards vary so much from city to city, bike routes will be ignored even though a few cities claim they are an integral part of the bicycling network.

motorized vehicles.[48] The assumption here is that as the ratio of bikeways to streets grows, higher levels of bicycle usage should result.



Roughly speaking, this chart can be broken down into three sections: Davis through Madison, San Diego through Portland, and Pittsburgh through Chicago. There appears to be a moderate relationship here, though the difference is mostly due to the presence of university towns. Removing university towns produces a startling change in the landscape:

[46] Of course this says very little about the quality of the bikeways, and even less as to how well they are distributed around the urban area. For the purpose of comparison, we will assume that a higher proportion of bikeways means greater access for more people, though there could be exceptions to this. Determining the veracity of this assumption would require a demographic analysis of each city well beyond the scope of this report. The quality and condition of bikeways cannot be compared usefully without on-site inspection.

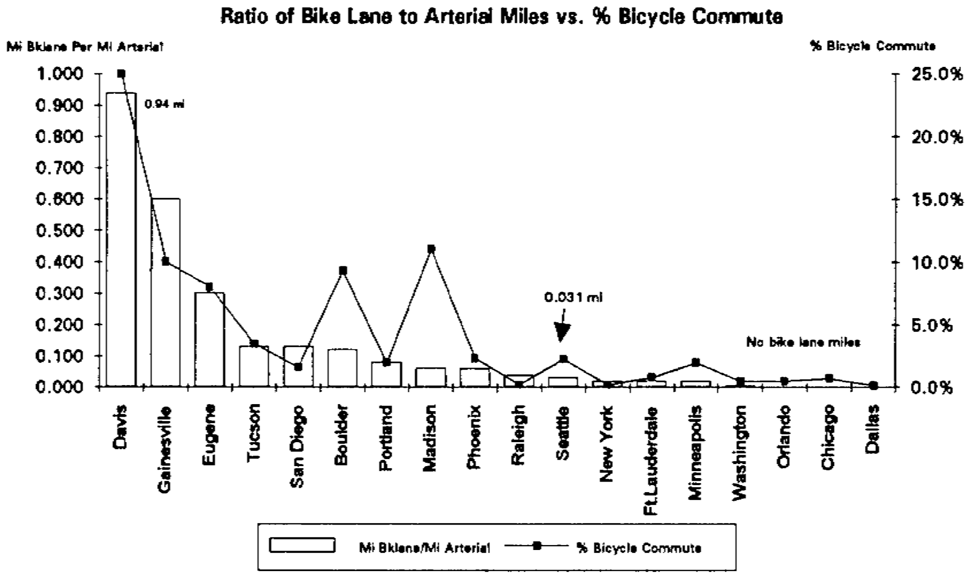


At best one can observe a very slight relationship between a high ratio of bikeways to proportion of bicycle commuters. obviously, the fluctuations make this a very tenuous connection, yet it should be noted that the average proportion of bicycle commuters for the left half of the chart (starting at Portland) is 1.7% as opposed to 0.7% for the right half.

6. Bike Lanes & Bicycle Commuting

An even better gauge of utilitarian cycling may be found in the ratio of arterial/collector miles to bike lane miles. Bicycle commuters must often travel on major thoroughfares to reach work destinations in high density areas. It is the perceived danger associated with such travel that scares off many potential bicycle commuters. Bike lanes are designed to provide a modicum of security to the bicyclist on heavily traveled streets.[47] If this is true, cities with a relatively high proportion of bike lanes to arterial miles should also have higher levels of bicycle commuting:

[47] This is a contentious issue within the bicycling community; some argue that bike lanes are more dangerous, and that wide curb lanes provide all the alleged benefits of lanes without confining cyclists to a narrow channel. In any case, in the popular view, bike lanes legitimize on-street cycling.



Unlike the other charts in which the left side is comprised exclusively of university towns, the arrangement is a bit different here. Neither San Diego nor Tucson, both with high levels of bicycle commuting for their size, can match university towns Madison or Boulder in terms of commuter ridership even though they have higher proportions of bike lanes. This may suggest both the limits of facilities in increasing utilitarian bicycling in a city with a general population as well as the effect of a university or college in generating a high level of purposeful cycling even when on-road facilities are limited. It may also suggest that reaching some minimum ratio of bike lanes to arterials may help increase bicycle commuting. To show this, let's imagine that Seattle is the dividing line between cities with a high or modest proportion of bicycle lanes from those with a low proportion (including those cities with zero miles of bike lanes).

Avg. Proportion of Commuter Cyclists by Bike Lane/Arterial Ratio
(All Cities)

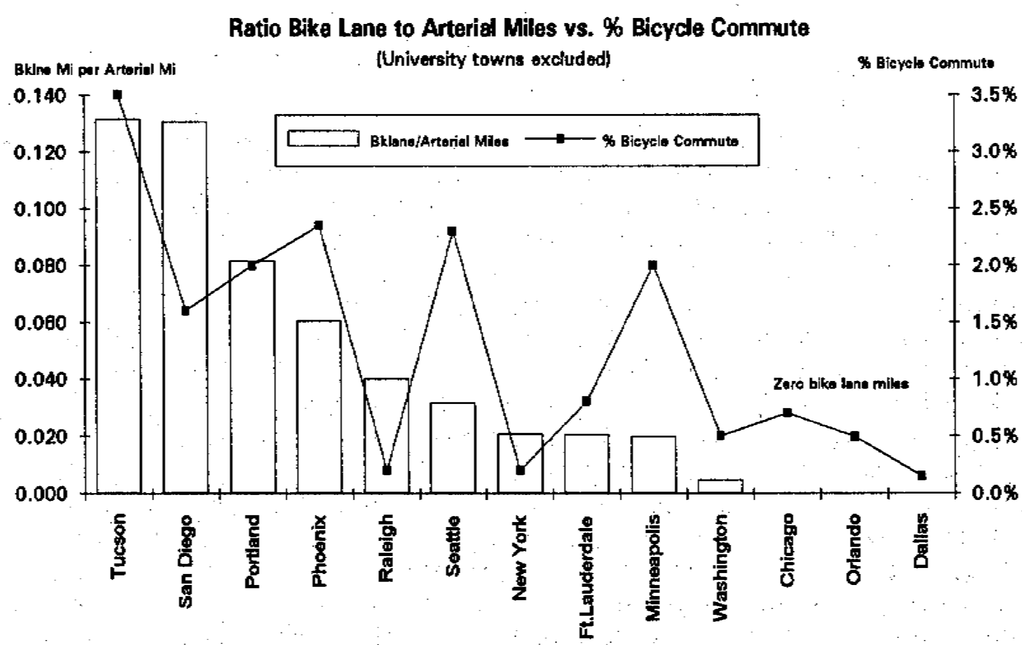
Ratio Bike Lane to Arterial Miles	Proportion of Bicycle Commuters (average)
Less than 0.35:1	0.63%
Greater than 0.35:1	6.8%

Though a correlation can be detected between the presence of bicycle lanes and rates of bicycle commuting, this fact alone cannot explain the ten fold difference in levels of commuter cycling because all the university towns are among the high ratio cities. If we remove all the university towns from the sample, we get the following results:

Avg. Proportion of Commuter Cyclists by Bike Lane/Arterial Ratio (University towns excluded)

Ratio of Arterial to Bike Lane Miles	Proportion of Bicycle Commuters (average)
Less than 0.35:1	0.63%
Greater than 0.35:	11.96%

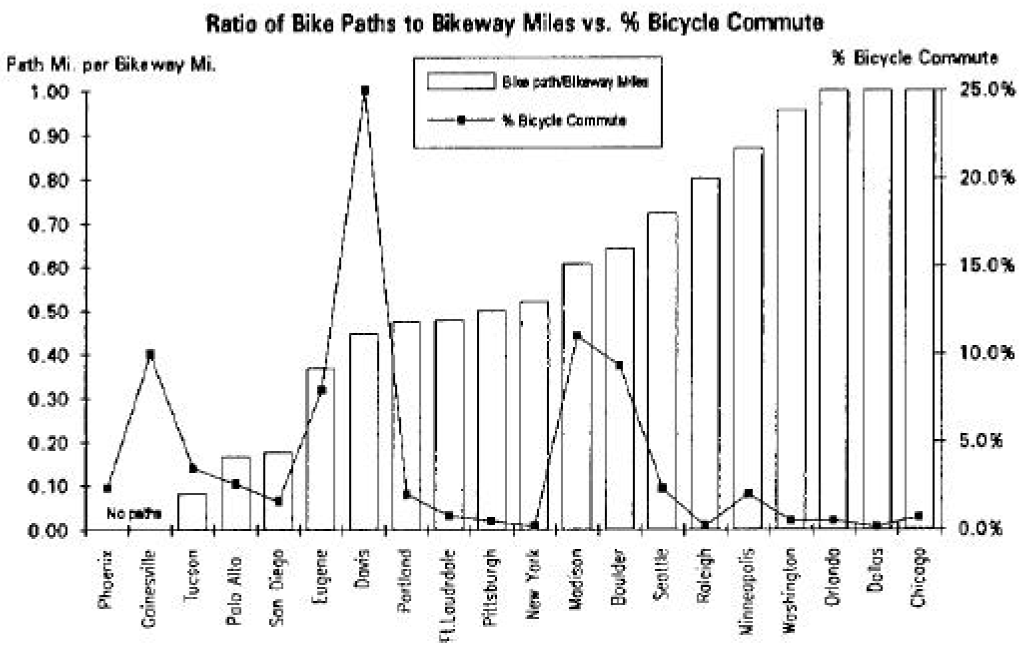
The difference is obviously much less impressive, but there are still three times more commuter cyclists in cities with higher proportions of bike lanes. For this reason it is worth reproducing the bike lane ratio chart with university towns removed.



Though bicycle commuting does not decline smoothly as arterial miles increase at the expense of bike lanes, a downward trend is nonetheless apparent. It seems fairly clear that cities with very few or zero miles of bike lanes are not generating much interest in bicycle commuting. Still one must be cautious in making inferences because of the numerous peaks and troughs evident in this chart. Moreover, innumerable other factors such as street layout land use, and traffic patterns,--- not to mention the dubious quality of bike commuting estimates - may be confounding the picture. Lastly, it should not be discounted that in some instances the presence of bike lanes may be a product of an organized, vocal, bicycle community. Under these circumstances, highly visible bicycling facilities may be a result, rather than a cause, of high levels of bicycle commuting.

7. Bike Paths

Separated paths are generally perceived by the public as the safest bikeway facility. Evidence in Seattle[48] suggests they largely are used for recreational riding. Less experienced recreational cyclists tend to prefer them, which suggests that they may act as a training ground for utilitarian cyclists.[49]But do they inspire bicycle commuting? To answer this question, below is a chart comparing cities by the proportion of their bicycle facilities which are in the form of paths with the proportion of bicycle commuters.
The answer to the above question is a resounding "no." Indeed, one might wonder whether somehow bike paths are a disincentive to commuter cycling! A careful look at



the cities with the highest ratio of bike paths indicates that many of these are the same cities with little, if any, bike lane mileage and low levels of bicycle commuting. The reason for this seemingly non-intuitive pattern may simply be that bike paths follow scenic corridors and do not necessarily lead to major destinations. But a high ratio of bike paths

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48 Surveys conducted in 1986 along the Burke-Gilman and Sammamish River Trails showed that, respectively, 88% and 97% of the cyclists were riding for recreation.

49 Anecdotal evidence would suggest that they do: The Burke-Gilman Trail in Seattle, far and away the most widely used facility in the region, has had increasing bicycle traffic throughout the last decade; it also has a growing number of bicycle commuters, as has the city itself. Minneapolis likewise his a major recreational facility - the 'Grand Round," 40 miles of dedicated paths --- which is the area's most popular facility. That popularity may explain why Minneapolis, with few on-street facilities, reports a notable 2.3% bike commuting rate to its central business district during summers.

is also an indication that bicycling has not been incorporated into the transportation network and is.limited to its recreational function.

