Integration of Bicycling and Walking Facilities into the Infrastructure of Urban Communities

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Integration of Bicycling and Walking Facilities into the Infrastructure of Urban Communities

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16. Abstract

Several manuals, handbooks and web resources exist to provide varied guidance on planning for and designing bicycle and pedestrian facilities, yet there are no specific indications about which of the varied treatments in these guides work well for users. This project highlights best practices and identifies program characteristics associated with high levels of non-motorized travel, with an emphasis on bicyclists and pedestrians. It highlights practices in the California communities of Davis, Palo Alto and San Luis Obispo. The case studies are used to illustrate how urban communities have integrated non-motorized transportation modes into the physical infrastructure and worked to educate community residents and employees. The most salient themes that emerged from this study are linked to the following user preference: (a) distance to desired land uses and activities; (b) route directness; (c) route connectivity; (d) the separation of motorized and non-motorized transportation modes; (e) safety; (f) convenience; and (g) education and outreach. The aforementioned themes are integrated into key guiding principles that correspond to the trip-making cycle, from the decision to engage in an activity through the choice of route to arrival at the destination.

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Cornelius Nuworsoo, Ph.D. is the Principal Investigator. He prepared the study proposal, conducted day-to-day project management and coordination of all tasks. He performed much of the analyses, wrote sections and compiled the study report.

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This project highlights best practices and identifies program characteristics associated with high levels of non-motorized travel, with an emphasis on bicyclists and pedestrians in the selected California urban case study communities of Davis, Palo Alto and San Luis Obispo. The case studies are used to illustrate how urban communities can better integrate non-motorized transportation modes into the physical infrastructure and educate and reach out to community residents and employees.

THE PROBLEM

U.S. cities lack a unified approach to promoting bicycle transportation because bicycle mode choice is dependent on such important factors as year-round weather conditions, topography, trip purpose, and trip length. This is reflected in the fact that there are numerous manuals, handbooks and web resources that provide varied guidance on planning for and designing bicycle and pedestrian facilities (See, for example, AASHTO, 1999; Florida DOT, 1999; Wisconsin DOT, 2004; California DOT 2005). Although many guidelines exist, there are no specific indications about which of the varied treatments in these guides work well for users. Some U.S. cities (for example, Davis, San Francisco, Santa Barbara, and so on) are highly acclaimed for effectively deploying bicycle-friendly and walking facilities, but most cities are generally not conducive to bicycling and walking. Many municipalities simply lack the resources to assess what is needed to integrate bicycling and walking with other means of travel. This study attempts to bridge that gap.

APPROACH

The study involved: (a) collection and analysis of primary data from field observations; surveys of users of non-motorized, public transit and automobile modes; interviews of system operators and managers; and (b) analysis of secondary data from previous study efforts in the case study cities. These findings are combined with those in related literature to determine recurring lessons or themes. The resulting themes are then used to develop guiding principles for integrating walking and bicycling facilities into urban infrastructure.

STUDY FINDINGS & POLICY IMPLICATIONS

Key findings from this research and associated implications for policy include the following:

1. *User Differentiation* - Some of the main issues associated with creating a cyclist and pedestrian-friendly community include safety, weather, distance, parking, lifestyle, and education. For different groups of people (for example, the elderly and commuting workers), these factors vary in importance. For example, frequent cyclists or adults who would like to cycle more often value the provision of facilities that are safe and that allow them to reach their destinations easily.

2. *Bicycle Lanes vs. Paths* - Bicycle lanes are often rated more desirable than bicycle paths, possibly due to the fact that the lanes are designed primarily to connect people to destinations whereas paths may have been designed for more recreational purposes.
3. *Cycling Safety* - The level of safety associated with cycling results from the quality of facilities as well as the skill level of cyclists. The fact that some cyclists ride on sidewalks, even though it is illegal, is a reflection of cyclists wanting to balance the convenience of using available connector routes and wanting to feel safe.
4. *Education* - Through education, cyclists and drivers learn how to accommodate each other, thus enhancing the safety of the travel environment for all. If cities want to create a better bicycling culture, they must develop well-rounded educational programs for children and adults in safe bicycling practices.
5. *Bicycle Parking* - Many survey respondents noted the importance of providing sufficient parking for cyclists. Cyclists want parking to be available at destinations the same way automobile drivers do. Availability of bicycle parking at key destination points can provide an incentive to bike.
6. *Trip Distance* - Trip distance is important in deciding both route and mode choice. The distance a person travels for each trip purpose is not only a function of the mix of land uses, but also the traveler's lifestyle.
7. *Convenience* - The number of people in the household with different schedules can make automobiles the most convenient travel option. As previous research has shown, providing facilities alone does not change traveler behavior. The convenience offered by the facilities, the awareness of the benefits of use, and education on proper use, are all important determinants in the choice to walk or ride a bicycle.
8. *Planning for Alternative Modes* - Rather than trying to retrofit alternative mode infrastructure after development has taken place, alternative mode facilities should be planned, designed and built when development first occurs, and not after. Continuing to build roadways and large parking lots that serve medium density development steers funding away from alternative modes. Additionally, it entrenches lifestyle patterns best served by the automobile. Some European cities have addressed this by focusing on a more balanced provision of mobility needs, rather than continuing to build roads.
9. *Route Directness* - Cyclists and pedestrians who use these non-automotive modes for more than recreation want direct routes, wide lanes that allow for passing, and signal phases for cyclists—in other words, many of the same things automobile drivers want.
10. *Traffic Calming* - Traffic calming elevates the importance of alternative modes, especially where non-motorized modes cross travel paths with vehicular traffic. There are an abundance of treatments available to towns and cities to suit various circumstances. Careful choice through a deliberative process can aid in the optimal use of funding to achieve user-friendliness.
11. *Complete Streets* - The Complete Streets movement provides examples, legislative options and ideas for retrofitting streets to accommodate all users. However, as

most people will not be walking or cycling throughout an entire city, it is important to provide infrastructure in places where walking and cycling to destinations are most feasible and most likely to occur. Cities should determine areas that could attract cyclists and pedestrians and focus on providing the best possible network in those areas.

12. *Separation of Bicycling and Walking Infrastructure* - Just as automobiles typically move at two to four times the speed of bicycles, bicycles typically move at two to five times the speed of walking. Consequently, for reasons of safety and convenience, bicycling and walking should be treated as separate methods of transportation where feasible.

13. *Recreational vs. Utilitarian Uses* - There are also distinct differences between utilitarian use and recreational use of alternative transportation modes. Bicycling and walking are different from driving cars in that walking or bicycling can, in and of itself, constitute recreational activity. This explains why approximately a third of all walking and bicycling trips are for recreational purposes while recreational trips by all modes combined is only half that proportion. Cities should therefore give particular consideration to both recreational and utilitarian uses when developing circulation plans.

I. INTRODUCTION

THE PROJECT

This project highlights best practices and identifies program characteristics associated with high levels of non-motorized travel, with an emphasis on bicyclists and pedestrians. The California urban communities of San Luis Obispo, Davis, and Palo Alto are used to illustrate how urban communities can better integrate non-motorized transportation modes into both their physical infrastructure and employee/resident education and outreach.

PROBLEM STATEMENT

With increasing concern about global warming, greenhouse gas emissions and rising fuel prices, non-motorized modes such as bicycling and walking are gaining importance as viable choices in urban transportation. Having emphasized automobile transportation for so many years, many cities in the United States are not accustomed to addressing alternative modes of mobility. This over-emphasis is reflected in personal travel habits of U.S. adults. At the national level, more than 90 percent of work trips are typically made by the automobile, 5 percent by public transit, 2.5 percent by walking, and a mere 0.5 percent by bicycle.[1] National concerns about energy use and recent greenhouse gas legislation (for example, California's AB 32 and SB 375) make it increasingly obvious that communities in the U.S. need to increase the level of non-motorized travel.

Even where alternative modes are addressed, not all U.S. cities have taken the same approach to promoting bicycle transportation because bicycle mode choice is context-dependent, related to factors such as year-round weather conditions, topography, trip purpose, and trip length. Even in cities like Davis, Palo Alto and San Luis Obispo, which have strongly promoted bicycling, there is room for improvement, particularly in the areas of design and planning tools for assessing the ridership, mode shift and safety impacts of expanding bicycle networks and pedestrian facilities. An analysis of these cities provides an important set of lessons to others on the dynamic nature of effective alternative transportation mode planning.

Several manuals, handbooks and web resources provide varied guidance on planning for and designing bicycle and pedestrian facilities (AASHTO, 1999; Florida DOT, 1999; Wisconsin DOT, 2004; California DOT 2005). There is also policy guidance at federal and local levels to promote bicycle and pedestrian travel. For instance, "The Bicycle & Pedestrian Program" of the Federal Highway Administration (FHWA) promotes bicycle and pedestrian transportation use, safety, and accessibility at the federal level. The program requires each state to have a bicycle and pedestrian coordinator in its state Department of Transportation. The responsibility of the coordinator is to promote and facilitate the increased use of non-motorized transportation. The program includes: developing pedestrian and bicycle facilities, promoting their use, and educating the public on how to safely use such facilities.[2] Although so many guidelines exist, there are no specific indications about which of the varied treatments in these guides work well for users. While some cities are highly acclaimed for deploying bicycle-friendly and walking facilities, most lag behind and lack the resources to assess what is needed to integrate them with other means of travel. This study attempts to bridge that gap.

STUDY APPROACH

This study investigates policy, infrastructure choice, and operations that emphasize mode shifts away from the automobile. It also analyzes how public education can facilitate increased mode shifts and how both the “hard” and “soft” aspects of transportation policy can enhance the integration of non-motorized modes into the existing urban transportation infrastructure. To accomplish this, three cities that have received national recognition as pedestrian- and bicycling-friendly places were studied.

This study provides insight into the following areas:

- Treatments most preferred by users
- Treatments that users, accident data, or system managers reveal as inappropriate
- Program characteristics associated with high alternative mode choice
- Key areas within the master planning process best suited to bicycling and walking

The study combines primary data from surveys of users of non-motorized, public transit and automobile modes with secondary data from previous study efforts in case study cities to identify program characteristics associated with high ridership levels and provide guidance on improving bicycle/pedestrian planning in urban neighborhoods and communities. The guidance document produced for this study includes visual documentation of examples along with user rating of various facility treatments.

Literature Review

The study began with an extensive review of related literature. The objectives of the review were twofold: one was to find documented answers to the study questions; the other was to identify issues to address in interviews and the user survey. The findings of this part of the project are summarized in Literature Review/Survey Development Research Section and Appendix A.

Case Study Interviews, Data Review and Field Observations

The second part of the study involved a series of activities documenting salient characteristics of the case study locations. Data collection activities included structured interviews with system managers and operators in the three case study cities. Appendix C includes a copy of the questionnaire used for interviews. Another set of activities included review and summary of existing data on the case study cities. Much of this data is based on periodic surveys conducted by the League of American Bicyclists, the agency that ranks communities for bicycle friendliness. A third set of activities involved field observations of specific treatments in the case study cites. These observations were used to create a visual typology of bicycle- and pedestrian-friendly features. Findings for this part of the study are summarized in chapter 3.

Survey of User Choices and Preferences

A survey on transportation mode choice, emphasizing bicycling and walking, was designed and administered to target groups including bicyclists, pedestrians, and the general public. Appendix D contains a copy of this survey instrument, and a summary of the results of this survey is summarized in chapter 4.