8. Presence of a College or University

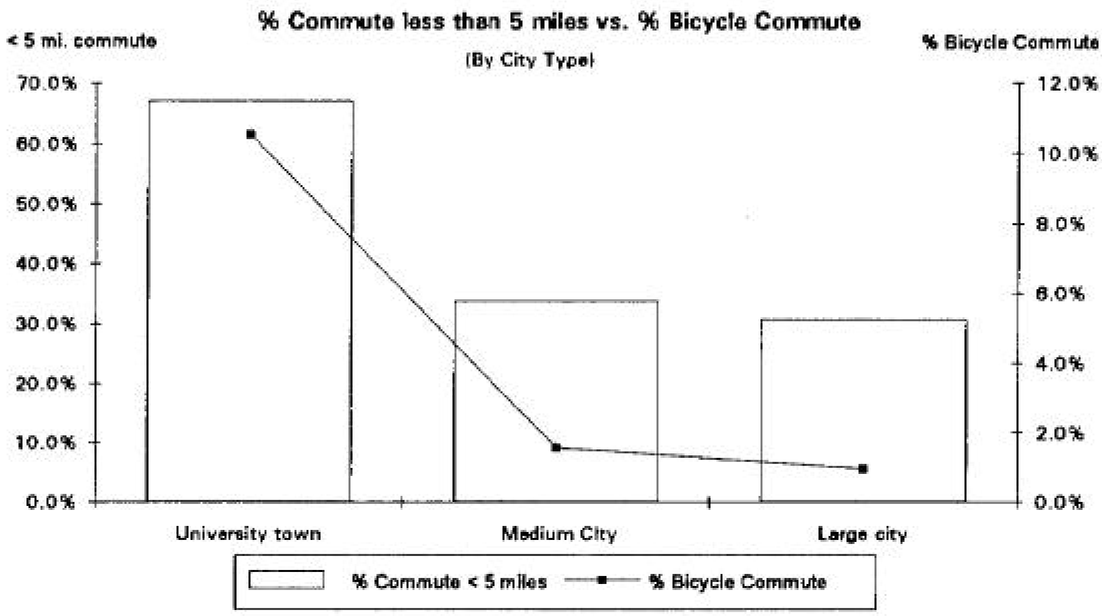
All indications thus far are that university towns have higher levels of bicycle commuting. The obvious explanation is that there is a large population of young, healthy people living within a reasonable distance of campus who may dress as, they please. But the university towns included in this study are generally more suitable for bicycling in other ways as well. For this reason it is worth reviewing the variables compared thus far, but this time aggregated into. three categories: University towns, medium-sized cities, and large cities.

Key Variables By City Type

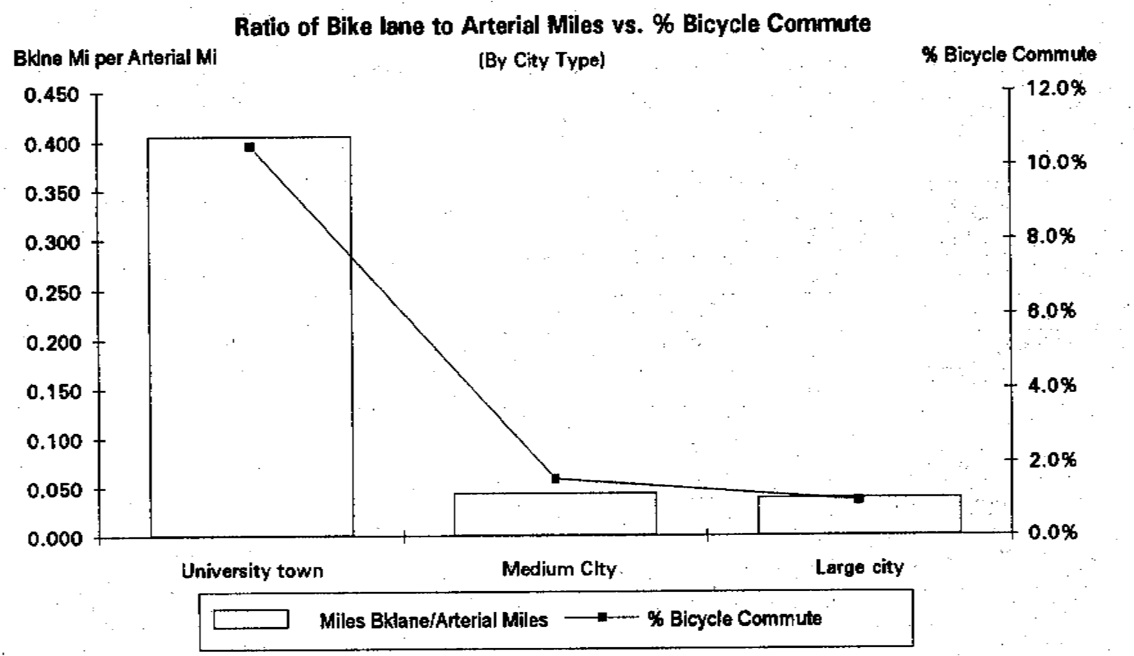
	University town	**Medium Cities**	**Large cities**
Population 114,200	386,000	2,400,000	
Area (sq.mi.)	33	90	351
Pop. Density	4,033	4,912	7,676
Bikeways: Total Miles	58	46	58
0 Miles Bike Lan*	34	19	36
# Miles Bike Paths	18	27	24
# Bike path/Bikeway Miles	0.41	0.68	0.53
Miles of Street	360	1,182	4,247
ArteriaUCollector Miles	122	356	1,229
Miles Bikeway/Street	0,224	0,199	0,016
Miles Bkwy per Sq.Mi.	2.7	0.5	0.2
Miles Bklane/Arterial Ml	0,405	0,044	0,039
Avg. Commute (all modes)	4.7	9.0	10.1
% Commute < 6 miles	167.0%	133.8%	30.7%
% Bicycle Commute	110.6%	11.4%	11.0%

These figures reveal several significant patterns. First is that the bicycling "gap" is greatest between university towns and medium-sized cities. In almost all respects pertinent to the bicycling environment, university towns have a significant edge, whereas the difference between large and medium sized cities with respect to key variables such as commute distance and relative presence of bike lanes, is relatively insubstantial. The most striking figure of all is that university towns have ten times the rate of commuter cycling that medium-sized cities do, which in turn have about one and one-half the commuter cyclists large cities have. What explains this gigantic difference?

Commuting distance: As suggested earlier, distance is a crucial variable in the choice to bicycle commute. The average commute distance in university towns is half what it is in large and medium-sized cities, and there are twice as many commuters who live within five miles of their destination.



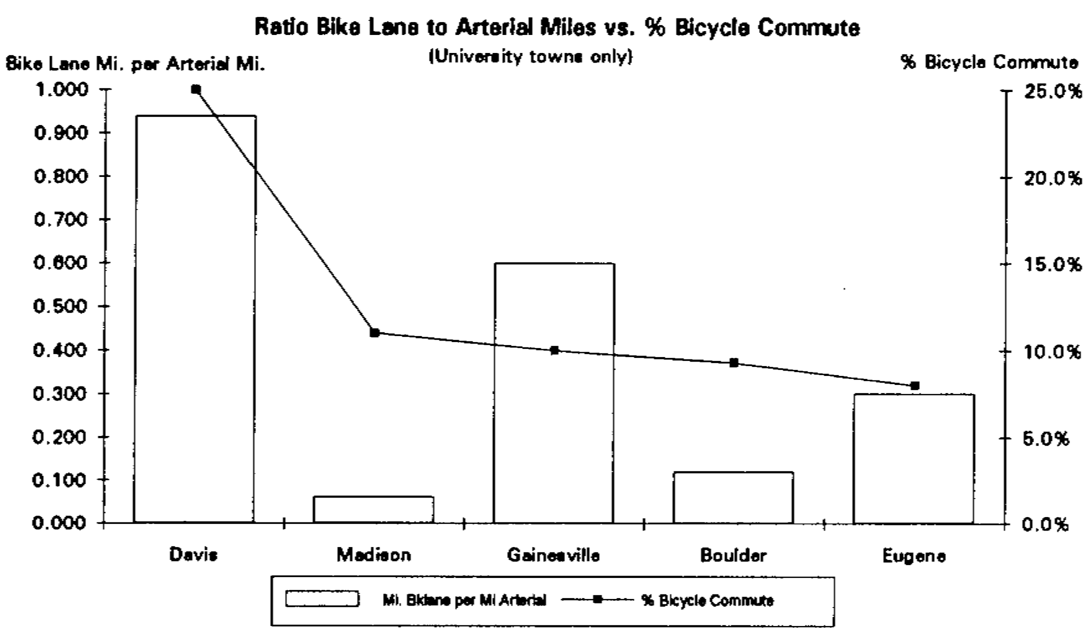
Bikeway Mileage: It is interesting to note that even though university towns are a fraction of the area size of big cities , in this sample they average the same number of bikeway miles, and almost the same mileage in bike lanes. University towns surveyed for this report have ten times more bike lanes per arterial mile than medium-sized cities.



All told, there can be little doubt that the bicycling environment of university towns is far friendlier than in larger cities. But even if we assert that the proportionate difference in commute distance and facilities could be held responsible for the difference in the level of bicycle commuting, it still would not account for the ten-fold difference. The rest is almost certainly a product of the high proportion' of students-in university towns. In a detailed study of bicycle comminuting in 300 college communities, Everett and Spencer (1983) found that mass bicycle commuting was closely associated with high levels of student cycling and were unable to identify any examples of mass bicycling that was primarily comprised of work or utility trips.[50] But given that bicycling conditions in university towns also vary, is it fair to lump them together? Differences I among them might reveal which factors carry greater weight in determining levels of commuter ridership. A closer look is warranted:

[50]Everett, M. & Spencer, J., "Empirical Evidence on Determinants of Mass Bicycle Commuting in the United States: A Cross Community Analysis," Transportation Research Record 912, 1983.

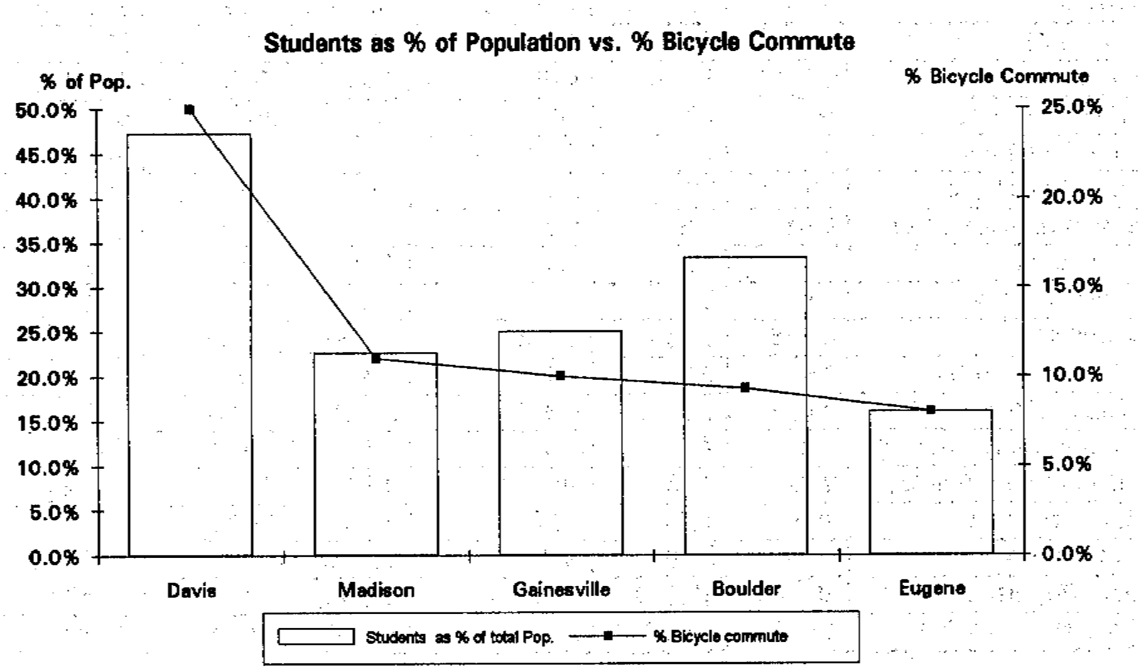
	Davis	Madison	Gainesville	Boulder	Eugene	University Town Averages
Population	55,000	190,000	140,000	80,000	106,000	114,200
Area (sq.mi.)	8	58	35	27	35	33
Pop. Density	6,875	3,276	4,000	2,985	3,029	4,033
Total Miles Bikeway	56	33	102	39	60	58
Miles Bike Lane	31	13	75	14	38	34
Miles Bike Paths	25	20	0	2	22	18
Bike path/Bikeway Miles	0.45	10.61	0.00	0.64	0.37	0.41
Miles of Street	106	587	400	280	427	360
ArteriaUColWor Miles	33	210	125	116	126	122
Mi.Bkwy/Mi.St	0.528	0,056	0.255	0.139	0.141	0.224
Mi.Bkwy per Sq.Mi.	7.0	0.6	2.9	1.5	1.7	2.7
Mi Bklane/Mi.Arterial	0.939	10.062	0.600	0.121	0.30	0,405
Avg. Commute(all modes)	3.0	7.2	4.0	5.1	4.0	4.7
% Commute < 5 miles	0.68	0.56	N/A	0.77	N/A	62.0%
% Bicycle commute	25.0%	11%	10.0%	9.3%	8.0%	10.6%
% cyc4e to classes	53.0%	26.9%	N/A	20.4%	N/A	40.0%
Student Population(est)	26,000	143,000	35,000	26,600	17,000	29,520
StudentsAs % of total Pop.	47.3%	22.6%	25.0%	33.3%	16.0%	28.8%



Everett found that bikeways along the road were associated with much higher levels of student cycling. However, the data from this very limited sample does not support this finding:

On the whole, the variables being compared do not correlate well with reported rates of bicycle commuting, with the

possible exception of students as a proportion of the population:
Davis reports the highest proportion of students and the highest level of ridership, while



Eugene is at the opposite extreme in both categories. In fact, Davis appears at the top of nearly every relevant measure: It has the,best ratio of bike lanes to arterials, shortest average commute, the highest percentage of students, is the most compact and densely populated of the university towns studied here, and by far has the most bicycle commuters. The problem is that none of these variables seems Able to explain the reported levels of bicycle commuting in the university towns. The most likely explanation for the Unrivaled level of utilitarian bicycling in Davis is simply the combined effect of its many bicycle-friendly features, each of which contributes some indeterminate amount to the overall level of commuter cycling.

If in fact the presence of a university alone could be said to generate X number of bicycle commuters, how do we explain the fact that the proportion of college students who choose to cycle to school also varies substantially depending upon the location?

City & University%	**Students% commuting5 miles or less**	**Students Bicycle Commute**	**% Total Pop. Bicycle Commute**
UC-Davis	68%	53%	25%
Univ. of Wis.-Madison	56%	26.9%	11%
U of Colorado-Boulder	77%	20.4%	9.3%
Univ.of Washington-Seattle	66%	10.9%	2.3%

Clearly, students (and non-students) do not bicycle commute at the same rates. It is equally clear that the cause of this variance cannot be attributed to commute distance: students at the University of Washington bicycle at a considerably lower rate than in Davis even though the percentage students living within bicycling range is almost identical. Part of the reason may simply be that Seattle is much larger and more congested. But there are substantial differences in the bicycling environment and in the policies that tap the potential.

Davis itself provides the most compelling evidence that it takes more than just the presence of a university to make bicycles a serious part of the transportation system. A survey conducted in spring of this year[5l] found that quite a number of others are cycling as well. Below is a breakdown by employer of those using a bicycle as their primary or alternative mode of travel to work or campus:

	UC Davis-Employees	**City Employees**	**School District**	**Private Sector workers**	**Students**
Primary Mode	27%	6%	9%	7%	53%
Altern. Mode	31%	37%	46%	29%	N/A

This can be seen as evidence that non-student mass cycling can and does occur, since the percentage claiming to bicycle commute in each of the above employment categories is greater than the total proportion of bicycle commuters reported by most other cities. The mere presence of a major university cannot by itself account for such a high proportion of active non-student commuter cyclists.(By comparison, 11.7% of the University of Wisconsin staff cycles to work, but among University of Washington staff only 4.5% commute regularly by bike, even though the percent of staff living within 5 miles of campus is slightly higher at the University of Washington!). It is almost certain that these high rates of cycling in Davis are due to a set of proactive policies and programs, many of which were inspired by the decision of UC-Davis back in the 1960's to minimize the presence of cars on campus.[52] They include:

- Construction of an extensive, linked network of bike lanes
- Bicycle registration
- Active enforcement of bicycle and motor vehicle laws
- Very high parking fees at UC-Davis campus
- Development which enhances access to bicycling, facilities and makes reliance on the automobile unnecessary.

[51] Wilbur Smith Associates, "City of Davis/UC Davis TSM Plan"; April 1991.
[52] Interview with David Pelz, City of Davis Planning Department.

Each of the above features serves to legitimize and institutionalize bicycling as a viable transportation: option. Though it is difficult to separate the effects of these programs from other features which make Davis attractive for cycling, studies of comparably-sized, similarly situated towns where little bicycle commuting takes place suggest that active policies are the difference.[53] Yet one is still obliged to ask how effective such programs would be if Davis were not blessed with 1) a warm, dry climate; 2) flat terrain; 3) compact area; 4) short average commutes; and, 5) a young population.

As impressive as ate the numbers coming out of Davis, some evidence suggests the trend toward commuter bicycling may have peaked. Survey data also reveals that the percentage of students and university employees who drive to campus has increased over the last few years, while the percent cycling has declined by about 3%. The authors of the study attribute this to increased enrollment at UC-Davis during the past five years, forcing more students and employees to live farther from campus.[54] Moreover, further increases in bicycle commuting will be hard to come by - particularly among segments of the population with no connection to the university, and thus free from the restrictive parking regulations on campus. Eighty-two percent of City employees indicated that nothing would induce them to bicycle more often.[55] Even under nearly ideal circumstances, as they seem to be in Davis, there appears to be a cap on the number of people willing to cycle to work.

9. Land use, Street Layout and Design Features

A number of urban design features beyond those already discussed affect the quality of the bicycling environment. However, very little evidence exists that can directly link these broader urban design elements with the level of utilitarian cycling, though there is much well-reasoned speculation on the subject.

a. Land Use: Sprawl is inimical to bicycling, since distance between trip generators is lengthened. That may explain why utilitarian bicycling is more common in cities than in suburbs. But as noted in regional data above, higher density does not necessarily correlate with higher levels of bicycle usage, at least at the city level. However, all else being equal, a compact environment at minimum can help make bicycling a viable option. Compactness, as opposed to

[53] EPA, p. 1 22.
[54] "City of Davis/UC Davis TSM Plan," 2-3.
[55] The question was open-ended and reads as follows: 'What would encourage you to ride more often?" The question was not designed to measure the travel preferences of respondents under any particular scenario or change of circumstances. Ibid., 3-7.

sprawl, makes bikeway linkage between key trip generators much more feasible. But while higher density shrinks distances between points of interest, it may also mean higher volume traffic on city arterials, thereby making roadway space scarce. This may explain why bicycling in some of our major cities is not terribly appealing to the less- than-committed bicycle commuter. Hence, compact land use must be accompanied by streets which include bicycle amenities that address traffic safety concerns. A perfect example of this has been the conscious effort in Davis to develop bicycle facilities along corridors with multi-unit housing. Moreover, to bolster compactness conducive to nonmotorized travel, Davis has refrained from developing a single shopping mall on the outskirts of town so as to maintain the viability of downtown shopping and minimize travel distances as much as possible.

b. Street Layout: Most of the cities surveyed are laid out as grids or modified grids. In general, a grid system maximizes direct access for bicycles in comparison with less conventional designs, such as the radial system. Perhaps no layout is as inherently hostile to bicycling as the "superblock," commonly found in suburbs, but also in some newer sections of cities such as Raleigh.[56] As the name would suggest, the superblock is a large residential block anywhere from one-half to one mile square with an arterial on its perimeter and lacking through streets within. Because movement is so restricted within the superblock, traffic on surrounding arterials tends to be heavy. Bicyclists who prefer traveling through quiet residential neighborhoods will find themselves forced onto these heavily traveled arterials in order to gain access to other areas.

Even though some lay-outs may be less conducive for cycling, other cities with classic grid systems like Chicago or New York report very little bicycle commuting. With this in mind, it is probably safer to assume that an unsuitable layout is more of a barrier to bicycling than a bicycle- friendly layout is an incentive to ride, though more study is warranted before any definitive conclusion can be reached.

10. Transportation Alternatives

The options available in a region should influence the commute decision, assuming of course that choice is a rational matter. For the majority, the automobile is the choice either because of preference, distance, or a real or perceived lack of alternative. The dominance of the automobile as the chosen commute mode has over time effectively narrowed the range of alternatives since land

[56] Raleigh's bike coordinator specifically identified this design feature as a cause of Raleigh's low rate of utilitarian cycling.

use, road design, and infrastructure have followed suit to create an "auto-friendly" environment throughout the country. That 'means the auto is almost always a viable option, assuming access to one. But certain conditions and policies can make driving less appealing and bicycling more appealing, thereby inspiring a mode-shift:

a. Traffic conditions/commuter stress: One would think that locales suffering from severe gridlock would have higher rates of bicycling, but the evidence does not support this. Cities associated with major traffic jams like New York or Chicago are not known for high levels of commuter cycling. This suggests that those who choose to bicycle commute do not do so because of driving conditions. But it may also be the fact that older, traffic-plagued metropolises tend to lack sufficient bicycling amenities conducive to such a switch. The inverse of this is a city that might be suitable for bicycling by climate or street configuration, but where traffic is not enough of a problem to inspire people to leave their cars at home. Dallas is such a case -- lots of streets with wide curb lanes, and an extensive network of usable bicycle routes - yet commuter cycling is insignificant. The apparent implication is that both light and heavy traffic may constitute disincentives to bicycle. However, the effect of traffic congestion on the decision to switch to bicycle commuting is not yet understood.

b. Public Transit: The effect of public transit on bicycling is also difficult to assess, since compelling evidence is severely lacking. The main question is whether a good public transit system constricts or bolsters utilitarian bicycling. Several issues converge here:

-Bike-on-Transit Allowed. A number of cities:have various provisions allowing bikes to be hauled along with the conveyance, but the majority of them restrict access-to off- peak hours, which obviously prevents bicycle commuters from linking up with the transit system. Phoenix, on the other hand, has had such extraordinary success with unlimited access during the initial stage of its bike-on-bus program that it is currently being expanded to include every bus in the city's fleet. But the promise is far from universal. After experiencing some success with it during the 1980's, Santa Barbara has abandoned its bike-on-bus program due to high upkeep costs. On the whole, bike-on-transit obviously extends the bicycle's range and thus must be seen as a boost to bicycling. But at the same time, carrying a bicycle on a train or securing it to a bus Ate not activities.everyone is likely to enjoy. This leads to an as yet unanswered question: Do bike-on-transit programs inspire people to take up utilitarian bicycling, or do they simply increase mobility and access for current users?

-Quality of Transit System. If a transit system is fast and efficient, and coverage is so extensive that access is always within walking distance, it may in fact be a disincentive to bicycle unless cycling conditions are optimum. It is interesting to note that the cities with the most extensive transit systems contacted for this report-New York, Washington D.C., and Boston - all have very low rates of commuter cycling. On the other hand, while mass transit in Davis is becoming more popular now that free bus service is available for students, bicycling easily remains the most popular mode.[57] on a day-to-day basis, weather also can make transit more appealing than bicycling.