BACKGROUND

Planners, engineers, and citizens have come to recognize that while automobile use over the last several decades has increased accessibility and the quality of life in some respects, the resultant auto-oriented cities has its disadvantages, including air pollution, traffic congestion, and high infrastructure maintenance costs. To reduce automobile dependence, many cities throughout the world have increased efforts in recent decades to plan for increased bicycling and walking, as a complement to existing public transportation.

The main goal of this expanded focus on multi-modal transportation is to increase safety for autos, cyclists, and pedestrians; reduce traffic congestion; make transit a viable option; and reduce the negative impacts of excessive auto use. In their study, Pucher and Dijkstra show that percentages of adults walking and bicycling in 1995 were six and one percent in the U.S., respectively, and above 20 and 10 percent in many European countries. At the same time, American pedestrians and cyclists were three and six times more likely than Dutch pedestrians and cyclists to be fatally injured. Pedestrians in the U.S. were also 23 times more likely to be killed than car passengers.[3] Goldsmith states that the major deterrent to cyclists in the U.S. is traffic safety, while the major barriers to walking are time limitations and fear of crime.[4]

A multitude of factors influencing the use of bicycling and pedestrian facilities in different cities have been identified in previous work. A number of cities have achieved positive results in increasing safety and bicycle use; however, a considerable amount of planning effort relies heavily on what planners and engineers *believe* cyclists and pedestrians need.[5] This study aims to look at the issue from the perspective of the cyclists and pedestrians to determine what facilities users actually want, and which characteristics of the built environment and infrastructure they prefer.

Cyclists and pedestrians often fall under the category of so-called “alternative” or “non-motorized” modes of transportation, but this research, along with many previous studies, show that the needs of cyclists and pedestrians are quite different. They display different behaviors and have different preferences. Within each of the categories, there is also a wide range of users, including inexperienced, young, recreational cyclists and experienced, commuter cyclists.

STATE OF BICYCLING AND WALKING IN THE U.S.

According to the Bureau of Transportation Statistics (BTS), 90 percent of work trips are typically made by the automobile, 5 percent by public transit, 2.5 percent by walking and a mere 0.5 percent by bicycle.[6] These facts reveal how meager the shares of non-motorized modes are when the work trip is concerned. The report notes that walking captures five times the share of bicycling and public transit captures ten times the share of bicycling.

According to the National Household Transportation Survey (NHTS), 10 percent of all trips are conducted by walking and 1 percent by bicycling.[7] This reveals a much higher share of non-motorized transportation modes for purposes other than work; however, bicycling captures only a tenth of the share of walking. Seventy to 90 percent of trips of all purposes are made by the personal automobile, depending on the metropolitan area. Buses are used for roughly 1.5 to 4 percent, except for school, where the percentage is roughly 20 percent. Trains make up roughly 0.5 to 1 percent of trips. Americans are thus predominantly dependent on mechanical means of travel that run largely on fossil fuels, unlike walking and bicycling.

The average walking trip is 3/4 of a mile. The average bicycling trip is just over 2 miles. Roughly 30 percent of walking trips and 40 percent of bicycling trips are for recreational purposes, whereas only 20 percent of all trips using all modes are recreational, which shows the sizable proportions of non-motorized trips that are for leisure rather than utilitarian purposes. This indicates that planning for multimodal transit must purposefully satisfy the specific needs of utilitarian and recreational uses.

America Bikes states: “the average family spends 18 percent of its annual income on transportation.”[8] Since some people may find it difficult to buy or maintain one or more automobiles, providing bicycling and pedestrian infrastructure allows access for people of all incomes. Other research shows that people reduce their driving in response to difficult economic times.

Current safety statistics suggest a need for increased pedestrian infrastructure. For example, Ernst and Shoup note in “Dangerous by Design” that “41 percent of pedestrian fatalities take place where there are no crosswalks available.”[9] These facts point to the need for non-motorized infrastructure to promote their use and for safety during use.

Taken together, this snapshot of conditions for walking and cycling show that there is abundant room to increase the share of non-motorized transportation in lieu of automobile use if the right conditions are created for use of these modes. The right conditions would include the availability and convenience of non-motorized transportation infrastructure and connections with desired land uses and activity centers. This study provides insight into how planners can better accommodate current and future bicyclists and walkers by determining what is desirable from their point of view.

II. LITERATURE REVIEW

SURVEY DEVELOPMENT RESEARCH

This chapter provides an overview of the aspects of published literature that relate to the study questions. The overview enabled the study team to identify issues and system characteristics to address in interviews with officials and to formulate questions posed in the user survey conducted as part of this study. Table 1 is a summary of issues included in this study. They are grouped into the following categories: facility characteristics, environmental characteristics, amenities and trip-maker characteristics. Appendix A provides additional details.

Table 1. Research Subject Categories and Issues of Interest

Research Subject Categories	Issues	Research Subject Categories	Issues
Facility Type	Mixed with automobile traffic	**Individual and Trip Characteristics**	Gender
	Bicycle lane		Age
	Bicycle path		Income
	Sidewalk		Cycling experience
	Trail		Private vehicle ownership
Nature of Roadway	Functional class		Safety concerns
	Sight distances		Personal security concerns
	Turning radii		Trip Length, time or distance
	Lane/median configuration	**Environmental/ Situation Characteristics**	Nature of abutting land uses
	On-street parking		Aesthetics along route
	Pavement type/quality		Degree of political and public support
	Intersection spacing		Level of public assistance
	Cycling treatments at signals		Education and enforcement
	Completeness of infra-structure		Availability of public transport
	Stop signs, red lights and cross streets		Cost or other disincentives
	Directness of roadway		Terrain grade
	Volume or mix of vehicles		Climate
	Driver behavior	**Amenities**	Availability of showers
	Pedestrian interaction		Availability of secure parking

Influence of the Built Environment

Many studies show that the character of the developed urban environment (that is, the built environment) affects physical activity;[10] however, people have different reactions to the environment of their local neighborhood or region. Handy says the built environment alone is not enough to influence activity, but it can facilitate activity.[11] Goldsmith also states, “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.”[12]

In comparing European and American cities, Pucher and Dijkstra state that average trip distances in European cities are about half as long as in American cities.[13] This is achieved by having more compact development with mixed uses, which also makes it easier and more convenient to walk or cycle. Urban design in Europe is geared towards people and alternative transportation rather than cars. In the Netherlands and Germany, for instance, well-lit pedestrian areas, pedestrian refuge islands, raised crosswalks that are clearly visible, and pedestrian-activated crossing signals are important in creating a safe environment for pedestrians and cyclists.[14]

Why do European cities appear to embrace walking and bicycling more than American cities, even with similarities in the built environment and promotion of these non-motorized modes? Two possible explanations may be considered—the short average trip distances in Europe, and the auto-friendly conditions in the U.S.

Looking at the interface with automobile drivers, the literature on traffic education specifically discusses the need to design the built environment to avoid pedestrian and cyclist collisions. Traffic calming is reported to reduce the number of traffic fatalities by 53 percent on average in traffic-calmed neighborhoods compared to those that are not. “The risk of pedestrian death in crashes rises from five percent at 20 mph, to 45 percent at 30 mph, and to 85 percent at 40 mph,” according to the British Department of Transportation.[15] Environments that are not safe for walking and cycling deter the use of these modes.

Bicyclists

Location Case Studies

Hunt and Abraham report: “some studies consider a particular location or city, and relate its attributes to aspects of the bicycling behavior of its population relative to other locations. Typically, certain characteristics of an area are identified as responsible for the comparatively high rates of bicycle use in the area. This has been done for the city of Davis in California, for European regions and for North American cities generally.”[16]

Replogle describes the changes made to accommodate bicycling in Copenhagen, Denmark.[17] In the 1970s, the city chose to stop building roads and began to add bus priority lanes and create a cycle path network. Over a decade, this resulted in a 10 percent drop in automobile traffic and an 80 percent increase in bicycle use. There was a slight reduction in the number of cycling accidents despite increasing the size of the bicycling network and use. The commute mode share in 1995 was one-third car, one-third transit, and one-third bicycling.

Other location studies show social and political aspects of behavior. A study that surveyed bicycle professionals in the "top bicycle-friendly cities" in North America concluded that a full-time bicycle manager, supportive politicians and government agencies, and active citizens were important in having a successful bicycle program.[18]

Hunt and Abraham contend that studies relying on aggregate levels of analysis to describe travel behavior have numerous fallacies.[19] The primary problems with studies that compare aggregate mode shares to aggregate measure of factors that are thought to have influence is that there is no direct behavioral basis. Since aggregate models only discern differences between zones, "a large part of the actual variation in travel demand behavior remains undetected."[20] Hunt and Abraham also point out that ecological correlation can lead to confusion over cause and effect; "for example: did the bicycling priority at certain traffic signals in the area give rise to the high volume of bicycling or vice versa?"[21]

Validated Expert Opinions

Models for rating bicycling facilities have been generated using expert knowledge and experience. These models include a bicycle safety-rating index, a roadway condition index and a proposal for a bicycling level of service (LOS) standard.[22] These models use evaluated roadway characteristics such as road type, roadway geometrics and physical conditions, traffic conditions, and control conditions to help determine suitability for bicycle routes. However, there is a concern that these models do not accurately predict actual cyclist behavior.[23] A study was done to calibrate the bicycle suitability assessment model in which cyclists were asked to travel the route determined most suitable by the model and then travel as many other routes and compare their preference of these routes to the "most suitable" route. The study found that cyclist perception of suitability can differ from a numerical prediction of suitability. The study also showed that traffic volume and speed are the most important factors for bicycle suitability. This study demonstrates the need "to develop a method of mathematically representing roadway conditions that are desirable for accommodating bicycling traffic."[24]

The National Cooperative Highway Research Project Report #616 establishes criteria for analyzing multi-modal level of service on urban streets. The study developed four models that capture the interactions of the various users of the street, that is, auto drivers, bus riders, bicycle riders, and pedestrians. The models are sensitive to the street design (for example, number of lanes, widths, and landscaping), traffic control devices (signal timing, speed limits), and traffic volumes. While the models can help in evaluating the benefits of "complete streets" and "context sensitive" design options, they do not identify user preferences for treatments that this research is seeking. The models can help, however, in the evaluation of both existing and planned bicycling and walking infrastructure in terms of the likely travel experience of users.

Polls of Cyclists/Cyclists Opinions

Polls of cyclists have been used to evaluate their preferences, concerns, and importance of factors that influence bicycling behavior. Various bicycling surveys show that the average utilitarian bicycling trip is between one and two miles, and the average commute trip of cyclists is between five and six miles.[25] A study that surveyed 552 cyclists found that “age was positively correlated with preference for on-road facilities and negatively correlated with preference for bicycle paths separated from the roadway. Safety, scenery, terrain, and bicycle safety education were more important to women on average than to men. As expected, bicycling experience was negatively correlated with preference for off-road facilities and concerns about safety, traffic, and terrain. Bicycle safety education was rated almost as high as the need for bicycle lanes to improve community bicycling conditions.”[26] It is worth noting that the apparent preference for bicycle lanes over bicycle paths is not necessarily the result of their physical and operational characteristics, but rather the relatively few number of paths available to riders and the fact that they often do not go to big attractor destinations. One can postulate that if an urban area has as many bicycle paths as bicycle lanes that connect the same numbers of trip attractors and generators, most people would choose the paths. Similar findings and conclusions are later revealed from the user survey conducted for this research project.