-Secure Parking at Transit Stations. Secure bicycle parking at major transit stops or "park and rides" enhances access and creates a natural link between travel modes that can bolster the attractiveness of both at once. Evidence on the subject is mixed - some cities report high levels of usage; others report just the opposite. Two important caveats are in order: 1) High quality racks or bike lockers are preferred for security reasons; 2) Regardless of the storage device, usage will be low if the transit stop is not easily reached by bicycle. This highlights an important point: good terminal facilities (i.e., storage) alone will not get people out on their bikes if routes for reaching the transit station are not conducive to safe bicycling. *Incomplete bicycle systems will fail to fully tap a potential target market.*

11. Political Support: Programs and Regulations

Cities with strong bicycle programs have managed to institutionalize the interests of bicycling into the policy process. Typically this means the creation of a bicycle- coordinator, or at minimum a planner with a strong affinity for bicycling, to ensure that bicycle-sensitive design features are included in all relevant traffic or engineering projects. Thus the evolution of a bicycle-friendly environment has begun: As facilities develop, new ridership is fostered, which in turn can help strengthen the political influence of bicyclists and thereby increase the chance that future projects will be undertaken. Below are a few measures which may affect levels of utilitarian cycling:

a. Travel Reduction Programs: These have become a common response not only to ease gridlock, but to meet new air quality standards. Both Phoenix and Tucson have implemented travel reduction programs requiring larger employers to reduce the percentage of employees driving alone to work. Though survey data from both areas show that VMT (vehicle- miles-traveled) are down, levels of bicycle commuting do not

[57] Interview with Dave Pelz.

appear to have increased substantially as a result of these programs. [58]

b. Road Design Regulations: Tucson requires that all new or redeveloped arterials and collectors include a 17-ft. wide outside (curb) lane, the outermost 5 feet of which will be striped; Dallas regulation also requires new roads be constructed with wide curb lanes. other cities have "bicycle-friendly" language in their road design manuals. However, since few "built" cities have the space for major roadway overhauls,, such stipulations may prove to be irrelevant.

c. Bike Racks/Lockers in New Parking Facilities: Some jurisdictions require that a fixed percentage of new parking facilities be set aside for bicycle parking. Tucson, for example, requires that bicycle parking spades total 8% of automobile spaces in new facilities. (The Tucson Travel Reduction Program also has encouraged 63% of participating, employers to provide some arrangement for bicycle storage). Seattle has a similar requirement. Other cities (such as Minneapolis which operates many parking garages) provide bike storage at all municipal facilities.

d. Shower Facilities at Work: Palo Alto appears to have the, nation's only ordinance requiring new shower facilities for new construction - one shower for every 10,000 square feet of office space. And some 42% of companies involved in the. Travel Reduction Program in Tucson have made shower facilities available to bicyclists.

e. High Parking Fees: Providing a stiff monetary disincentive to driving is one of the secrets behind Davis, California's high rates of commuter bicycling. The University of California has made driving to campus very expensive through extremely high parking rates, impelling large numbers of students and staff to take up bicycling as an alternative. The effectiveness of the UC-Davis program is in stark contrast to University of Washington in Seattle, where cheap plentiful parking has made driving a reasonably attractive alternative, which helps explain why bicycle ridership is only about half that of other universities. The Davis approach, along with the aforementioned Harris Poll, which found that steep gasoline price hikes would inspire a new generation of bicycle commuters, provides,evidence that an economic "stick" can effectuate a mode shift. (That economics' is hot widely identified as-an incentive to bicycle may simply indicate how relatively inexpensive it is to drive or take a bus). However, while it may be feasible for a university to create demand for bicycle facilities via administrative fiat, it is rather unlikely that many

[58]"Travel Reduction Program (Tucson), Validation Study," Behavior Research Center, lnc.,Phoenix; "An Evaluation of the Clean Air Force Don't Drive One in Five' Campaign," O'Neill Assoc. Inc., Tempe.

jurisdictions will muster the political will to tax themselves into bicycling.

F. Education: Some believe bicycle education programs can generate new bicyclists. Whether it is as influential as facilities, demographics, and environment in determining aggregate ridership is a contentious issue; limited evidence suggests that education and promotion are not.[59] This subject was not systematically explored for this report.

12. Climate

Among the cities surveyed, two climatic variables were compared with levels of bicycle commuting: The annual mean daily high temperature, and the number of days per year with measurable precipitation. Neither variable showed any obvious correlation with levels of commuter cycling. Although weather should allow the ordinary rider to make more bicycle trips over the course of a year in San Diego than in Madison or Minneapolis, the latter two cities report higher levels of bicycle commuting. But these are annual, rather than seasonal rates. Severe weather is unquestionably a daily disincentive - snow and ice in the Northeast and Midwest; heat, high humidity and torrential thunderstorms in Orlando and Ft. Lauderdale; the burning summer sun in Arizona. Climate proves to be extremely difficult to disaggregate from other aspects of the bicycling environment, but what data there is suggests the market for bicycling is not circumscribed by climate; only the number of bikeable days per year is affected by the weather.

Summary: cities and Bicycling

Cities dominated by a university have much higher levels of utilitarian bicycling than cities without one, regardless of size. This tendency appears to hold even if non-university towns have an excellent network of bicycle facilities, such as Tucson. But because university towns are smaller, generally less congested, have relatively more commuters traveling shorter distances, and tend to have a higher ratio of bicycle facilities, one cannot be sure that it is the university which generates the bicycling. Commuter campuses such as University of Washington in Seattle have much lower rates of bicycling, even though commuting distances for students are no different than for students in university towns; the difference lies with the bicycling environment and the relative attraction of other modes. Nonetheless, more students bicycle commute in Seattle than anyone else.

[59] Everett asserts that education and promotion are of secondary importance, finding that they could only explain about 13% of the variation in student cycling.

Due to important differences in data collection and survey techniques which weaken comparability, the small variance in levels of commuter bicycling between large and medium-sized cities may not be enough to conclude that area size or population matters. For example, fairly large cities such as Phoenix and San Diego report greater levels of cycling than medium-sized cities like Orlando, Raleigh, or Pittsburgh. But with the exception of Raleigh, these cities tend to have higher ratios of bikeways to streets.

All in all, though correlations between individual variables and levels of bicycle commuting are relatively weak, (especially when one excludes university towns), if we divide non-university towns in half by their level of bicycle commuting, a certain pattern emerges:

Variables by % Bicycle Commute
(University Towns excluded)

Variable	Less than 1%	More than 1%
Population	1.7 million	619,000
Area Size	204	199
Density (Pop. per sq. mile)	7755	3885
Ratio Bikeway to Street Miles	0.022	0.037
Ratio Bike lane to Arterial Miles	0.012	0.076
Ratio Bike path to Bikeway Miles.	0.78	0.33
Avg. Area Commute Distance	9.4	8.8
% Commute Less than 5 miles	26%	36%
Average Bicycle Commuting Rate	0.4%	2.3%

Aggregating cities in this way allows us to make a general association between the combined effect of these measurable variables and commuter cycling. It now appears more certain that area size is largely irrelevant. Average commute distance reveals very little, but the proportion commuting five miles or less is considerably greater in cities with more bicycle commuting. But the most striking gap regards bicycling facilities as they relate to road mileage. **Even with university towns excluded from consideration,, cities with higher levels of bicycle commuting have on average 70% more bikeways per roadway mile and six times more bike lands per arterial mile**. Interestingly, bike paths make up a much higher proportion of bikeways in cities with lower levels of bicycle commuting. In other words, they have a much lower proportion of on-road facilities. **Given the considerable difference in the levels of bicycle commuting between the two groups, the presence of on-road facilities looms large.**[60] Still a word of caution is warranted. Correlation

[60] A regression analysis of the key variables showed that the ratio of bikeways to street miles accounted for most the variation in bicycle commuting (R^2 = .86), but when university towns are removed from the calculations, the ratio of bike lanes to arterials appears to have the most impact, though it is only of moderate strength as an explanatory variable (R^2 = .53). Given the different ways that levels of bicycle commuting (the dependent variable) were determined by the cites included here and the small and

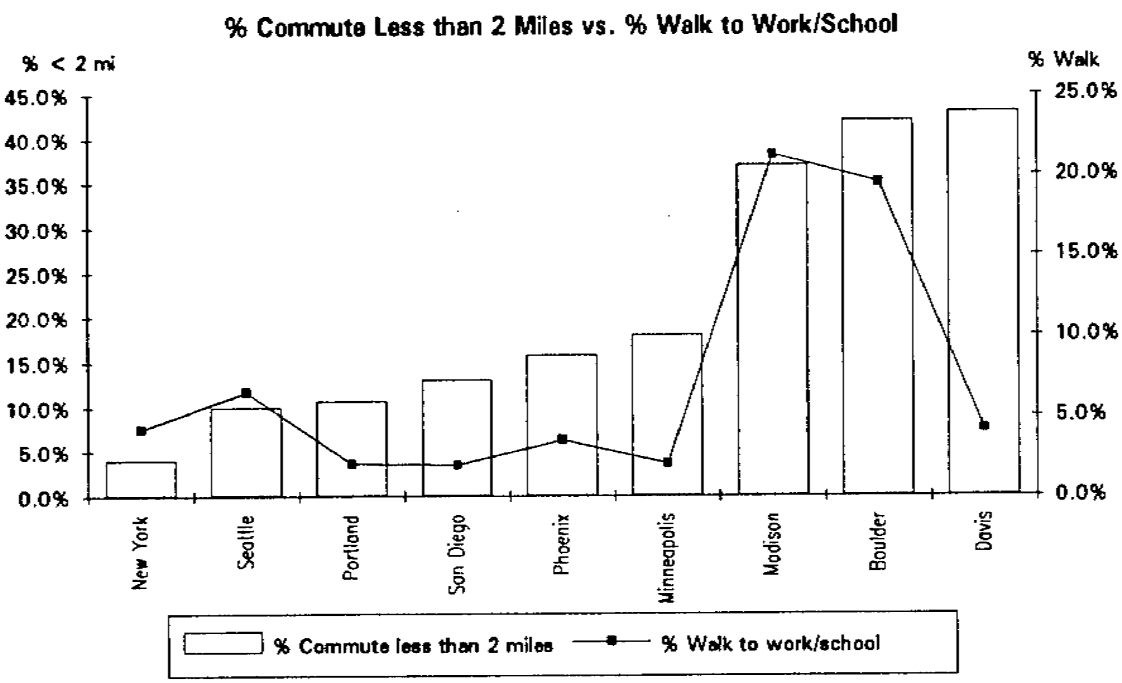
does not prove causation: a growing bicycling market may well have preceded and inspired construction of such facilities.

B. FEATURES AFFECTING AGGREGATE LEVELS OF WALKING

Like bicycling, the decision to walk is affected by a variety of personal, perceptual and environmental conditions. Unfortunately, data regarding the personal and perceptual content of the decision is extremely limited. That leaves us with a couple of broad, environmental variables: Distance and density.[61]

1. Distance

With respect to the work commute, the relevant measure is the proportion of commuters traveling less than two miles a distance that can be covered on foot in about 30 minutes. If distance is the key variable, as the proportion commuting less than two miles rises, so should the proportion of those walking to work:



A mild correlation is evident if we ignore the extreme ends of the chart. New York is the hardest to explain, but the fault may lay in disparate data sources.[62] Davis probably

inconsistent sample size for the variables included in the equation, regression analysis is of limited value.

61 Because of the absence of information on walking trips in general, the commute will once again be the trip of interest.

62 The only mode split information available on walking came from the Urban Transportation Planning Package (UTPP) portion of the 1980 Census, whereas the proportion commuting less than 2 miles is

suffers low rates of walking because bicycle commuting is so extraordinarily popular. There is no other explanation why the walking rate should be so much lower than other university towns while it has the highest percentage of commuters traveling less than 2 miles on the daily commute.

Data supporting the relation between distance and walking have been 'collected in Chicago in the last few years. The Chicago Area Transportation Study (CATS) examined the travel habits of residents in Chicago's CBD and found that 36.5% of all trips were accomplished on foot, and that 10% walked to works Not surprisingly, 75% of all trips were less than two miles in length. This is in stark contrast to data coming out of a couple of suburban districts of Chicago as part of the same study:

Walking in Chicago Area: CBD vs. Suburban Counties

Criteria	Chicago CBD	Lake County	McHenry County
Total Trips Less than 1 mile	51%	18%	21%
Total Trips Less than 2 miles	75%	36%	40%
Walking as % of all Trips	36.5%	3.9%	2.9%
Driving as % of all Trips	24%	81%	80%
% Walk to Work	10%	0.9%	0.7%
% Walkable Trips Walked	72%	22%	14%

The startling aspect is not the high proportion of walking in the central business district, but the appallingly low level of walking in the suburban counties even though short trips are not uncommon. To highlight the contrast between central city and suburb, the percentage of actual trips walked as a proportion of all trips within walking distance was calculated. For this exercise it is assumed that all trips less than one mile are walkable and all reported walking trips are less than one mile.[63] The percentages in the last row indicate that even when suburbanites could walk, they seldom do by comparison with CBD residents.

Similar data from Ontario, Canada, were collected regarding the work trip. Respondents were asked if they consider themselves living within walking distance of the work place and whether they actually walk to work:

derived from a study by the NY City DOT entitled "Improving Manhattan Traffic and Air Quality Conditions," - which is examining commutes to the CBD only whereas UTPP is city-wide data.

[63] This is simply row #3 divided by row #1. This calculation was not provided by CATS, but was carried out by the author of this report as an analytic exercise.

% Walk to Work in Three Cities in Ontario, Canada

city	% Live With-in Walking Distance	% Living Close to Work who Walk	% of Total Who Walk to Work	% Living Within 5 km (3.1 miles)
Toronto	12.4%	65.3%	8.2%	30%
Ottawa	15.5%	73.5%	11.5%	24%
ThunderBay	26.8%	47.4%	13.0%	35%

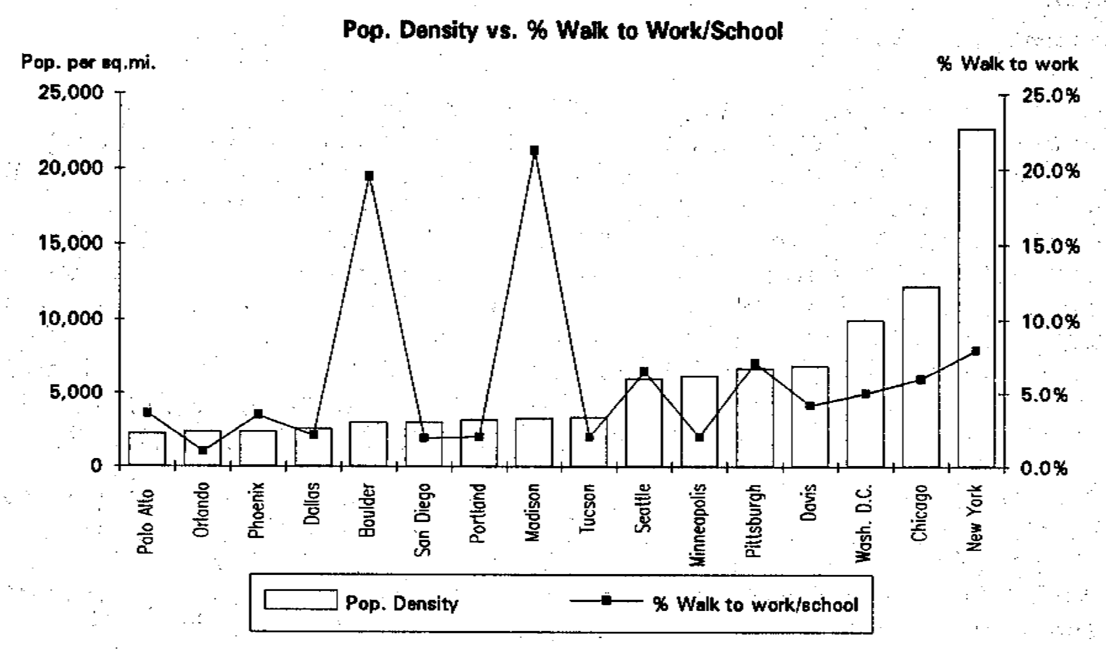
Rather than rely on an objective standard to determine walkability, the Ontario study deems distance an entirely subjective measure. By this account, a very high proportion of those who consider themselves within walking distance of work do in fact walk. on an objective scale, a fairly high proportion of people walk to work, the percentage increasing as the city gets smaller. A similar result was found regarding errands. About 30% of ontarians declared that it was already easy to walk on errands, and of those, well over 60% walked on errands most of the time. Another 50% stated they would like to live where they could walk on errands.

Distance alone does not suffice to entirely explain walking habits, though it surely defines the limits of walking: Virtually no Ontarian living beyond 5 km of work walked to work. But with data limited to this small sample of American and Canadian cities, other conclusions are premature.[64]

[64] Most cites contacted for this report were unable to provide data on the proportion commuting less than two miles. A number of cities also could not provide a recent mode split for walking. Thus for Dallas, New York, Chicago, Eugene, and Pittsburgh, the figures are taken from the 1980 UTPP

2. Density

Greater density is associated with a higher concentration of services, and therefore more reasons to explore the environment on foot:



With the exception of Madison and Boulder, density seems a better predictor of walking rates than distance. Though far from a perfect fit, the rate of walking appears to rise as density increases. This is also supported by the CATS study of Chicago CBD residents and outlying areas. However, this does not appear to be the case in Ontario. Data from the three cities studied suggest just the opposite -- the proportion claiming to walk to work decreases with population density! It should be noted, however, that density typically varies from area to area within a city. For example, university campus districts or areas with a high proportion of multi-family dwellings will have higher than average densities, and very likely, higher levels of walking. Aggregated data on levels of walking do not ordinarily reflect these neighborhood variations. Therefore, a geographically large city whose population is concentrated in a few areas could well have very high levels of walking while the average density appears low. Thus a city's average density could obscure the actual relationship between density and walking. Ottawa appears to be such a city.

3. Other Factors

The lack of data on individual walking habits and overall walking statistics makes it especially difficult to assess the roles of less objective features such as urban design, sidewalks, and crosswalks. What evidence there is tends toward the anecdotal:

Infrastructure: Sidewalks may matter, but they do not explain differences in the popularity of walking between cities. All of the cities reported that either the entire city proper, or all but the fringe had sidewalks. Information on the general quality of sidewalks and pedestrian crosswalks was not readily available.

Places to Walk: Several cities such as Washington, D.C., Portland, Madison, Minneapolis, and Toronto have made special efforts to make central business districts pedestrian-friendly. Pedestrian malls, auto-free zones, skybridges, underground walkways, etc., make walking on short trips and errands more pleasant, but such projects tend to be focused in areas where substantial walking would occur anyway. The degree to which such improvements bring additional people into the area for the purpose of taking a stroll is information sorely lacking.

Recreational facilities clearly generate a substantial amount of leisure walking. Seattle has numerous parks excellent for walking spread around the city, which helps explain the very high rate of recreational walking. Whether these facilities inspire higher levels of utilitarian walking trips is unknown.

Relative Convenience: As the Seattle survey indicated, proximity to destination and avoidance of driving are motivations for some walking trips. That is part of the reason walking is such a dominant form of travel within central business districts and normally ignored in outlying areas. In any urban CBD, it is a considerable hassle to drive on a one mile errand: Traffic and parking provide all the disincentives needed to promote walking; perhaps more important, time would not be saved by driving. But in fringe or suburban areas parking spaces are usually plentiful, and if not free, then much cheaper than CBD parking. The convenience that inspires short walking trips in downtown districts disappears in less densely populated areas, even though many errands are close enough to be handled on foot. This may explain the wide variance in walking habits between CBD and suburb described by the Chicago Area Transportation Study.

CHAPTER III. FACTOR ANALYSIS- DETERMINING WHAT REALLY MATTERS

A. THE INFLUENCE OF THE BICYCLING ENVIRONMENT ON AGGREGATE RIDERSHIP

As indicated in the previous chapter, there is reason to believe that bicycling facilities play a role in determining aggregate ridership: on average, cities with relatively more bicycle facilities have more bicycle commuters. The problem is two-fold: First, these are aggregate averages; on a city by city basis, the effect of bicycle facilities on ridership fluctuates considerably. None of the variables explored in the last chapter can be shown to correlate consistently or smoothly with a changing rate of bicycle commuting. Second, it is virtually impossible to disaggregate the effect of "fixed" elements of the environment such As weather or the proportion of students in the population from manmade factors such as bike lanes. The array of influences is staggering, and results in many perplexing questions:

-If facilities matter, why should Madison have as much or more utilitarian bicycling as Gainesville or Eugene, which have more bike lanes?

-If climate matters, why does Seattle have more bicycle commuters than San Diego?

-If proportion of students matters, why does Raleigh (not strictly a university town, but a large university is located there) have so little commuter cycling compared to San Diego or Portland?

-If commute distance matters, why should Chicago, with 40% of its population within 5 miles of the work place, have so few bicycle commuters?

For most of the cities, features advantageous for bicycling seem to be offset by at least one disadvantage. That suggests the sum total of advantages might be of predictive value in estimating the potential for bicycle commuting in an urban area. To determine if this holds any promise, below is a table listing what appear to be "ideal" conditions for utilitarian bicycling, and the cities which meet these criteria:

Cities Meeting Ideal Criteria for High Levels of Bicycling

Ideal Criteria	Cities Meeting the Ideal
Students > 20% total pop.	Davis, Madison, Boulder, Gainesville
Mild, dry climate[65]	Davis, San Diego, Palo Alto, Boulder, Tucson, Gainesville
40% of total population commutes 5 miles or less	Davis, Boulder, Madison, Seattle, Portland, Chicago, (Eugene, Gainesville)[66]
Bike lane/Arterial mileage ratio greater than 0.05:1	Davis, Boulder, Eugene, Gainesville, Madison, Portland, Tucson, San Diego, Phoenix
Bikeway/Street Mileage ratio greater than 0.05:1	Davis, Boulder, Eugene, Gainesville, Madison, Raleigh

Though the dividing lines for the criteria are obviously arbitrary, the previous chapter indicated that to varying degrees these categories may influence aggregate levels of bicycle commuting. (As noted earlier, climate influences day-to-day travel decisions; hence more favorable weather suggests more bicycle trips per year). In any case, all cities with notable levels of bicycle commuting meet at least one, and more commonly, two of the standards. Not surprisingly, Davis meets each standard, followed by the other university towns, and then, sprinkled around the other categories, the medium and large cities with moderate levels of bicycle commuting. Low cycling towns Chicago and Raleigh each appear to meet one criterion.

The shortcomings of this approach are obvious: other criteria such as political support and urban design are more difficult to measure and compare. Still, the implication of this chart is straightforward, even if it must be stated with extreme caution: These criteria seem to be correlated with higher levels of utilitarian bicycling.

B.EFFECT OF PUBLIC POLICY ON INDIVIDUAL BARRIERS AND INCENTIVES FOR UTILITARIAN BICYCLING

1. Ranking the Importance of Barriers

The purpose of this section is to establish the connection between key barriers confronting the individual identified in Chapter I and the objective conditions discussed in detail in the last chapter. Each barrier will be judged in light of the following criteria:

1. Link to "objective" conditions: All barriers vary in the extent they affect individuals. Some, however, are grounded in external conditions which affect everyone,

[65] Defined as follows: Mean daily high temperature between 65^0 and 82^0 F, and less than 60 days of measurable precipitation annually.
[66] Eugene and Gainesville probably also qualify, but figures were not available.

whereas others are so subjective that they may defy generic solutions.

2. Whether it is institutional or structural in nature: Some barriers result from conditions so deeply ingrained in our society that solutions will require fundamental change well beyond the scope of bicycling and supporting facilities.

3. Addressable via Public Policy: This is recognition, that not all disincentives to bicycling can be eliminated through public policy initiatives under our current system of government.