The city of Calgary conducts a cyclist survey every four years in the CBD to better understand cyclists needs and improve facilities. The survey found that “commuter cyclists spend an average of 50 percent of their journey on pathways and 45 percent on-road.”[27] The top request from cyclists was to improve the bicycle lanes both inside and outside of the downtown. A secondary request was to increase secure parking, change room and shower facilities. Those surveyed also expressed a “considerable interest” in a “bicycle station” facility. The survey also found that even though it is more dangerous to ride on the sidewalks, 44 percent of cyclists stated that they ride on the sidewalks.[28]

In Denmark, bicycle paths are facilities that are either off-road or essentially bicycle lanes separated by a median or barrier from mixed traffic. According to Bernhoft and Carstensen, most users in Denmark identify the presence of a bicycle path as an important factor in route choice. Besides the physical environment, many cyclists are focused on taking the shortest and most direct route possible. This is especially true for younger cyclists. Older cyclists are more likely to choose routes based on the presence of a bicycle path and less traffic. The study also found that 30 percent of riders find smooth pavements to be important when choosing a route, and the availability of signalized crossings is also a major factor.[29]

Other surveys show that more experienced cyclists are less fearful of safety issues,[30] and state lower stress levels than inexperienced cyclists with regards to high traffic volumes, narrower bicycle lane widths, and vehicle speeds.[31] Stress levels increase as lane volumes increase, lane widths decrease, and vehicle speeds increase. In general, 25 mph traffic produces a medium stress level and 45 mph traffic produces a high stress level.[32]

According to Hunt and Abraham, “when respondents are able to present wish-lists without any ‘cost’ they are encouraged to identify as much as possible. Rating different factors on their own is a somewhat abstract process, which can lead to some inaccuracies. Any sort of introspection concerning motivations has various problems, including the tendency towards ex post rationalization and even memory loss regarding decisions made in the past.”[33]

Non-cyclists

According to Hunt and Abraham, the issue over asking opinions of non-cyclists is that they have relatively little basis for evaluating various bicycling facilities. Therefore, the assumption can be made that if they choose to cycle, their preferences will evolve the same way the preferences of current cyclists have evolved.[34]

Discrete Choice Analysis

Choice analysis involves looking at the factors that affect cyclists’ decisions through development of logit models. Data about these factors are gathered through either revealed preference surveys (RP) or stated preference surveys (SP). Hunt and Abraham discuss the benefits and issues associated with each type of survey. RP surveys are valuable because they show the actual behavior and choices cyclists make in different situations. RPs are problematic because they represent a cyclist’s choice among many alternatives and not necessarily their ideal preference. It can also be difficult to determine the true preference of one individual factor if it is correlated with another factor. If the shortest route length is along arterial roads, we are not sure if cyclists prefer arterial roads or the shortest route. SP surveys, if developed correctly, can pinpoint preferences of specific attributes more clearly. However, there is always the question of whether or not the data represents reality and actual choices riders would make.

SP surveys show the value of bicycling facilities through time value, percent of total travel time, dollar value, travel distance, and ranking of importance. Modeling studies have shown many factors that are related to bicycling choice as “sex, car ownership, age, proportion of students within the population, ethnicity, socio-economic class and income. In addition to these, other physical variables of relevance have been found to include journey distance, degree of urban density and weather attributes, particularly mean temperature and rainfall and, very significantly, hilliness.”[35]

Cervero and Duncan looked at a discrete choice model of factors affecting bicycling behavior based on data from the 2000 Bay Area Travel Survey.[36] Slope and riding through a low-income neighborhood were the most significant deterrents, along with the number of vehicles in a household and traveling after dark. The model suggests that people are more likely to ride a bike if (a) they were black; or (b) male; or (c) engaging in social or recreational activity. Having a pedestrian or bicycle friendly environment increased the likelihood of choosing to cycle and was more significant than having land use density or diversity.

Nelson and Allen reviewed data on 30 cities to establish a correlation between certain factors and the percentage of bicycling commuters in an urban area. It was found that miles of bicycle path, percent of college students and number of rainy days were factors that helped to predict the percent of bicycling commuters in the area.[37] Dill and Carr continued this study using more cities and more variables. They found that if there is more bicycling infrastructure, there are higher rates of bicycling. Other variables, such as number of rainy days, vehicle ownership, percent of college students, and number of people employed in agriculture were significant together, but were not significant predictors on their own. For example, New Orleans, which has very little bicycle infrastructure, has a high percent of bicycling commuters, possibly due to lower income levels.[38]

Other studies look at how riders react to specific facilities. There are three main types of roadways available for bicycling in the U.S.: regular roadways with no special provisions for bicycles, bicycle lanes, and off-road bicycle paths. Streets without provisions for bicycles are the lowest ranking roadway type among users. Hunt and Abraham show that one minute in mixed traffic is equivalent to roughly four minutes in a bicycle lane or two minutes on a bicycle path. Reducing the amount of time a cyclist spends in mixed traffic is worth $17 per hour, as opposed to $4 per hour for reducing time on a bicycle path.[39]

Bicycle lanes are often the highest-ranking facility because they are seen as safer than riding in mixed traffic and also provide a more efficient means of getting from origin to destination than many off-road facilities. To use an improved bicycle lane, a cyclist would be willing to ride an extra 16 minutes, opposed to an extra four minutes for a bicycle path improvement.[40] Other factors that affect cyclists are on-street parking and the quality of the pavement. Users are willing to ride nine minutes longer to use a route where on street parking has been removed.[41] Another study finds that bicycle lanes have the highest utility from the point of view of inexperienced cyclists.[42]

Garrard observed the behavior of commuting cyclists at different locations around the Central Business district of Melbourne, Australia.[43] This study shows that women are more likely to use off-road facilities when they are available and use them more often than men. Women also generally cycle shorter distances than men. Also important are the facilities for parking bicycles at destinations, and facilities cyclists can use to change and shower. Availability of a secure, individual parking location for a bicycle is equal to 8.5 minutes on an arterial road. Taylor and Mahmassani found that individual bicycle lockers were valued as a 2.5 times greater incentive than only covered, lockable parking.[44]

Handy used a nested logit model to examine the decisions to both own and use a bicycle in six U.S. cities. The results showed strong effects of the attitudes of individuals as well as the physical and social environment on both ownership and use of bicycles. An important attitudinal variable, for instance, is whether respondents “liked riding a bicycle.” An important factor of the physical environment is “distance to destination.” And an important factor of social perception is “who else is bicycling.” The authors concluded therefore that “a multifaceted approach to increasing bicycling is needed, one that focuses on the individual level as well as the social and physical environments.”[45]

Pedestrians

Location Case Studies

Montgomery County, Maryland developed a Pedestrian Friendliness Index.[46] Scores were assigned to different zones based on the availability of sidewalks, bicycle paths, bus stop shelters, building setbacks, and local land use heterogeneity. The author found that the scores reflected variation in mode choice between automobiles and transit. Montgomery County also performed a sidewalk inventory. This inventory, along with mode choice data, showed that the presence of sidewalks was a significant predictor for whether people walked to transit, cycled to transit, or drove to work.

In Portland, the METRO planning agency developed a Pedestrian Environment Factor (PEF) to help in pedestrian prediction models. The agency gave zones scores based on sidewalk continuity, ease of street crossings, local street characteristics, and topography. "The PEF proved to be a significant factor in determining automobile ownership."[47] People with knowledge of a nearby location to walk to are more likely to be active.[48]

Polls of Pedestrians

Facilities important to pedestrians include sidewalks and crosswalks. Crosswalks are either located at intersections or mid-block, and can be signalized or without a signal in both types of locations. According to Bernhoft and Carstensen, 40 to 60 percent of pedestrians consider the presence of a sidewalk an important factor in route choice.[49] About 70 percent of users will cross a street where there is a crosswalk, rather than crossing at the most convenient location. However, only 38 percent say they will divert their route to use a crosswalk and 20 percent say they will never divert their route to use a crosswalk.[50] Also, 85 percent of pedestrians say their route choice is influenced by the presence of a midblock crosswalk and 74 percent of respondents said the presence of a signal influenced their decision to cross. Only 10 percent say they wait for a green signal while many others either wait for an acceptable gap or for traffic to clear completely.

Studies also show that most pedestrians are concerned with the fastness or directness of the route. With older pedestrians, the smoothness of the route, presence of sidewalks, and presence of pedestrian crossings are more important factors than the directness of the route.[51] In general, pedestrians are more likely to choose routes with higher Level of Service (LOS), and even more so on longer trips.[52]

Safety is a major concern for pedestrians. Studies show that pedestrians do not like encounters with cyclists; short pedestrian signals, which can add to concern for right-turn-on-red (RTOR) vehicles; and high speeds or high traffic volumes on the road.[53] At the same time, pedestrians often do not comply with the DON'T WALK signal at intersections.[54] These studies show that pedestrian behavior is more sporadic than that of cars. Acceptable wait times in cars may not be equally acceptable to the pedestrians. And pedestrians are not as concerned with a pleasant walking environment at their destination as they are with having an adequate walking environment on their way to a destination.[55]

Discrete Choice Analysis

Cervero and Duncan looked at a discrete choice model of factors affecting walking behavior based on data from the 2000 Bay Area Travel Survey. The authors found that longer trip distances and slope of the land are major deterrents for walking. Other significant deterrents were rainfall, walking through a low-income neighborhood, being disabled, and the number of vehicles in a household. People were more likely to walk for recreation or social reasons. Factors of the built environment played a small role in whether or not people would walk, though density and diversity of land uses were more influential than pedestrian and bicycle friendly design.[56]

Schlossberg and others show that many pedestrians are willing to walk about half a mile (or approximately 10 minutes) to access a train station. This is twice the assumed acceptable walking distance commonly used for planning purposes.[57]

Pikora and others show that the availability of a shop is more likely to influence pedestrians than the presence of sidewalks. However, the presence of sidewalks, along with having access to a high-quality public space, and less car traffic are also more likely to increase pedestrian activity.[58]

INNOVATIVE PRACTICES

Traffic Cells have been implemented in many cities throughout the world. The purpose of the Traffic Cell is generally to reduce the amount of vehicular traffic that enters a particular part of a city. Stopping automobile traffic from entering the area encourages walking, biking, and transit use in these areas. The UC Davis campus is an example in California; other cities that provide this treatment include Gotenberg, Sweden, and Nagoya, Japan.[59] On a smaller scale, a few blocks of streets are converted permanently to pedestrian-only zones, typically in central cities where the volume of pedestrians is high, to enhance the safety of the walking public.

DIGEST OF FACILITY CHARACTERISTICS

Appendix A includes a digest of various facility characteristics and associated cyclist or pedestrian behavior as reported in the literature from surveys and analyses conducted in other studies. These characteristics helped in the formulation of questions posed in the user survey conducted in this study.

III. CASE STUDY RESEARCH

THREE STUDY CITIES AND CAMPUSES

The California cities of Davis, Palo Alto and San Luis Obispo are ranked platinum, gold and silver respectively by the League of American Bicyclists. All three cities have a high percentage of college students and a mild, year-round climate. Davis and Palo Alto also have a flat terrain. In Davis, for instance, bicycle commute mode share is 14 percent, which is roughly 35 times the national average.

Appendix B includes case study descriptions that combine information from interviews, campus plans, U.S. census data, and the League of American Bicyclists. Though some of the information is subjective, such as which people are the most influential in a community, the descriptions provide a good idea of how pedestrian and bicycling infrastructure has developed in these communities.

FACTORS IMPORTANT TO BICYCLE- AND PEDESTRIAN-FRIENDLY CITIES AND CAMPUSES

The following subsections provide highlights of interviews conducted with bike officials about factors contributing to the development of bicycle- and pedestrian-friendly cities.