4. Amenable to short-term solution: This is a measure of the ease with which the barrier can be removed, or at least alleviated in the short term - Meaning within five years.

5. Degree to which removal of barrier likely to increase utilitarian cycling: This assessment amounts to a judgment on the overall significance of this barrier in limiting bicycle usage.

Nature of Barriers to Bicycling and Potential Solutions

Barrier	Objective link	Institutional or structural in nature	Address-able by public policy	Amenable to short-term solution	Degree to which removal will increase utilitarian cycling	
Distance; too far to ride	Land use; history; cul-tural habits	Yes - profoundly so	Yes - but issues very complex	No - except possibly at local level	Impact could be profound	
Too dangerous; traffic safety	Lack of safe on-street bicycle facilities	Partially; Infrastructure ill-designed for bicycle	Yes, but systemic remedy costly	Yes - but need major political support	Depends on quality of bikeway system & other aspects of environment.	
Lack ancillary facilities - shower, parking, etc.	Work-place facilities inadequate	No	Only to ex-tent policy can get employer interested.	Yes	Relatively minor by themselves; best preceded by linked bikeway system to employment centers	
Need car for work	Limited utility of bicycle	Yes	No	No	N/A	
Inconvenient	Infrastructure institutional & hampered	Limited ties widespread and acceptance	Possibly	No ways,ancillary facili-	Somewhat- if bike- mobility attitudes change drastically	deficient; social
No reason to switch: Mode "inertia"	Driving costs low to indivi-dual; social costs ignored	Yes- eco-nomic system in lock-step with auto	Yes - but not without titanic struggle	No-unless economic chaos the goal	Substantial if trip distances reduced; also depends on available alternatives	

This table illustrates the complex nature of these barriers and the relative difficulty in removing them - particularly those deeply rooted in our society. At least two barriers the need for a car and the perception that bicycle commuting is inconvenient - cannot be overcome easily through public policies. Distance, the most basic and important constraint on utilitarian bicycle usage, is also the most intractable factor. Traveling substantial distances for ordinary activities has become a fundamental feature of American life, which makes it all the more resistant to quick fixes. Yet without somehow altering this, bicycling is likely to remain a minor aspect of our transportation system.

It appears that the concerns over traffic safety and the lack of ancillary facilities may be the most amenable to short term solutions. Traffic safety is best addressed by improving bicycle facilities, particularly on-road bikeways. **To make bikdways truly safe means to have unimpeded access to all Parts of the city via a network of linked bicycle facilities.** Such a system could bring out a sizable portion of latent bicyclists, at least for short commutes ' and some errands. Besides generating the political support for this investment,, the main drawback may simply be to find the necessary roadway space for a comprehensive network of bikeways.

Terminal facilities such as parking and showers can also be improved markedly in the short run. But showers will necessitate considerable cooperation from employers, which means policies will have to be developed which make it easy and cost effective for them to install such amenities. While end facilities make a bicycle system complete, they cannot on their own generate as much enthusiasm for utilitarian cycling as a linked network of safe bicycle facilities would.

2. incentives to Shift to Bicycle Commuting

It is one thing to alleviate impediments to bicycle commuting identified explicitly by bicyclists; it is another to foster a mode shift if travel options do not appear to match the advantages associated with other modes, especially the automobile. This means bolstering aspects of bicycling in ways that match the positive features associated with the automobile. The table below is a sketch of the barriers to bicycle commuting from the perspective of a motorist, and the kind of changes it would take to effectively promote bicycle commuting.

Reasons Pre-fer Car as Primary Mode	Corresponding Disincentive to Bicycle	Perceived Advantage of Automobile	Policy Options for Increasing Levels of Bicycle Commuting
Travel Time	Distance	Speed;cover great distances.	Promote short trips in congested zones; develop efficient network of bikeways; direct routes; maps with comparative travel times.
Convenience	Traffic safety; weather, unfriendly infrastructure	Comfort-,' protection from elements; privacy; flexibility.	Make bicycling easy; Full bicycle system; unimpeded access; parking plentiful; employers required to supply shower facilities. In short, institutionalize bicycling.
Need car for work/other reasons	Need car; mode "inertia"; options inconvenient.	Drop off kids; carry tools, samples; errands during	Awareness on how to use bicycle for practical tasks; better, safer bicycle facilities will reduce "need" for car. Retool infrastructure. day easy.
Cost	None	Appears inex-pensive if only include gas, oil in calculations.	Demonstrate low cost of bicycling, real costs of operating single occupancy vehicles. Raise.gas, parking, "gas guzzler" taxes to cover full social cost of driving. Eliminate free parking.

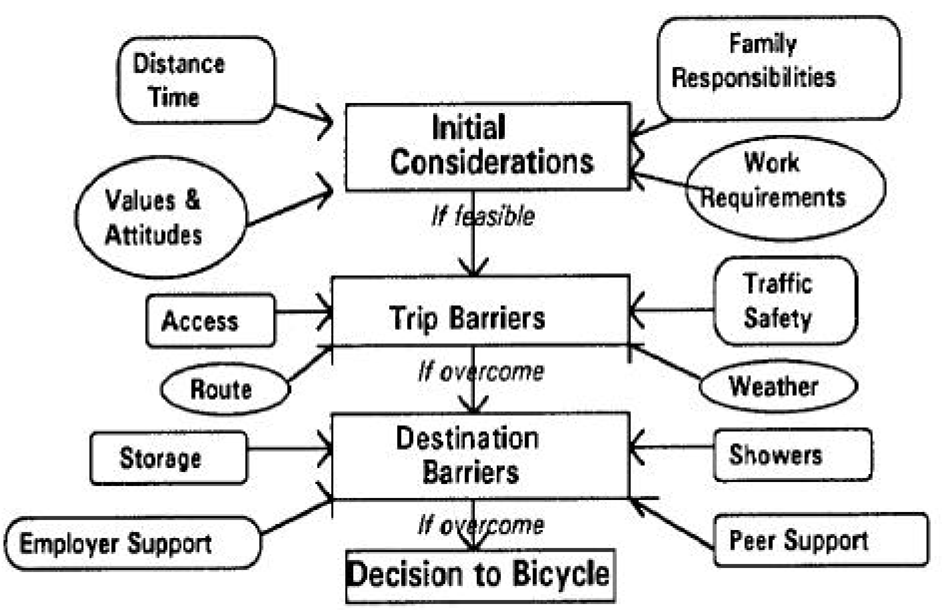
For the most part, the reasons people choose driving over bicycling stem from broad advantages which, under current conditions in most places, bicycles are unable to match. One should not assume the reasons people,prefer driving a car are entirely irrational, and that people are anxious to shift modes. Indeed, some studies suggest that the work commute is not perceived to be as stressful as some observers believe it iS.[67] None of the possible solutions will easily alter habit or perception; nor is it certain that many of the reasonable objections to bicycling *can* be overcome. Indeed, unless travel distances shrink, the automobile is unlikely to recede in importance (short of a catastrophic energy shortage). That does not bode well for utilitarian bicycling, unless simultaneously bicycling becomes far more attractive and disincentives to drive become far more severe. That would mean imposing upon drivers the full social costs of air pollution, congestion, and dependence on foreign energy sources. But the short-term political and economic consequences of such a move make it unlikely. Furthermore, it is unclear how many motorists confronted with stiff disincentives to drive would switch to bicycling as opposed to mass transit.

SUMMARY: ARRIVING AT THE DECISION TO BICYCLE COMMUTE

The decision to bicycle commute (or for that matter, choose any travel mode) is not well understood. That leaves room for a bit of theorizing on the broad relationship between the elements that have been discussed in this study. Below is a diagram of the decision to bicycle commute incorporating many of the factors examined in this report:

Given the relative importance of the key variables, the decision might be viewed as three-tiered: "Initial considerations" is where basic travel decisions are

[67] Palo Alto, Orange County, and Puget Sound area travel studies all indicated that driving to work was not considered stressful by a majority of



respondents.

resolved; at this stage larger aspects of one's life must be considered, along with distance, which in many instances determines the mode by default rather than choice. Trip barriers are taken up once the idea of bicycling seems like a feasible option; at this point the practical questions of accessibility, route selection and traffic safety receive priority, while weather remains a daily variable. Lastly, are the barriers associated with arrival - generally not insurmountable if other obstacles to bicycle commuting have been removed - but for some, these constitute a final hurdle to be cleared before the decision to cycle is made.

This diagram is by no means able to encompass all relevant factors; nor is it applicable to everyone. This also is not to suggest that everyone goes through such an orderly thought process in deciding whether or not to bicycle commute. What it does is organize relevant factors according to their place in the decision process, reflecting what should be a natural progression in deciding whether to bicycle commute.

Other Utilitarian Riding: Little specific to non-commute trips has been discussed in this report. On an aggregate level, much less is known about such trips, except that surveys of individuals show higher levels of utilitarian riding than bicycle commuting. Evidence explaining this difference is largely absent,, but is probably due to two factors which deter people from bicycle commuting: Distance and time. For the commuter distance is fixed, but a person can pick and choose what errands can be accomplished by bicycle. Second is that time is a major constraint for the work commute, while it may be much less so for non-work trips, allowing them.to be achieved at a slower, more relaxing pace.

Chapter IV. The Inadequate State of Data Collection on Non-Motorized Transportation

If non-motorized travel is to be effectively incorporated into urban transportation systems, levels of usage first must be examined in much greater depth than is currently the case, especially at the local level. (Up-to-date baseline data at the national and local level is beginning to appear; some results of the 1990 National Personal Transportation Study have just been released and data from the 1990 Census Journey to Work is expected out this year). This is particularly true with respect to walking: ***None of the cities contacted for this report had carried out any studies or surveys dedicated solely to assessing the role of walking in their transportation systems.*** only one city (Seattle) had substantive information on the walking habits of its residents, including reasons why people do and do not walk. Though more than half the cities knew roughly how many of their residents commute by foot, a substantial minority could not even provide a reasonable estimate. Fewer than five cities had data on the proportion of walking with respect to all trips. A handful of cities had conducted travel surveys in which walking was treated as a separate option, but in none of those was walking explored in any depth. Some travel surveys and mode-split data even lacked a distinct category for walking, or linked it with bicycling; a few such surveys conducted by regional transit agencies simply ignored non-motorized transportation altogether, lumping the less common modes together as an amorphous "other". Below is a summary of available data on walking among the cities contacted for this study:

Walking for Utilitarian Reasons: Available Data by City

city	% Commute by foot (City-wide or CBD)[68]	% of all travel	Avg. Trip Distnce	Trip Purpose	Demographic breakdown on walkers	Reasons for & barriers to walking
Chicago	x (CBD only)[69]	X	x	x	x	
Seattle	x		x	x	x	x
Boulder	x	x	x		x	
Davis	x					
San Dieao	x	x	x			
Phoenix	x	x				
Madison	x'(Univ. only)					
Minneapolis	x					
Tucson	x					
Portland	x	x		x		
Palo Alto	x					x
Orlando	x (CBD only)					
Raleigh						
Wash. D.C.	x					
New York	x (CBD only)					
Ft.Lauder-dale						
Gainesville						
Dallas						
Pittsburgh						
Eugene						

Bicycling fares a bit]better in that a number of cities have conducted studies specifically for the purpose of examining bicycle ridership. Nonetheless I a majority of the cities surveyed had not conducted a bicycling attitude study in recent years (if ever), and very few could pin down with much precision the extent to which its residents relied on bicycling as a means of transportation. The numerous blank slots in the table below are indicative of how few resources have been dedicated to examining the bicycling market and existing usage.

[68] The purpose of this column is to indicate which cities have generated this data themselves since 1980. Slots without an Y do not mean a complete absence of this data, since R is in the UTPP adjunct to the 1980 Census.
[69] The Chicago Area Transportation Study (CATS) is currently engaged in a multi-year study of Chicago area residents' travel behavior. The survey is being conducted area-by-area and, thus far, data is available for only a few areas of Chicago; aggregated data for all residents is absent. Currently available travel data is restricted to those who reside in the CBD (a mere fraction of the total population) and a few outlying areas.