City of Davis, California

The city engineer asserts that Davis has had good results because bicycling is a way of life. He maintains that the California law that requires planners to plan for all modes and abilities when updating the general plan will help other cities achieve similar results. According to Marshall, cities should reach out to the business community because they are a good ally. He feels that planners can help businesses recognize that bicycling may be good for business.[60] According to Dill and Carr, cyclists may spend more time downtown because they made an effort to be there.[61] Consequently, Dill and Carr recommend that cities provide on-street bicycle parking and outdoor dining. Some barriers to bicycling include the fact that people are really busy and some stores are far away. People cannot be expected to cycle every day, but maybe occasionally. Marshall feels that cities should recognize that not everyone's schedule is flexible. There is also a perception that bicycling is unsafe. When car use increases, bicycling does become less safe. The weather is sometimes a barrier to bicycling, and still many people do not recognize its health benefits.[62]

Marshall emphasizes that creating a bicycling community took a community effort. Interestingly, no one particular group was the most important. He considers elected representatives, city and university staff, community activists, and ordinary residents equally influential. On the other hand, Goddard considered the community activists, ordinary residents, and city staff the most influential in supporting bicycling. Local business owners are considered equally influential, but in a generally negative sense. Elected representatives have also been highly influential. Transit agency staff and MPO staff have had some influence, but the MPOs are particularly important in providing money.

Consultants are rarely used in the city of Davis.[63] The local MPO staff asks Davis city staff for advice on standards.

Davis is considered a unique community because of its long bicycling history. Some of the important steps it would recommend for other cities to take are:

1. Create a grassroots movement involving community, staff, and elected officials
2. Engage the community in a forum, finding their needs and their barriers
3. Make bicycle facilities convenient
4. Go through the process of creating a Bicycle Plan so there will be concrete steps for implementation
5. Make sure Transportation Engineering staff understand the importance of bicycle/pedestrian planning and the principles of design
6. Tap into the will of community activists
7. Find influential people who are cyclists who can talk to the Council
8. Find people in City Departments who are sympathetic to the cause
9. Do research to find grants

City of San Luis Obispo, California

Our interviewees assert that some of the key players in bringing about change have been the general bicycling public, bicycle clubs, the Bicycle Advisory Committee, the pro–alternative transportation City Council, and the Public Works Department.[64,65] Increased community interest along with increased funding for alternative transportation has allowed for improvements to facilities. Students, facilities planning staff, and commuter and access services at Cal Poly have produced good bicycle and pedestrian results.

Both Peggy Mandeville and Dan Rivoire believe elected officials and metropolitan planning staff are the most influential stakeholders. Consultants are considered the least influential. Other groups such as community activists, residents, employees, business owners, and transit agency staff fall between these two groups. Dan Rivoire believes that university staff and community activists are influential.

Officials consider the following steps to be the most important for starting bicycling and walking programs:

1. Have policies that support goals for alternative transportation in the Circulation Element of the General Plan
2. Adopt a Bicycle Plan
3. Work with advocacy groups, develop community support, and raise funds

4. Include bicycle projects in the budget program
5. Develop partnerships among stakeholder groups
6. Apply for grants
7. Set-up a Bicycle Advisory Committee
8. Provide adequate staffing
9. Provide education and enforcement
10. Celebrate success as a way of marketing and disseminating information
11. Monitor progress and make needed adjustments

City of Palo Alto, California

The City Council has been important in bringing about change in the community. It supported updating the Bicycle Master Plan, increasing bicycle parking downtown, and the Safe Routes to School program. The school districts and parent-teacher association (PTA), the Silicon Valley Bicycle Coalition, Western Willow neighborhood group, and strong individual advocates have also been influential.[66] The Palo Alto Bicycle Advisory Committee, the Planning and Transportation Commission, and various officials are important players as well.[67] These groups meet on a regular basis to identify and prioritize future projects and programs. Kishimoto also mentioned the importance of the Safe Routes to School program in promoting a culture of bicycle riding from kindergarten through high school.

The elected representatives, city and university staff, and advisory groups are considered most influential[68,69]; community activists, consultants, and residents are also highly influential, but employers, transit agency staff, MPO staff, and schools are slightly less influential.[70] According to Rius, these secondary groups are only moderately influential.

At Stanford, about 4,300 students and employees bike to school on a daily basis. Approximately 40 percent of students and 13 percent of employees are regular bike commuters. According to Ariadne Scott, the Bicycle Program Manager for the University, the main factors driving Stanford’s bicycle program are the University’s General Use Permit and its targeted educational program. Largely due to the flat terrain and large area of the main campus “it is simply easier to get around by bike than most other forms of transportation.”[71] Stanford has had a Bicycle Program Coordinator since 1998. Presently it is a full-time staff position with budget for several part-time paid student helpers who reach out primarily to the undergraduate population. Scott considers the strongest component of the program to be its educational efforts, which includes bike safety class offered twice a month. Since 2008, 1,600 students have participated in the program and it is also free to the community. It is co-hosted with Stanford’s Public Safety department. Students who might otherwise get fined for violating bike safety rules (for example, failing to stop at a stop sign) can avoid paying fines by participating in this training (also called fine diversion).

In general, bicycling and walking programs in the city and the university have been independent of one another. However, both entities realize and recognize the value of creating a more integrated network, given that many of the students, faculty, and staff are residents of the Palo Alto community and the examples that follow illustrate this growing partnership. The University's Margherite shuttle bus takes students and employees to the two main Palo Alto rail stations and also connects with primary local bus routes. Additionally, there is a bicycle valet service during football games at Stanford. Volunteers from the Silicon Valley Bicycle Coalition run this free service. During the 2009-2010 season participants parked about 1,000 bicycles per home game and raised funds to support the Coalition in the process.[72]

Both city and university program managers consider the following steps to be important for starting and enhancing bicycling and walking programs:

1. Having a Bicycle Master Plan that is integrated with the larger General Plan
2. Creating educational programs early on (for example, during New Student Orientation at Stanford, in kindergarten for elementary schools) and continuing education
3. Engagement with local bicycling community (for example, through establishment of a bicycle advocacy coalition)

WORLD SCAN OF INNOVATIVE PRACTICES

Many innovative practices and projects are taking place in the U.S. and Europe. They deal with various scales of influence, but all aim to increase both safety and convenience for cyclists and pedestrians. Pucher and others[73] conducted an international review and assessment of the effects of various levels of such interventions as infrastructure provision, integration with public transit, education and marketing programs, and policies on increased bicycle use. They concluded that integrated packages of many different complementary programs are necessary to realize substantial increases in bicycle use. Some of the innovative interventions identified are described in the subsections that follow. Similarly, Krizek and others conducted a comprehensive review of the international literature on walking and cycling in which they identified what the authors termed soft measures that deal with pricing, programming and education and hard measures that deal with community and infrastructure design. The authors also concluded "urban environments with high levels of walking and cycling typically represent a combination of many factors that help promote these modes of travel."[74] Other studies such as Forsyth[75] and Krizek point to these conclusions.

Organizations

Many organizations throughout the U.S. propose different ways for cities to increase bicycle and pedestrian friendliness or safety with different approaches achieving similar goals. Two such organizations and their recommendations are identified next.

America Walks[76] offers the following recommendations for walkable communities, which focuses on the nature of the built environment that results from land use planning:

1. Create a range of housing opportunities and choices
2. Encourage community and stakeholder collaboration
3. Foster distinctive, attractive communities with a strong sense of place
4. Make development decisions predictable, fair and cost effective
5. Mix land uses (for example, housing and retail)
6. Preserve open space, farmland, natural beauty and critical environmental areas
7. Provide a variety of transportation choices
8. Strengthen and direct development towards existing communities
9. Take advantage of compact building design

Smart Communities[77] also offers the following recommendations for walkable communities, which focuses on operational improvements to transportation facilities:

1. Provide linked walkways
2. Pedestrianize intersections with the aid of medians and bulbouts
3. Enhance ADA accessibility
4. Practice good signal placement
5. Offer illumination/visibility at intersections
6. Provide safe median crossings
7. Have specific pedestrian access points for schools
8. Eliminate parking where pedestrians will walk behind cars
9. Provide safe pedestrian access to shopping center
10. Install auto-restricted zones and parking restricted zones
11. Combine walking with transit
12. Practice walkable scale land use planning

Programs

The CIVITAS Initiative

The CIVITAS Initiative "helps cities to achieve a more sustainable, clean and energy efficient urban transport system by implementing and evaluating an ambitious, integrated set of technology and policy-based measures" by implementing integrated packages of technology and policy measures in the field of energy and transportation in order to build up critical mass and markets for innovation. In its most current version of the initiative, 5 demonstration projects are taking part in 25 cities within CIVITAS PLUS. These demonstration cities in Europe are to be funded by the European Commission. Sample projects include those that promote a less car intensive lifestyle and encompass car-free housing, sustainable leisure and recreation, shared car use and ownership, and motorized two-wheelers and bicycles.[78]

High-Tech Bicycle Rental

Electronic bicycle rentals are now in use in several European cities (for instance, Amsterdam, Brussels and Copenhagen) and such U.S. cities as Minneapolis and Washington DC. One of the most popular electronic bicycle rental systems is the Parisian Velib. The Velib is a self-service system that offers thousands of bicycles located at hundreds of stations throughout Paris. As a testament to the system's high convenience, the stations are operational 24 hours a day, they are fully automated, and bicycles can be returned to any Velib station. To rent a bicycle, a Velib compatible bank or chip card is required at the station's terminal. See Figure 1.

Figure 1. A Sample Velib Service Station

Complete Streets

The complete streets program involves the idea that all streets are created to allow users of all modes, ages, and abilities to have safe access. In adopting these policies, agencies take on the view that all transportation improvements are opportunities to create safe access for all users by all modes. As gas prices and infrastructure costs increase, providing for multiple modes can save users on transportation costs. Money that is not spent on transportation could be available as disposable income. Because private autos are generally the most expensive form of transportation, switching to alternative modes allows families to save and spend more money on other needs. The Complete Streets bill that certain states have passed requires that all modes be considered when cities review their Circulation Elements. These requirements enhance attention to bicyclists, walkers and wheelchair users.[79]

Safe Routes to School

This program encourages children to bicycle and walk to school. The program helps educators, parents, and students decide for their local school the options that can help students get to school safely. The community then makes a plan, which may include some infrastructure improvements and funding options. The program also encourages promotional activities and special events to educate and encourage students to continue bicycling or walking.[80]

Infrastructure

Complete Network

A complete network of bicycle facilities is important in encouraging bicycle use. In addition, auto-free areas with streets for bicyclists and pedestrians only are also desirable for walking and cycling. Providing direct origin-to-destination routes for bicycles and pedestrians and less direct routes for cars also encourages the use of alternative transportation. At intersections, special signal phases add to the safety of cyclists and walkers.[81]

Bicycle Superhighway

A new trend in bicycle friendly nations like Holland and Denmark is the “bicycle superhighway.” In Copenhagen, they plan to develop these routes, as shown in Figure 2, on existing bicycle paths with several added improvements. According to the city’s vision, planned modifications include:

1. Smooth surfaces free of debris, ice, and snow
2. Routes to be as direct as possible without detours
3. Uniform signage and other homogenous visual expressions
4. Bicycle maintenance stations with air and tools along the routes
5. Wide routes to allow maintaining high speeds to overtake slower cyclists
6. Cyclist priority when crossing streets
7. Signal coordination on routes with frequent traffic signals to enable cyclists traveling at 20 km/h consistently, to ride the band of green signals, termed “Green Wave”

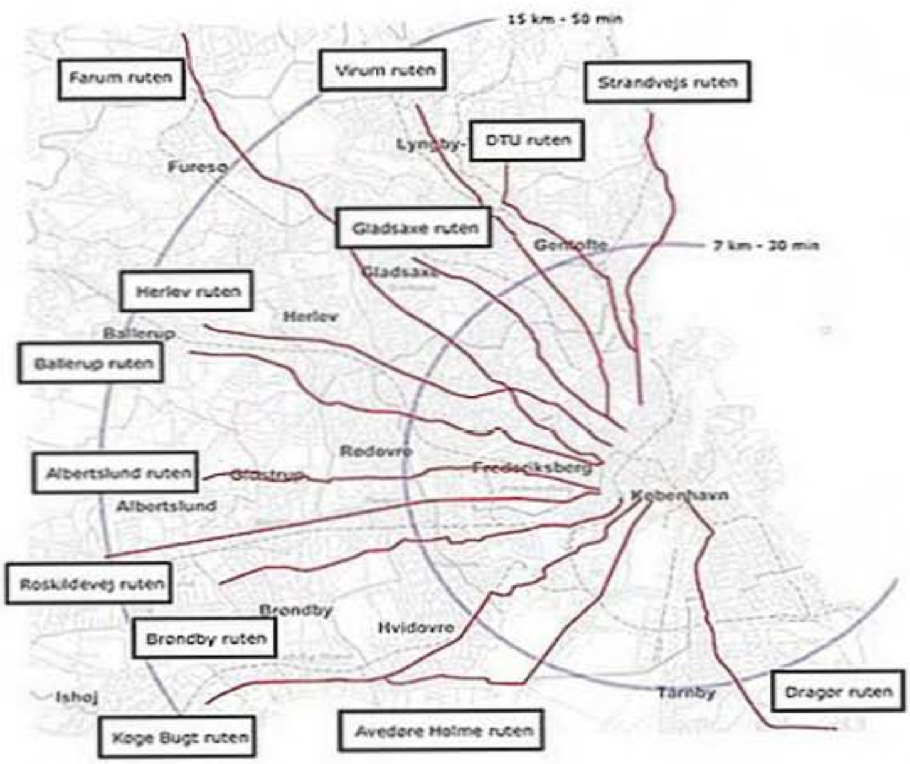

Figure 2. A Map of Bicycle Superhighways in Copenhagen

Traffic Management

Traffic Cells

Traffic Cells are auto-free or reduced auto zones that are implemented in many cities around the world. The purpose of the Traffic Cell is to reduce the amount of vehicular traffic that enters particular parts of a city by restricting automobiles from entering the area. The creation of Traffic Cells encourages walking, bicycling, and use of public transit in the restricted areas. The UC Davis campus is an example in California where central campus is treated as a traffic cell. Other cities with similar traffic management schemes include Gothenburg, Sweden and Nagoya, Japan.[82] Often, traffic cells are used around city centers to encourage people to access the center through bicycling, walking, or public transit.

Continuous Green Signal for Pedestrians

In 2009, the city of Graz, Austria, introduced a new type of traffic management at a highly used pedestrian crossing. The basic phase is always green for pedestrians while cars have a red signal. Cars are detected by a loop at a certain distance from the intersection. If vehicle speed exceeds 30 km/h when approaching the crossing, the driver encounters a red signal. If the motorist slows down to a predetermined lower speed, the green signal comes on. An evaluation showed that not only do pedestrians benefit, but the queuing of cars has also been reduced.

Shared Zones

The shared zone, termed Begegnungszonen in Switzerland, may be designated along individual streets, open squares, or over an entire system of roads. The identifying characteristic of these zones is that while pedestrians and motor vehicles can both occupy the area, pedestrians always have the right-of-way. Vehicles must stop and let any pedestrians move uninterrupted. For these actions to be possible, speeds must be kept very low. These zones are different from the "shared traffic lanes" marked by the double-chevron-over-bicycle sign, termed "Sharrow," to remind autos and bicycles to share the road. There are more than 200 shared zones in Switzerland and Germany. Figure 3 shows an identification sign and picture of a shared zone.[83]

Figure 3. A Shared Zone with Pedestrians, Bicycles and a Bus

According to Swiss federal law, the defining aspects of the Begegnungszonen are:

1. Pedestrian traffic always gets precedence, even over public transportation

2. The pedestrians may not, however, obstruct traffic unnecessarily (no loitering in the street)

3. The posted speed limit is 20 km/h

4. Signs mark the entrance and end to these zones and display the speed limit

5. Parking is only allowed in designated areas

Figure 4 shows examples of pedestrian priority zones in Burgdorf, Bern, and Biel, all in Switzerland.

a. Signage for Shared Zone, Switzerland

b. Begegnungszonen Burgdorf, Switzerland

c. Begegnungzone in Bern, Switzerland

d. Begegnungzone in Biel, Switzerland

Figure 4. Examples of Shared Zones in Switzerland

Community Design for Reduced Auto Speeds

Complementary to such traffic management schemes as shared areas, traffic calming and raised crosswalks is a movement to reduce auto speeds and promote walking and bicycling. One such advocacy group in the U.S. is America Walks, a national coalition of local advocacy groups dedicated to promoting walkable communities. Like similar advocacy groups, "America Walks is a national resource which fosters walkable communities by engaging, educating, and connecting walking advocates."[84] These movements advocate the following to help reduce the speed of automobiles, thereby making environments safer for pedestrians:

1. Narrower streets

2. Street trees and mature tree canopy, or other landscaping

3. On-street parking

4. Buildings located close to the sidewalk
5. Raised crosswalks
6. Reducing the number and width of traffic lanes

This type of advocacy is reflected, for instance, in policies of the City of Davis, California, which restricts major roads to no more than four lanes. Similarly, Olympia, Washington has proposed “narrower standards for lane widths based on a roadway’s target speed, add shorter block lengths and tighter curb radii – not exceeding 10 feet in urban and suburban areas or 25 feet on bus and truck routes.”

A GENERALIZED TYPOLOGY OF BICYCLE & WALKING FACILITY TREATMENTS

The project team observed field treatments of walking and bicycling facilities in the three case study cities of Davis, Palo Alto and San Luis Obispo. The aim of the field work was to perform first-hand documentation of treatments from which to derive a typology that categorizes groups of treatment options. To enrich the field observations, an additional city, Santa Barbara, California, was also surveyed. Just like the original three cases, Santa Barbara also has a high bicycle-using student population; the League of American Cyclists ranks it “Silver” in bicycle friendliness by the League of American Cyclists. Table 2 is a summary list of the generalized typology of treatments and identifies the case study cities where individual treatments were observed. The table reveals at a glance the complexity of different treatments applied in the various case study communities. Pictures from the field visits are presented in the recommendations chapter of this report.

For ease of organization, treatments are divided into six broad categories: (a) types of bicycle lanes are identified by adjacency to automobile lanes; (b) types of walking lanes are also identified by adjacency to automobile lanes; (c) grade separation differentiates whether there is concurrency with automobile lanes and whether the crossing goes over or under the roadway; (d) at grade crossings and intersections are by far the largest collection and differentiation of treatments for pedestrians and bicyclists; (e) types of separation identifies the provision of facilities jointly or exclusively for human, bicycle and automobile traffic; (f) parking identifies the level of sophistication in the provision of bicycle parking facilities. It is noteworthy that it is not only the number of different treatments, but also the extent of deployment that contribute to the friendliness of a community for bicycling or walking.

Table 2. A Generalized Typology of Bicycle & Walking Facility Treatments

Treatment	Locations			
	Davis	Palo Alto	San Luis Obispo	Santa Barbara
Bicycle Lanes				
Wide shoulder lane for bicycles and parking	√	√		
Divided shoulder lane for bicycles and parking	√	√	√	√
Shoulder bicycle lane without parking	√	√	√	√
Separate two-way bicycle path and walking trail	√	√	√	√
Dual treatment: on-street bicycle lane and separated bicycle path	√		√	√
Walking Paths				
Wide shoulder lane for walking and parking	√	√	√	√
Sidewalks next to travel and parking lanes	√	√	√	√
Sidewalks and Bi-directional Bicycle Lanes separated by flower beds from travel lanes	√			√
Types of Lateral Separation				
International Trends and Emphasis: three-way separation of autos, cyclists, walkers	√	√	√	√
Two-way separation of autos and cyclists	√		√	
Two-way separation of autos and walkers	√	√	√	√
Separated bicycle path only	√		√	
Street shared by autos and bicycles (“Sharrow”)	√	√	√	√
Bicycle Boulevard		√	√	
Grade Separation				
Bicycle/Pedestrian overpass over freeways and Rail Lines	√	√	√	√
Bicycle underpass concurrent with road underpass	√			
Bicycle-only under-pass	√			√
Bicycle Lane across Highway Bridge	√			

Table 3. A Generalized Typology of Treatments (continued)

Treatment	Locations			
	Davis	**Palo Alto**	**San Luis Obispo**	**Santa Barbara**
At-Grade Crossings and Intersections				
Bicycle only roundabouts for bicycle paths	√			√
Bicycle & bus roundabouts (no automobiles)	√			
Separate pedestrian paths at roundabouts	√			
Bicycle signal phase at signalized intersection	√		√	
Bicycle signal at intersection with no automobile traffic signal	√			
Road Diet for Reduced Pedestrian Crossing Distance		√		√
Bulb-outs for reduced pedestrian crossing distance		√		√
Textured cross-walks for improved visual demarcation of pedestrian crossings				√
Raised cross-walks (speed table) for improved pedestrian visibility and auto speed calming				
Bicycle- pedestrian connector at mid-block location	√			
Bicycle- pedestrian connector at cul-de-sac	√			
Parking				
Bicycle racks	√	√	√	√
Bicycle stations	√	√		√
Bicycle lockers	√	√	√	√
Bicycle rental stations	√			√

KEY FINDINGS

General Characteristics

There are certain factors that cities with high bicycling mode shares have in common. Many cities have more than one of these major characteristics:

1. Flat terrain
2. Compact development with mixture of land uses
3. Mild climate
4. Interconnected network
5. Bicycling culture

Davis has all of these features. Palo Alto is larger than Davis, but it also has all the characteristics. San Luis Obispo is very hilly and compact with a fairly good climate and a university, which helps to add to the bicycling culture. It is noteworthy, however, that cities like Amsterdam and Copenhagen have cold climates and are not as small as the built-up area, but are flat, have mixed land use and have strong bicycling cultures.

Local Involvement

The research has revealed that many bicycling communities have at least one of the following:

1. Bicycle advisory committee or commission
2. Bicycle advocacy groups
3. Bicycle clubs
4. Elected officials or city engineers and planners who advocate bicycling

Davis offers a lesson on the importance of local involvement. It originally had a strong city official who was a bicycling advocate, and it developed a culture of bicycling. When this official retired and many newcomers came to the city, the mode share dropped, but more recently a bicycling advocacy group has been created, which has helped to increase the bicycling mode share again.

Planning

It is important for cities in California to have Bicycle Master Plans in order to secure funding from the California Department of Transportation[85] for bicycling projects. The Complete Streets movement provides examples, legislative options and ideas for retrofitting streets to accommodate all users. While the Complete Streets approach may be desired for an entire city, sometimes the best bicycle connection between two locations may be a bicycle path rather than a bicycle lane along a major arterial. Thus it is important to exercise flexibility in choosing the most appropriate option for specific circumstances from the menu of treatments identified in the generalized typology.