Bicycling for Utilitarian Reasons: Available Data by City[70]

city	% Commute by bike (City-wide or CBD)	% of all trips	Avg. Trip Distance	Bicycle Demand/ Attitude Survey	Travel Survey w/ Bicycling Category	Project/ Program Follow-up Study	Bicycle Counts of Key Corri-dors
Chicago							
Seattle	x			x	x	x	x
Boulder	x	x			x		x
Davis	x			x	x		
San Diego	x	x			x		
Phoenix	x	x		x	x	x	
Madison	x				x (Univ.)		x
Minneapolis	x						x
Tucson	x				x	x	
Portland	x	x		x	x	x	x
Eugene							
Dallas							
Pittsburgh							
Orlando	x				x		
Ft.Lauderdale	x				x		
Gainesville	x						x
Raleigh						x	x
Wash. D.C.							
New York	x			x	x		x
Palo Alto	x				x		

What the lack of data on bicycling and walking highlights is an apparent lack of interest among cities across the country in discovering and fully exploiting demand for non-motorized transportation. For neither substantial investment in nor neglect of non-motorized transport is justified unless more is done to determine actual levels of utilitarian walking and bicycling, and what influences those levels. This latter point is crucial, and represents a major missing link in most regionally specific material. All in all, a number of gaps must be filled:

Travel Distances: Much of this report has focused on the powerful role played by distance in mode choice. Thus any attempt to develop and promote non-motorized alternatives must be preceded by a thorough examination of travel distances, particularly the daily commute. As mentioned earlier in this report, the quality of commute distance figures ranged from "guesstimate" to fairly precise numbers generated from massive data bases. Fewer than half the

[70] As with the table on walking data, an 'x' indicates the city itself has generated this data.

cities surveyed had breakdown of commuters by trip mileage. Yet all of these cities expressed a desire to increase nonmotorized transport. A careful analysis of commute distances will provide a baseline for potential mode shifts to walking or bicycling. Acquiring such data is thus an essential first step in developing a strategy to promote non-motorized alternatives.

Walking and Bicycling Should be Reported as Separate Modes: Lumping bicycling and walking together is of no value whatsoever, since it may cause policy makers to view them as inseparable, and thus identical. Neither mode is best promoted this way, since they serve different segments of the population and pose vastly different sets of problems.

Incentives and Barriers: Very few region-specific reports pursued this aspect of mode choice in much depth, yet it is crucial information in assessing the potential for non-motorized alternatives. It is particularly important to understand what people find attractive about their current mode that other modes are unable match. One issue that demands study is the effect of parenthood on mode choice- particularly since the parents of young children tend to fall into the age bracket most widely correlated with bicycle commuting.

The Effect of Facilities on Mode Choice: This represents a serious shortcoming in available data, particularly with respect to bicycling. Case studies which carefully examine the affect of specific facilities on levels of utilitarian bicycling are few in number, especially in the last ten years.,Of course these are far from simple to accomplish, but they are essential in order.to gauge the role of objective factors (in particular, infrastructural enhancements) in stimulating shifts to non-motorized travel. These entails well-planned pre- and post-project counts along with detailed surveys of facility users.

Longitudinal Studies of Travel Behavior: many individuals change their mode of travel over time due to a variety of factors - job, area of residence,, family requirements, transportation options, etc. Monitoring the travel behavior of selected individuals over the course of several years might uncover the factors that inhibit utilitarian bicycling and walking and also aid in distinguishing personal and/or demographic influences on mode choice from external or objective factors. None of the cities surveyed here had carried out any such study.

Compare Users and Non-users of Non-motorized Modes: studies in which dedicated utilitarian bicyclists and walkers are systematically compared with dedicated motorists and transit users appear to be largely absent from the literature. Such a study might well reveal some striking differences (or similarities) in demographic characteristics, such as educational background, as well as in attitudes and values. A few of the surveys and reports reviewed contain data which allude to such differences, but none focused extensively on this topic.

CHAPTER V. DETERMINING DEMAND FOR NON-MOTORIZED TRANSPORTATION: A REVIEW OF ANALYTIC APPROACHES

A number of widely divergent approaches have been employed in evaluating and predicting potential demand for bicycling and walking. At this point it would be useful to review and assess the value of these approaches in light of the current state of information on non-motorized transport.

A. CORDON COUNTS

As indicated in the above table on available bicycle data, bicycle counts at key locations are a widely used tool for assessing the change in ridership over time, and-for measuring the effectiveness of anew facility, project or program in generating new demand. Unfortunately, it is a very crude measuring device, and unless the counts are conducted consistently, and the subsequent analysis handled with the utmost sensitivity, the value of such counts is highly dubious. Any number of factors can result in changing ridership over time that are unrelated to the effectiveness of a facility in stimulating usage: New trip generators in the vicinity, changing demographics, improvements in competing transportation modes or in alternate routes, general trends in ridership, fuel shortages or price hikes, etc., all may affect the data. Furthermore, unless the count is conducted as part of a comprehensive vehicle count, the data is without a context. In other words, a reported increase in bicycle usage might simply reflect an increase among all forms of travel, but unless general traffic counts are done simultaneously with the bicycle counts, this would remain unknown, and any conclusions drawn from the bicycle count itself would be premature. In short, accounting for the effect of other variables on the bicycle count is an essential, if daunting task, but without such an effort conclusions based on counts will be difficult to justify.

B. MODE CHOICE/PREFERENCE/ATTITUDE SURVEYS

These kinds of surveys are of course designed to measure the traveling habits of the public. In fact, there are two distinct goals. one is to gauge current habits by asking straightforward questions regarding work location, distance to work, and usual travel mode,,along with a typical range of demographic questions. Not surprisingly, this was the most frequently encountered approach of most of the cities surveyed. However, such an approach is nothing more than a useful cataloguing of aggregate behavior, for even if collected annually, by themselves such numbers can merely reveal change, not explain it. In short, while focusing on current mode choice and demographics may provide us some interesting correlations, this approach doesn't offer much insight into the choice itself. Presumably for that reason, a number of recent surveys delve a bit deeper into travel habits, asking questions about commute stress, work schedule, parking, alternatives, travel patterns, travel- related concerns, current TDM programs, etc. Even if not designed specifically to elicit attitudes toward nonmotorized transportation, an in-depth questionnaire with such a wide range of questions can reveal a good deal about the public's perception of the current transportation system and may even suggest the kinds of changes the public might be willing to accept. But this depends on whether the survey elicits information of sufficient depth; accurate, but superficial data could lead to the wrong policies. For example, suppose a survey revealed that a substantial majority of downtown commuters in city X were under forty years old and that most of them lived within 5 miles of the central business district. By itself, that might lead to the reasonable conclusion that an improved bicycling infrastructure is in order. However, if the survey had asked whether the worker commutes directly from home to work, it might have been discovered that a majority of those under forty need their cars to pick up their children at day care. Under these circumstances, a major investment in commuter bicycling infrastructure might result in less use than planned. The point is really an obvious one: Such surveys can create the illusion of a market that seems to hold much more potential than it really does.

C. SPECULATIVE SURVEYS

The above caveat may be even more applicable to the 'speculative' market survey now widely employed to plumb the depths of the alternative transportation market. This technique is perhaps better described as a 'contingency- based mode preference survey.' Rather than simply inquire about current habits and attitudes, the respondent is presented with a series of "what if" variations, events or changes which theoretically might influence the choice of a travel mode. A number of cities have employed this technique in their travel surveys, as did a major national survey on bicycling conducted in 1990. The technique is based on a conditional question followed by a set of circumstances. The question typically reads: *"Would you consider using your bicycle for work trips and errands if .... "*

1) "...there were a comprehensive network of bikeways.."
2) "...your employer provided bike racks and a place to shower and change clothes.."
3) "...free parking was not available?"

The responses to these contingencies supposedly reveal the potential for mode shifts and suggest that appropriate policies could stimulate a dramatic rise in bicycle usage. But a number of problems with this kind of survey,weaken such assertions. First, the conditional question is often phrased in a way that makes a 'yes' response comfortably non-committal, inevitably inflating the proportion appearing to favor bicycle commuting. Second, the conditions themselves represent an incomplete range of factors affecting mode choice and usually ignores the most important barrier of all: distance to the work place. Moreover these surveys rest on two questionable assumptions regarding the mode choice process: First, they assume that piecemeal improvements in the bicycling environment will themselves generate substantial mode shifts; second, these surveys assume that people will do as they say - which, according to research cited earlier, has not proven true with bicycling. As demonstrated throughout this report, the individual decision to bicycle commute (or choose any mode) items from a host of subjective and objective factors ' not all of which pertain directly.to the bicycling environment.

Speculative surveys are more useful when the scenarios are carefully crafted so that the context is unambiguous. This is the approach taken in *Feasibility of Demand Incentives for Non-Motorized Travel*. This report recognizes that a broad array of factors influence the decision to walk.or bicycle, and that these factors must somehow be evaluated in light of each other if meaningful conclusions are to be reached. Listed below are the major features built into the study design:

-The cities and neighborhoods from which the sample was drawn were chosen for their contrasting features which represent "types" - in terms of land use, density, demographics, and trip attractors - which the authors contend are typical to many areas of the country, thus broadening the applicability of the data. The overall sample size is exceptionally large, resulting in adequate sample size for the key subsets of bicyclists and walkers. (This is a major drawback for almost all mode preference surveys in which bicycling and walking are examined). Still, the design is flawed because participants were I self-selecting. Though they distributed the surveys randomly, they could only process those which were returned. A glance At the socioeconomic profile of the respondents indicates that a high percentage were college educated, a proportion far beyond national averages. That probably skewed the responses to some questions.

-A great deal of demographic and travel data were collected from each respondent, including mode choice, trip distance, number of stops, and number of people on the trip. Then mode choice for the last trip is measured against mode preference.

-Respondent was presented with a series of strategies or scenarios for increasing non-motorized alternatives and then in light of these scenarios was asked a second time about mode preference.

-Travel attributes associated with bicycling and walking were rated by each respondent; the data was then broken down and compared by primary travel mode.

-A perceptual model was developed through a factor analysis of mode attributes - broken out by specific mode, by site, by trip type, and by all modes and sites lumped together.

-Based on factor analysis, a preference model was developed for predicting mode shifts for each of the scenarios.

Based upon the scenarios, this model estimated mode shifts to walking and bicycling that were substantially smaller than the stated preferences of respondents. This gap between stated preference and probable behavior is a major weak spot for all speculative surveys and reveals the need for research into why attitudes toward bicycling and walking are generally positive while behavior congruent with such attitudes is so relatively rare.

D. MARKET-BASED STRATEGIES

Though focusing primarily on perceptions of travel modes under a series of scenarios, *Feasibility of Demand Incentives for Non-Motorized Travel* can also be viewed as a sophisticated example of the "market-based strategy". In its more standard guise, this approach eschews theoretical scenarios and concentrates on demographics, travel behavior, mode perception and willingness to change. A good example of this is a study by McKeever, Quon, and Valdez.[71] Part and parcel of their approach is to find out what factors people consider in choosing a mode and their reasons for not wanting to consider an alternative mode. Applying traditional regression analysis to the data, this approach can yield some rough estimates of who is likely to switch to alternative modes.

Some market-based strategy reports focus entirely on demographic features to estimate the potential for nonmotorized modes. Using data derived from the Bay Area Travel Survey in 1981, Deakin (1985) defines a demographic target group for Bay Area commuter cycling. Guiding these estimates is a set of reasonable assumptions based on her review of the literature and a series of interviews with local and state officials. Her target market is defined as:

[71] McKeever, Quon, & Valdez, 'Market-Based Strategies for Increasing the Use of Alternate Commute Modes," presented at the 70th Annual Meeting of the TRB, January 1991.

- Employed full-time
- Under 40 years old
- Travel less that 7 miles one way to work
- Drive alone during the peak period

- own a bike suitable for commuting.