Engineering

Appropriate infrastructure must:

1. Connect land uses and activity centers in the city
2. Make cyclists and pedestrians feel and be safe
3. Provide the appropriate amount of bicycle parking and other amenities

A bicycle station (for example, in Santa Barbara) is a multi-amenity facility with sheltered parking similar to a parking structure for automobiles. While a bicycle station may be considered a high level, all-in-one amenity, it is the availability of the amenities that is important. Both Cal Poly and UC Davis, for instance, do not provide the bicycle station with sheltered bicycle parking, but do provide many of the same types of facilities, such as showers and lockable bicycle parking. In the Cal Poly experience, the more bicycle racks that are provided, the more bicycle racks are used, which is indicative of a certain level of latent demand.

Education and Encouragement

Because everyone is a pedestrian at some point, the basics of being a safe pedestrian are generally taught by parents or in school. In some European countries, all children will have instruction in school on safe bicycling (and walking) techniques. This gives all citizens the ability to cycle safely. Education programs in the U.S. are generally run by bicycling groups within cities. They reach some students and some people who are interested in bicycling, but do not reach a large portion of the population.

Enforcement

Enforcement is important for establishing a law-abiding bicycling culture, which in turn garners more respect from auto drivers and pedestrians. The research reveals that the best type of enforcement is that which is combined with education, and is similar to automobile drivers being ordered to engage in driver education training following citations for violations.

Evaluation

Periodic evaluation helps to enhance the provision of walking and cycling facilities. As a result of evaluation, the City of Davis, for instance, is leaning toward removal of parallel bicycle paths from major arterials because of conflict with turning vehicles. Evaluation helps identify the types and locations of needs of walkers, cyclists and all other travelers. It therefore needs to be integrated into the implementation of facilities.

Utilitarian Use and Recreational Use

The literature review showed that many people were willing to walk further for commuting purposes (for example, walking to a train station) than for other purposes. People typically take the shortest route whether or not there is any sort of infrastructure provided for pedestrians. In short, street decorations do very little to encourage commuting by walking, but land use factors do encourage people to walk.

General Observations

Though there is perhaps a specific type of community layout that is best suited for cyclists and pedestrians, having a few of the general characteristics (flat terrain, compact development, mixture of land use, mild climate, inter-connected network) can allow a city to develop into a cycling and pedestrian friendly community. Many communities, specifically in California, have good climates despite being hilly or low-density. Though geography cannot be changed, every city can create a bicycling culture through advocacy groups, clubs, school programs, and involved city officials or planners. Conversely, even if a city is a perfect candidate geographically, without any sort of advocacy, alternative travel options may not be provided for thereby creating opportunity for choice.

There is an abundance of treatments available to towns and cities to suit various circumstances. Careful choice through deliberation can aid in the optimal use of funding to achieve user-friendliness. If the U.S., or a particular city, wants to create a better bicycling culture, the citiy must create more extensive educational opportunities for children and adults in safe bicycling practices.

This research shows that bicycling and walking have very little in common, and therefore should be treated separately as methods of transportation. There are also distinct differences between utilitarian use and recreational use. Bicycling and walking are in turn different from driving cars in that walking or bicycling can by themselves constitute recreational activity, while driving is almost always utilitarian, so there is little need for separation of utilitarian versus recreational driving. Considering that recreational trips make up only 20 percent of all person trips, and bicycling and walking modes are composed of 40 and 30 percent of recreational trips respectively, this means that providing for utilitarian bicycling and walking may be an important step in increasing alternative mode share. Cities should therefore consider both recreational and utilitarian uses when developing circulation plans.

IV. SURVEY OF BICYCLING AND WALKING FACILITIES

THE SURVEY

This chapter introduces the survey conducted to capture user travel choices and preferences with special focus on bicycling and walking. The chapter also presents a summary of findings under the general headings of: user characteristics; travel characteristics; rating of travel environment in terms of bicycling and walking facilities; bicycling behavior; and walking behavior.

Survey Administration

A general user survey was administered to residents of the three case study cities of Davis, Palo Alto and San Luis Obispo. The target population included three distinct groups: (a) non-motorized travelers, that is, bicyclists and walkers; (b) public transit users; and (c) automobile drivers. To achieve this, samples of residents were randomly solicited within specific target strata that included the college campuses (for all three groups), farmers' markets (for all three groups), members of bicycle coalitions (for bicyclists) and users of designated bicycle and walking paths (for bicyclists and walkers respectively) in the case study cities. Some respondents answered and returned questionnaires to surveyors while others mailed them back. Many others took instruction cards and filled the surveys online. The number of useable responses completed for all case study cities combined was 658 of which approximately half were filled directly online by survey participants. Inferences in general would be accurate to 4 percent within a 95 percent confidence interval. Appendix D shows a copy of the survey instrument.

Sample Data and Weighting

As with all surveys that cannot compel randomly selected subjects to respond, there is some element of self-selection bias. The sampling process continued till all strata of interest were adequately represented in the responses. To correct for bias, a two-stage weighting technique was applied to the sample data. The first stage calculated weights based on the distribution of case study area residents by the age cohorts applied in the user survey (which reflects ranges used by the U.S. census). This is to account for the fact that certain ages in the distribution were over-represented while others were under-represented relative to the same distribution in the census. The 2008 distribution of residents by age and gender was retrieved from the American Community Survey (ACS) and applied. The second stage corrected for the fact that more males were represented in the survey than females compared to the Census. Appendix E shows details on the distribution of survey participants by age and gender in the sample and ACS as well as the weights that were applied.

PARTICIPANT CHARACTERISTICS

Age Distribution

The survey targeted respondents who were 18 years old or above. Thus less than 1 percent of respondents were under 18 years old. The largest single age group by far (35 percent) was young adults (between 18 and 24), largely due to the large population of college-age respondents in San Luis Obispo. The next largest respondent age category (25 to 34) had only half as many respondents. There was a prevalence of these two younger age groups among participants in Davis and San Luis Obispo, while Palo Alto reflects a more normal distribution of age groups. Table 4 shows the relative distribution of ages for survey respondents in the three case study cities. Figure 5 depicts the differences in age distribution of survey participants.

Income Distribution

The more youthful population of respondents in San Luis Obispo and Davis also tended to have lower personal income levels, 46 percent and 42 percent respectively of respondents are students compared to 7 percent in Palo Alto. The proportionately higher ages of respondents in Palo Alto is reflected in their distribution within the upper income categories. See Table 5 and Figure 6.

It was apparent that some of the cells of the distribution would end up with too few respondents to enable robust analysis; therefore, some analyses presented in subsequent sections called for the combining of certain respondent categories.

Table 4. Relative Distribution of Ages of Respondents by Case Study City

Age Group	Davis	Palo Alto	San Luis Obispo	Combined (All Case Studies)
under 18	0%	0%	1%	1%
18-24	11%	10%	44%	35%
25-34	51%	15%	15%	17%
35-44	14%	19%	11%	13%
45-54	14%	24%	11%	14%
55-64	9%	17%	12%	13%
65-74	0%	8%	5%	6%
75+	0%	6%	0%	2%
Case Study Total	100%	100%	100%	100%

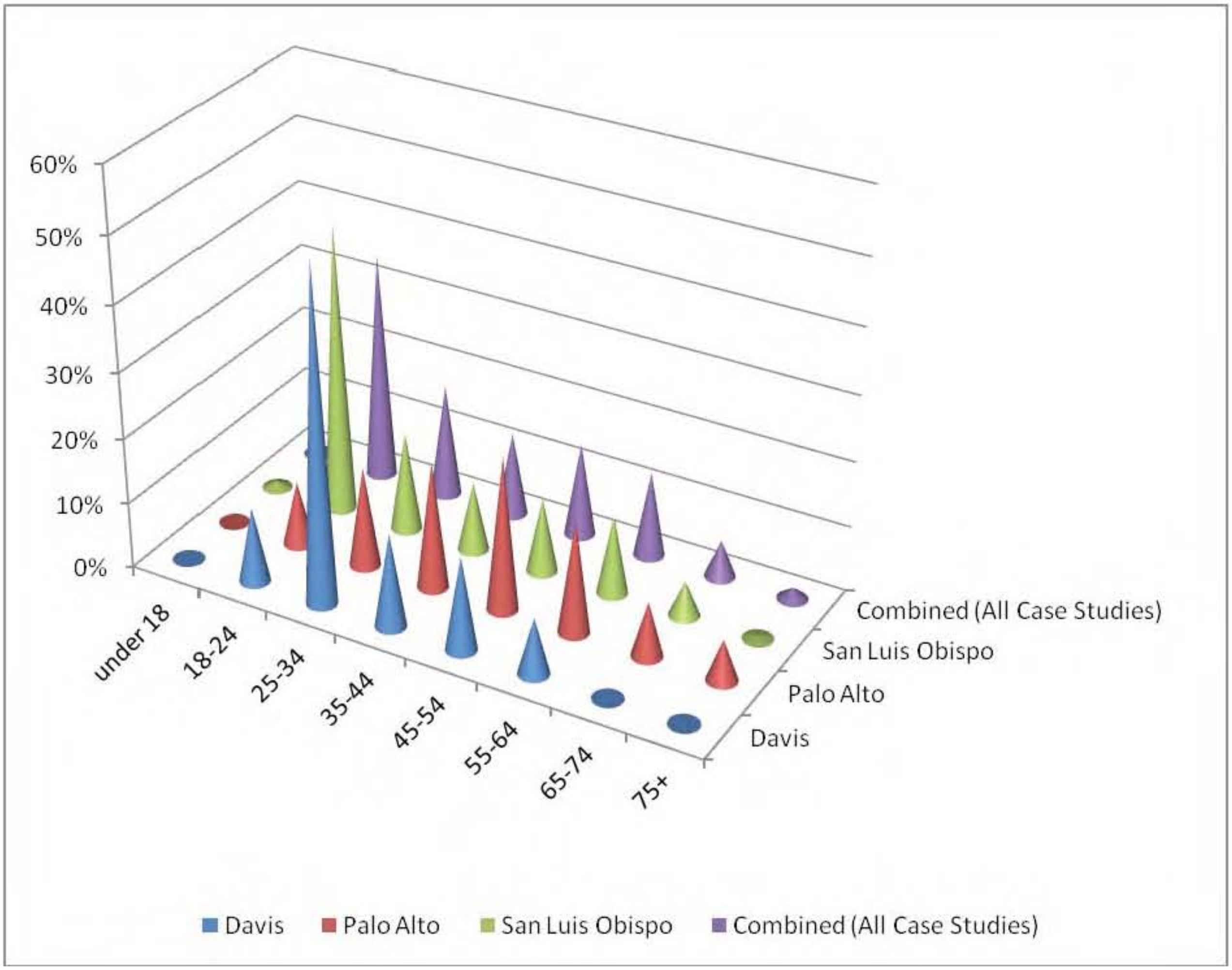

Figure 5. Age Distribution of Survey Respondents by Case Study City

Table 5. Income of Respondents by Case Study City

Annual Income	Davis	Palo Alto	San Luis Obispo	Combined (All Case Studies)
None	9%	8%	19%	16%
Under $20k	17%	7%	35%	28%
$20k-39k	26%	6%	8%	9%
$40k-59k	20%	12%	9%	10%
$60k-79k	3%	7%	12%	11%
$80k-99k	6%	11%	8%	8%
$100k-149k	14%	20%	5%	9%
Over $150k	6%	30%	4%	9%
Case Study Total	100%	100%	100%	100%

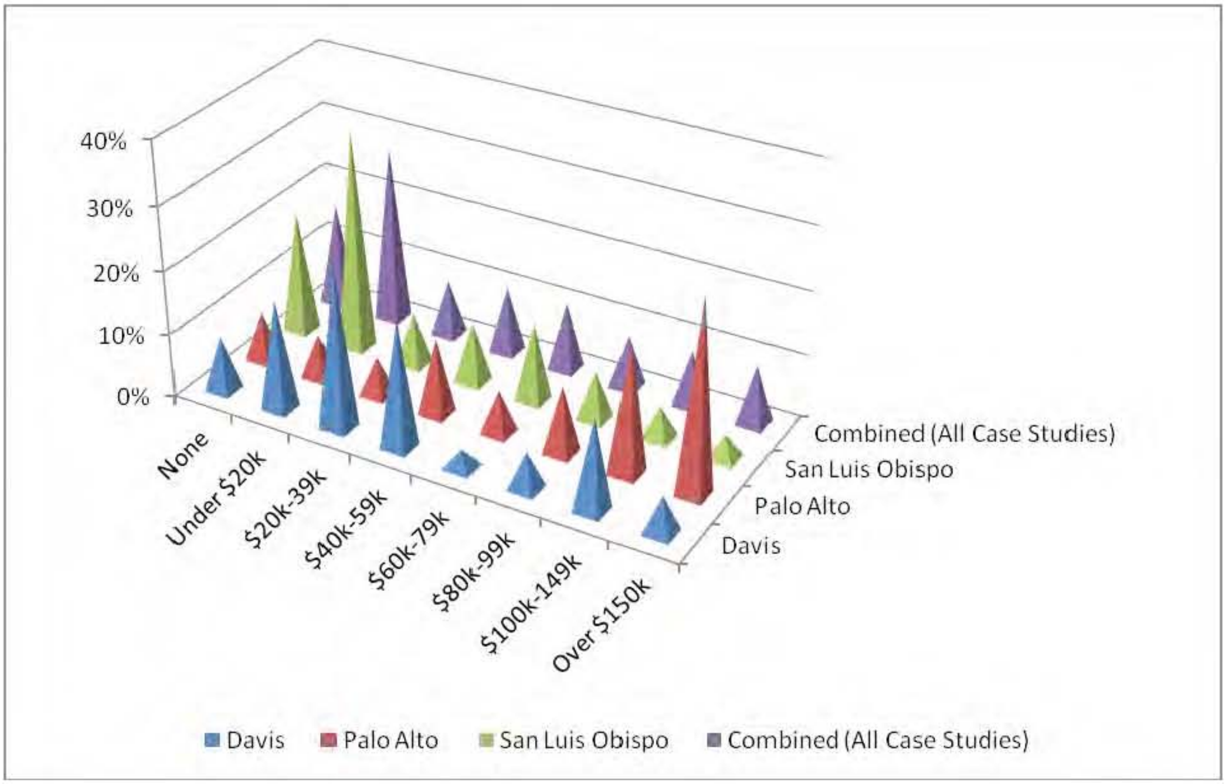

Figure 6. Income Distribution of Survey Respondents by Case Study City

Gender

With a 60/40 split of male to female respondents, there is some gender gap in responses. The split is reversed in Davis where this phenomenon is consistent with its census data.

Employment

Nearly two out of every five respondents were students, a result that is not surprising in college towns administering a survey that targeted bicyclists and walkers. However, close examination revealed that the high proportion of students was captured in Davis (42 percent) and San Luis Obispo (46 percent), but not in Palo Alto (7 percent). This difference can be explained by Palo Alto's location within an area rich with local high tech companies. The catchall "other" category (including government workers, retirees and homemakers, among many others) is the next highest employment category (31 percent) followed by those in the education and office sectors (with 11 percent each). Another sector with a significant number of respondents is information (6 percent); two-thirds of respondents in this category resided in Palo Alto. This latter observation is consistent with the relatively high incomes reported among participants in Palo Alto. Table 6 shows the distribution of respondents by employment type.

Table 6. Respondents by Type of Employment

Type of Employment	Responses	Percent
Student	255	37.8%
Other	206	30.5%
Office	75	11.1%
Education	74	11.0%
Information	38	5.6%
Retail	15	2.2%
Financial	9	1.3%
Agriculture	3	0.4%
Total	675	100%

TRAVEL CHARACTERISTICS

Vehicles Available

The overwhelming majority of respondents (91 percent) had an automobile available for travel. Nearly as many respondents (87 percent) had a bicycle available for travel. Respondents chose the automobile for work or school trips 36 percent of the time and the bicycle 33 percent of the time. Table 7 shows the distribution of vehicle availability by vehicle type.

Table 7. Number and Type of Vehicles Available to Survey Respondents

Number of Vehicles Available	Type of Vehicle Available			
	Automobile	Motorcycle	Bicycle	Other
One	373	32	272	41
Two	181	4	137	12
Three	28	4	73	4
Four	16	3	89	2
One or more	598	43	571	59
None	60	615	87	599
Total	658	658	658	658
One or more	91%	7%	87%	9%

In Table 8, the raw data from respondents is weighted, scored and averaged for ease of comparison by stated mode preference. In general, respondents had 1.5 automobiles, 1.5 motorcycles and 2 bicycles available for use. Those who prefer bicycling tend to have more bicycles available.

Table 8. Number and Type of Vehicles Available by Mode Preference

Stated Mode Preference	Type of Vehicle Available			
	Automobile	Motorcycle	Bicycle	Other
All Respondents	1.46	1.54	1.93	1.4
Prefer Bicycling	1.38	1.48	2.18	1.21
Do not Prefer Bicycling	1.56	1.5	1.54	1.5
Prefer Walking	1.43	1.14	1.46	1.13
Do not Prefer Walking	1.46	1.65	2.09	1.47

It is not surprising that those in higher income brackets tend to generally have more vehicles of every type available, as shown in Table 9.

Table 9. Number and Type of Vehicles Available by Income

Income	Type of Vehicle Available			
	Automobile	Motorcycle	Bicycle	Other
None	1.18	1.60	1.65	1.45
Under $20k	1.25	1.40	1.68	1.40
$20k-39k	1.36	1.00	1.64	1.50
$40k-59k	1.57	1.00	1.85	1.75
$60k-79k	1.48	1.25	2.07	1.17
$80k-99k	1.71	2.00	2.12	1.50
$100k-149k	1.72	1.75	2.17	1.57
Over $150k	1.84	2.33	2.80	1.00
All Respondents	1.46	1.58	1.93	1.44

Mode Choice for Commuting

Out of all commute trips made by survey respondents, 40 percent were by auto, 32 percent by bicycle, 15 percent by walking, and 10 percent by public transit. These results reflect the fact that the survey covered a multimodal collection of travelers to provide a diversity of opinions and preferences for the study. In terms of frequency, 40 percent of respondents used the same commute mode 5 to 7 days of the week. Sixty percent used the same commute mode 1 to 4 days per week. If three days or less are defined as a “partial” week and four or more days are defined as a “full” week, then there is an even split between those who chose any one mode partially and those who chose it fully during the week. It is interesting to note that this observation holds true consistently across the various modes used for commuting, as shown in Table 10.

Table 10. Weekly Frequency of Commute Mode Choice

Mode of Travel	Number of Commute Days							Total	Percent of all Commutes
	1	2	3	4	5	6	7		
Automobile	104	60	45	27	125	8	25	394	**40%**
Motorcycle	7	1	3	1	3	0	1	16	**2%**
Bicycle	45	58	31	41	73	19	52	319	**32%**
Walk	40	21	16	9	24	5	31	146	**15%**
Transit	29	11	11	17	23	1	2	94	**10%**
Other	9	3	1	0	6	0	1	20	**2%**
All Modes	234	154	107	95	254	33	112	989	**100%**
Percent of days in week	**24%**	**16%**	**11%**	**10%**	**26%**	**3%**	**11%**	**100%**	

Distribution of Mode Choice

Among those who prefer bicycling, 55 percent of commute trips were made by bicycle. This group also had the lowest percentage of commuting by auto. Those who prefer to walk were the most likely to walk (33 percent) on commute trips, but chose the auto (42 percent) more than any other means of travel (See Table 11). The high incidence of automobile choice by those who prefer walking reflects the spatial separation between many of the activity locations that respondents need to access.

Table 11. Percent of Commute Trips by Mode Preference

Stated Mode Preference	Commute Mode					
	Automobile	Motorcycle	Bicycle	Walk	Transit	Other
All Respondents	40%	2%	32%	15%	10%	2%
Prefer Bicycling	25%	2%	55%	9%	8%	1%
Do not Prefer Bicycling	55%	1%	10%	24%	9%	2%
Prefer Walking	42%	1%	13%	33%	9%	1%
Do not Prefer Walking	35%	1%	46%	8%	8%	1%

LOCAL ENVIRONMENT

Friendliness of Travel Environment

The vast majority of respondents perceive their cities to be “friendly” for bicycling (86 percent) and for walking (90 percent). This result validates the cities’ recognition by the League of American Bicyclists. Table12 provides additional detail on respondent perceptions of how conducive their cities are to bicycling and walking.

Commensurate with the high levels of perception is the numerical rating of environmental friendliness as shown in Table 13. While there are high ratings for both bicyclist-friendliness and pedestrian-friendliness among all groups, the younger age groups and respondents in the 75+ age group gave the highest ratings for bicycling friendly neighborhoods.

Table 12. Perception of Environmental Friendliness

Friendliness	Bicycling	Walking
Very much	38%	53%
Somewhat	48%	36%
Others	14%	11%
All Respondents	100%	100%

Table 13. Ranking of Environmental Friendliness

Age Group	Bicycling Friendly Neighborhood[1]	Bicycling Friendly Places[2]	Pedestrian Friendly Neighborhood[1]	Pedestrian Friendly Places[2]
under 18	4.31	4.53	3.67	4.53
18-24	4.03	4.24	3.92	4.27
25-34	3.96	4.21	3.79	4.10
35-44	3.91	4.13	3.80	3.97
45-54	3.92	4.34	3.58	4.00
55-64	3.85	4.21	3.51	4.02
65-74	3.86	3.78	3.78	3.95
75	4.19	3.96	4.03	3.73

[1] *"Neighborhood" refers to the home area of the respondent*

[2] *"Place" refers to the destination of the respondent*

Infrastructure Availability Rating

Survey respondents considered the majority of facilities that support walking and biking to be of good or excellent quality. In these areas, the majority of respondents rated their cities' bike lanes, paths, and sidewalks as good or excellent. Table 14 provides additional information on resident perceptions in this category.

Table 14. Quality of Facilities

Rating	Bicycle Lanes	Bicycle Paths	Sidewalks
Excellent	19%	17%	28%
Good	51%	38%	56%
Fair	24%	24%	14%
Inadequate	6%	21%	3%
All Respondents	100%	100%	100%

BICYCLING BEHAVIOR

Minutes Willing to Ride a Bicycle

In general, respondents indicated a willingness to travel 15 to 30 minutes by bicycle depending on trip purpose. Table 15 shows that respondents are willing to bicycle on average 15 minutes for shopping, 26 minutes for recreation, 19 minutes for work, 15 minutes for business, and 20 minutes for other purposes. Those who prefer to bicycle are willing to bicycle for slightly longer periods for every trip purpose. Those who do not prefer biking have the shortest time periods they are willing to bicycle except for recreational purposes. These findings have implications for both the placement of activity locations and the provision of bicycling infrastructure.