From here it simple arithmetic to arrive at a numeric estimate, and what emerges is a conservative, yet credible range. Essentially Deakin has created a device for determining who should be included in (and implicitly, who should be excluded from) the primary target market, the segment of the public most likely to switch to commuter bicycling. But she is unable to estimate what proportion of these will be deterred by the numerous subjective and objective factors that affect individuals differently. Thus Deakin concedes that her range represents a probable upper bound on the size of the market. This demonstrates the inherent limitation of this approach; nonetheless, it ,significantly narrows the hunt for the elusive bicycle commuter.(One could also quibble with the finer points of her target market, but this is a technical rather than a substantive limitation). Lastly, it is important to note that this strategy was facilitated by the existence of a large data base of travel information stemming from the aforementioned Bay Area Travel Survey.

Erickson (1991) attempts to refine Deakin's approach and apply it to a particular market (northeastern Illinois). Lacking regionally generated data used in Deakin's study, Erickson develops a model for projecting short-term and long-term mode shifts by using data for this region drawn from the 1980 Urban Transportation Planning Package (UTPP). With minor modifications, his short-term target market resembles Deakin's, but he goes one step farther and attempts to refine the target for lower and upper-bound predictions. He does so by applying existing national bicycle usage statistics against the locally defined target market. For example, Erickson suggests that the proportion willing to make the switch to bicycling be based on the percentage of regular riding adult cyclists and current bicycle commuters (the numbers come from separate studies) multiplied times the general short-term target market. Unfortunately, bicycle usage statistics are themselves rough approximations of reality; thus employing them as multipliers against a loosely defined local target population could yield some highly misleading estimates.

One variant on such estimates of demand is to apply yet other factors against the generally defined target market. Such factors would take into account the terrain, weather, and the quality of the bicycle facilities, among other possibilities. [72]

Deakin and especially Erickson rely heavily on numerical analyses to yield estimates of potential ridership, but neither ever quite address why the individuals behind the numbers are not currently traveling to work by bicycle, nor what it is that will motivate these people to fit the role the numbers say they should play.

D. THE UTILITY MODEL

This approach assumes that individual decision-making with regard to the choice of a travel mode is a rational process, and that the decision is largely based on objective factors such as time and cost. "Logit" Mode Choice Models work from this premise. These models attempt to predict the share of work trips for each travel mode available to commuters in some defined area. The estimated mode split is based on the imputed utility of the various modes, which is nothing more than the weighted value of the characteristics that influence the choice of that mode. The calibration of these characteristics ultimately is what determines the accuracy of the model. The key issue here is whether bicycling and walking can be captured in such models given that difficult--to-measure subjective factors may be constraining mode shifts to non-motorized forms. The answer, based on the review of one such model, is simply that subjective and personal factors are ignored.[73] What distinguishes this model is that bicycling and walking are worked into the picture by evaluating the effect that the pedestrian and bicycling environment have on public transit ridership; the focus is on "transit serviceability.11 Thus features such as the presence and extent of sidewalks, land use mix, bicycle infrastructure, restrictions on automobile access, etc. are qualitatively assessed for a given locale, and are then assigned weights as measures of bicycle and pedestrian friendliness. The weights for each characteristic are then added up to attain a "transit serviceability index". This is folded back into the overall model. It is claimed that the model has provided good predictions of actual mode splits. Unlike the market-based strategy models, this modified logit-mode choice model focuses exclusively on objective conditions and makes no attempt at outlining a demographic profile of likely converts to non-motorized modes. But by doing so it ignores individual aspects of mode choice, and implicitly, may be recognizing their unmeasurable nature. With both logit mode choice and market-based strategy, how

[72] This approach was used by William Feldman of the New Jersey DOT in 'VMT Reduction In the Year 2000 Attributable to the lmplementation of a Statewide Bicycle Transportation Strategy."
[73] Replogle, Michael,"M-NCPPC 1988 Logit Mode Choice Model For Home-To-Work Trips".

to measure and incorporate subjective personal factors in individual mode choice models remains an unanswered question.

CONCLUSION AND RECOMMENDATIONS

Though bicycling and walking are popular forms of exercise and recreation, they are not widely used as purposeful travel modes. This is true of all ages, though bicycling is much more prevalent among those under 45 years old. Ironically, bicycling, which can carry one farther and faster than walking, is relied on less for utilitarian purposes than walking. That stems from a common perception that on-road bicycling is neither safe nor convenient. Where bicycle facilities are more extensive, and more specifically, when bike lanes are incorporated into a city's street system, utilitarian bicycling appears to be more popular. This relationship, however, has not been clearly established in the literature; the effect of facilities on purposeful walking also remains unknown.

Levels of bicycling and walking vary substantially from place to place. Cities with relatively high levels of utilitarian cycling seem to have some or all of the following characteristics: More people commuting short distances, a high proportion of bikeways and bike lanes, a mild climate, and a large proportion of students in the population. University towns enjoy the highest levels of bicycling, and in some instances, very high levels of walking, though few places had data on the use of walking for short errands. Data suggest that urban density and the inconvenience associated with driving stimulate some short walking trips, particularly in central business districts where places of interest tend to be close and parking is limited. Surveys, however, indicate that exercise, recreation, and enjoyment are the most commonly cited reasons for walking or bicycling.

Two overarching themes link the limited role of nonmotorized travel in America. One are the great distances people travel both on the daily commute and for many ordinary activities. Distance is identified by both walkers and cyclists as the major disincentive to bicycle or walk more frequently. Genuine solutions to this are complex and would involve a major change in the way we live and work. This seems to preclude a major shift in travel habits toward non-motorized forms in the short run. The second theme is the predominant role of the automobile in our transportation system. Evidence shows that automobiles are used for many short trips which could be accomplished by walking or bicycling. To most people, the advantages of the automobile as a commute mode far outweigh the benefits associated with bicycling and walking. However, where driving is made less convenient and much more expensive, non-motorized transportation is more popular.

Recommendations:

- Bicycling should be promoted and requisite facilities expanded or enhanced in those places where high levels of bicycling are likely. Atear with hiqh concentrations of people under 35 (such as university communities), short travel distances between key trip generators (5 miles or less for the work commute; 2 miles or less for errands), and space for on-road facilities should receive top priority

- Cities should target specific demographic markets for bicycling. For example, as bicycling commuting is predominantly the province of the young, it should be marketed to -them as a healthful and potentially timesaving mode of travel.

- Focus should be placed on creating a linked network of bicycle facilities so that access to all areas of a city are enhanced. If a city wide system is infeasible, then facilities could be concentrated in areas or along corridors where the.young live and move. Ancillary facilities should receive priority only when it can be demonstrated that-these, and not the quality of the bicycle facilities, are the Primary impediment to increased bicycling.

- More bike lanes and wide curb lanes Along arterials are the preferred investment strategy for raising the level of bicycle commuting in the short term; they should be a standard feature for all new roads and be a required component of roadway rehabilitation.

- Single-occupancy vehicles should be actively discouraged in areas of high traffic Congestion via strong economic disincentives. Any policies which diminish the convenience or significantly raise the cost of driving will encourage at least some people to experiment with non-motorized modes of travel.

- Park trails and bike paths should be expanded they Provide healthful recreation and may motivate some to walk or bicycle for utilitarian reasons. Such "spillover" effects demand more study.

- Sidewalks in good repair are essential in all urban and most suburban areas as a minimum facility to encourage walking. The higher the density in a given area, the greater the imperative for sidewalks.

- Knowledge of bicycling and walking habits must be vastly expanded, and approaches to data collection should be standardized to make regional comparisons more meaningful. A major effort should be undertaken to determine how walkers and bicyclists are similar to and different from other segments of the population. Developing a profile of bicyclists and walkers will help define a target market for non-motorized transportation.

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	Davis	Palo Alto	Boulder	Eugene	Gainesville	Orlando	Madison	Raleigh	Minneapolis	Pittsburgh
Population	55,000	56,000	80,000	106,000	140,000	166,000	190,000	212,000	358,000	370,000
Area (sq.mi.)	8	25	27	35	35	71	58	91	58	55
Pop. Density	6,875	2,240	2,985	3,029	4,000	2,338	3,276	2,330	6,172	6,727
Mean High Temperature	73.71	69.0	65.3	63.3	81.4	82.8	56.1	70.3	54.2	59.9
Days 0.1"+ Precipitation	47	38	51	138	75	116	118	112	114	153
Terrain	Flat	Flat	Mostly flat	Flat +hills	Flat	Flat	Flat + hills	Mildly hilly	Flat	Rolling hills
Total Mi's.Bikeway	56	42	39	60	102	5	33	50	46	20
Ml Bike Lane	31	35	14	38	75	0	13	10	6	10
Ml Bike Paths	25	7	25	22	0	5	20	40	40	10
Bike path/Bikeway Miles	0.45	0.17	0.64	0.37	0.00	1.00	0.61	0.80	0.87	0.50
Mi's of Street	106	N/A	280	427	400	430	587	806	1,078	800
Arterial/Collector Miles	33	N/A	116	126	125	N/A	210	N/A	306	248
Mi's Bkwy/Mi Street	0.528	N/A	0.139	0.141	0.255	0.012	0.056	0.062	0.043	0.025
MI.Bkwy per Sq.Mi.	7.0	1.7	- 1.5	1.7	2.9,	0.1	0.6	0.5	0.8	0.4
MPs SklaneIMl Arterial	0,939	N/A	0,121	0,302	0,600	0,000	0,062	N/A	0.020	0.040
Avg. Commute	3.0	11.0	5.1	4.0	-4.0	12.0	7.2	N/A	7.0	6.0
% Commute < 5 miles	68.0%	N/A	77.0%	N/A	N/A	22.0%	56.0%	N/A	35.0%	N/A
% Bicycle Commute	25.0%	2.6%		8.0%	10.0%		11.0%	0.2%	2.0%	0.5%

	Tucson,	Portland	Seattle	Washington	Phoenix	Dallas	San Diego	Ft.Lauderdale	Chicago	New York
Population	403,000	435,000	516,000	628,000	1,000,000	1,000,000	1,000,000	1,300,000	2,800,000	7,300,000
Area (sq.mi.)	156	137	86	63	424	390	331	411	228	322
Pop. Density	2,583	3,175	6,000	9,968	2,358	2,564	3,021	3,163	12,281	22,671
Mean High Temperature	81.7	62.0	59.7	66.4	85.0	76.9	70.5	83.5	58.7	62.2
Days 0.1"+ precipitation	52	149	158	112	35	78	43	80	126	121
Terrain	Flat to rolling	Some hills	Hilly	Flat	Flat	Flat	Flat	Flat	Flat	Flat
Total Mi's.Bikeway	73	76	54	44	59	42	113	33	18	94
Mi Bike Lane	67	40	15	2	59	0	93	17	0	45
Mi Bike Paths	6	36	39	42	0	42	20	16	18	49
Bike pathBikeway Mi's	0.08	0.47	0.72	0.95	0.00	1.00	0.18	0.48	1.00	0.52
Mi's of Street	1,751	2,092	1,394	1,102	3,802	6000	2,519	.3,900	3,676	5,585
Arterial/Collector Miles	509	490	477	433	977	N/A	711	834	989	2172
Mi's Bkwy/Mi Street	0.042	0.036	0.039	0.040	0.016	0.007	0.045	0.008	0.005	0.017
MI.Bkwy per Sq.Mi.	0.5	0.6	0.6	0.7	0.1	0.1	0.3	0.1	0.1	0.3
Mi's Bklane/Ml Arterial	0.132	0.082	0.031	0.005	0.060	0.000	0.131	0.020	0.000	0.021
Avg. Commute	10.6	6.6	9.0	8.5	9.0	N/A	10.6	8.0	12.6	N/A,
% Commute < 5 mile$	32.0%	40.0%	40.0%	N/A	34.7%	N/A	32.0%	N/A	40.0%	6.0%
% Bicycle Commute	3.5%	2.0%	2.3%	0.5%	2.4%1	0.2%,	1.6%	0.8%	0.7%	0.2%

Appendix #1 **Compiled by Stuart Goldsmith**