Table 15. Average Time Willing to Ride a Bicycle for Trip Purpose (Minutes)

	Shopping	Recreation	Work	Business	Other
All Respondents	14.6	25.8	18.9	14.5	20.8
Prefer Bicycling	15.0	26.5	20.4	16.3	21.9
Do not Prefer Bicycling	13.7	24.1	14.5	8.4	16.7

Choice of Bicycling Facility Types

Table 16 indicates that the most popular facilities chosen by respondents are major streets with bicycle lanes and minor streets with or without bicycle lanes, though all available streets are used by at least two-fifths (43 percent) of bicycle riders. The percentages are very high in all categories for those who prefer to bicycle. Bicycle boulevards and bicycle paths have low percentages relative to the other facilities. These observations are consistent with findings reported in the literature and may be explained by the fact that major and minor streets (with or without bicycle lanes) provide the most direct routing between activity centers and comprise a much more complete network than bicycle paths and boulevards. For those who do not prefer cycling, the percentage usage of minor streets is by far the highest, followed by separated bicycle paths. This result reinforces the observation from the literature and field observations that non-motorized travelers prefer to avoid interactions with automobiles.

There are notable variations in the usage levels by demographic characteristic:

1. Males consistently have higher reported use percentages than females in all categories. There is a 20 percent difference by gender between many of the ‘street’ categories, and only a 10 percent use gap between bicycle boulevards and bicycle paths.

2. Those under 18 years old use minor streets with bicycle lanes more than any other type of route. Those 18 to 34 years old use bicycle boulevards and bicycle paths less than those in other age groups.

3. People in the lowest income category have the lowest percentage of bicycle use overall. People with the highest incomes have the highest percentage of bicycle use overall, followed by people who make under $20,000 per year.

Table 16. Frequency of Choice of Various Types of Bicycle Facilities

	Major Streets with Bicycle Lanes	Minor Streets with Bicycle Lanes	Major Streets	Minor Streets	Bicycle Boule-vards	Sepa-rated Bicycle Paths
By Preference for Bicycling						
All Respondents	59%	54%	44%	59%	43%	46%
Prefer Bicycling	85%	80%	66%	86%	66%	65%
Do not Prefer Bicycling	32%	24%	18%	28%	16%	25%
By Gender						
Female	45%	44%	27%	49%	35%	44%
Male	72%	62%	58%	67%	49%	48%
By Age						
under 18	53%	83%	35%	65%	65%	65%
18-24	60%	54%	43%	55%	31%	40%
25-34	67%	57%	43%	56%	39%	43%
35-44	54%	45%	41%	59%	48%	45%
45-54	70%	59%	46%	68%	44%	57%
55-64	57%	42%	43%	59%	44%	51%
65-74	54%	40%	31%	54%	43%	54%
75+	52%	42%	58%	58%	42%	26%
By Income						
None	53%	63%	37%	56%	44%	46%
Under $20k	66%	59%	48%	63%	42%	47%
$20k-39k	60%	44%	38%	54%	44%	40%
$40k-59k	57%	43%	36%	50%	35%	48%
$60k-79k	60%	48%	48%	56%	47%	32%
$80k-99k	57%	40%	55%	66%	32%	38%
$100k-149k	61%	46%	33%	57%	30%	54%
Over $150k	67%	72%	56%	72%	67%	67%

Preference for Bicycling Facility Types

Table 17 is a summary of how respondents ranked the usefulness of various bicycling infrastructure. Respondents consider major streets with bicycle lanes the most useful followed by minor streets with bicycle lanes, bicycle paths, bicycle boulevards, minor streets, and finally major streets. For those who do not prefer cycling, major streets with bicycle lanes and bicycle paths have the highest values. For those who prefer cycling, all but major streets have a high level of usefulness.

Females rated separated bicycle paths and bicycle boulevards higher than males, which is a reflection of lower tolerance of interaction with autos. The younger age groups give the highest usefulness rating to major and minor streets with bicycle lanes, which reflects the desire for direct routing. Older age groups find minor streets as well as bicycle boulevards more useful, which again reflects the desire to avoid interaction with automobiles. The middle age groups find the bicycle paths most useful, which reflects their tendency to bicycle for recreational purposes.

Table 17. Stated Preference for Types of Bicycle Facilities (on 5 point scale)

	Major Streets with Bicycle Lanes	Minor Streets with Bicycle Lanes	Major Streets (without Bicycle Lanes)	Minor Streets (without Bicycle Lanes)	Bicycle Boule-vards	Sepa-rated Bicycle Paths
By Preference for Bicycling						
All Respondents	4.46	4.13	3.27	3.90	4.10	4.11
Prefer Bicycling	4.44	4.22	3.28	3.94	4.27	4.12
Do not Prefer Bicy-cling	4.51	3.86	3.22	3.77	3.63	4.08
By Gender						
Female	4.44	4.32	3.11	3.98	4.47	4.61
Male	4.47	4.01	3.34	3.85	3.88	3.78
By Age						
under 18	4.60	4.38	3.37	3.85	3.85	4.31
18-24	4.61	4.29	3.29	3.69	3.98	4.22
25-34	4.55	4.39	3.26	3.84	4.23	4.33
35-44	4.35	4.26	2.83	3.94	4.44	4.49
45-54	4.49	4.13	3.02	3.91	4.34	4.31
55-64	4.51	4.13	3.14	3.91	4.38	4.39
65-74	4.19	4.27	2.96	3.81	4.60	4.37
75+	3.95	2.81	4.19	4.61	3.46	2.11

Revealed vs. Stated Preferences for Bicycling Facilities

Figure 7 is a general comparison of the revealed and stated preferences for bicycle facility types presented in the previous two sections. The revealed preferences indicate that bicyclists' choice of facilities is partially determined by the options available to them. This finding is intuitively clear. The respondents' stated preferences show that, given the choice, users would prefer facilities with designated bicycling lanes to those without any. Results imply a user desire for bicycle travelways that are "separate" from automobile travel lanes. The preference for facilities along existing roadways is again a reflection of the need for route directness and connectivity between activity locations. The analysis suggests that the ideal bicycle infrastructure would separate bicycles from autos, provide the most direct routing, and enable network connectivity. It would be physically separated from, but run alongside, the major and minor street network. This is consistent with the current international trend in the development of walking and bicycling facilities (See Figure 8 for examples).

Bicycling Facility Type	Revealed Preference Rank	Change in Ranking	Stated Preference Rank	Bicycling Facility Type
Major Streets with Bicycle Lanes	1st		1st	Major Streets with Bicycle Lanes
Minor Streets	2nd		2nd	Minor Streets with Bicycle Lanes
Minor Streets with Bicycle Lanes	3rd		3rd	Separated Bicycle Paths
Separated Bicycle Paths	4th		4th	Bicycle Boulevards
Major Streets	5th		5th	Minor Streets
Bicycle Boulevards	6th		6th	Major Streets

Figure 7. Differences in Revealed vs. Stated Preference Ranking of Bicycling Facility Types

Sidewalk Use for Cycling

As a reflection of the bicycle friendliness of the case study cities, the overwhelming majority of bicyclists (73 percent) do not use sidewalks. Nearly all of those who cycle on the sidewalk do so occasionally (25 percent of respondents). When they do, it is due to either heavy automobile traffic or lack of bicycle facilities on the streets.

Intersection Use by Cyclists

In conformance to traffic laws, the most frequently selected response for dealing with intersections is “riding through like a car” (79 percent). The next highest chosen response is: “take the route with the fewest intersections” (30 percent).

Comfort in Sharing Bicycle Paths with Pedestrians

Nearly 60 percent of respondents are somewhat or very comfortable sharing pathways or sidewalks with pedestrians. The remaining respondents are not comfortable sharing these spaces with pedestrians.

Figure 8. Examples of the Ideal Bicycling Facility Type

Factors in Route Choice for Bicycling

Table 18 presents a summary of how important various factors are when choosing bicycle routes. On a scale of 1 (not important) to 5 (very important), the two top-ranked factors (with 4.0 each overall) are the speed of automobiles and the pavement condition. Next in importance are route directness and length. These results confirm the study's assertions about ideal characteristics for cycling facilities. Terrain and parked car density scored in the middle for importance. The bottom-ranked factors are social (crime) and visual (beauty). Even the bottom-ranked factors were considered somewhat important on the scale, however these results indicate they are less important than conventionally believed.

Table 18. Ranking of Factors in Choice of Route for Bicycling

Factors	All Respondents	Prefer Bicycling	Do not Prefer Bicycling
Speed of Autos	4.00	3.93	4.15
Condition of Pavement	4.00	4.01	3.96
Directness	3.86	3.83	3.93
Length	3.82	3.76	3.78
Terrain	3.42	3.34	3.62
Density of Parked Cars	3.30	3.24	3.43
Crime	3.16	3.08	3.34
Beauty	3.05	3.23	3.19

Factors in Bicycle Mode Choice

Table 19 ranks the importance of various factors affecting whether or not respondents chose the bicycle as the means of travel. On a scale of 1 (not important) to 5 (very important), the top-ranked factor (with 4.4 overall) is distance. The next most important factors are availability of locked bicycle parking, rain, and terrain. The third tier of importance factors are infrastructure (connectivity to destination and availability of bicycle lanes and paths), comfort, and personal ability. The bottom-ranked factors deal with such bicycle amenities as availability of covered parking, showers, and personal lockers.

Relative to mode preference and respondent demographics, there are a few variations in the response distribution. Respondents who do not prefer bicycling rank weather, terrain and temperature to be much more important than those who prefer bicycling. With those in older age groups, terrain and one's ability become increasingly more important factors. Women generally ranked all factors as more important than men.

Table 19. Ranking of Factors in Choice of the Bicycle as the Mode of Travel

Factors	All Respondents	Prefer Bicycling	Do not Prefer Bicycling
Distance	4.39	4.29	4.53
Other	4.15	4.10	4.23
Availability of Locked Parking at Destination	3.98	4.05	3.87
Rain	3.92	3.78	4.14
Terrain	3.80	3.57	4.10
Facilities connect to destination	3.69	3.70	3.66
Availability of Bicycle Facilities (Lanes and Paths)	3.54	3.57	3.50
Comfort	3.54	3.45	3.65
Ability	3.44	3.25	3.70
Temperature	3.36	3.07	3.77
Bicycle Maintenance	3.18	3.05	3.38
Availability of Covered Parking at Destination	2.41	2.43	2.34
Availability of Showers at Destination	2.38	2.32	2.45
Availability of Personal Lockers at Destination	2.26	2.21	2.31

WALKING BEHAVIOR

Minutes Willing To Walk

In general, respondents indicated a willingness to walk between 10 minutes and 15 minutes depending on trip purpose. Table 20 shows that respondents were willing to walk on average 10 minutes for shopping, 16 minutes for recreation, 13 minutes for work, 10 minutes for business, and 13 minutes for other purposes. These averages correspond to about half a mile of walking, and have implications for placement of activity centers to promote walking. Consistently, both those who do and those who do not prefer walking were willing to walk one and a half times as long (typically two-thirds of a mile) for health and recreation. For all trip purposes, those who prefer to walk are only willing to walk a couple more minutes than those who do not prefer to walk. In this case, there is no significant difference in responses between walkers and non-walkers.

Table 20. Average Time Willing to Walk for Trip Purpose (Minutes)

	Shopping	Recreation	Work	Business	Other
All Respondents	10.7	16.0	12.6	10.3	13.1
Prefer Walking	12.9	16.2	15.0	12.7	15.4
Do not Prefer Walking	9.7	16.0	11.6	9.4	12.0

Choice of Walking Facility Types

Table 21 indicates that the most popular facilities chosen by respondents are major and minor streets with sidewalks. The second tier is held by separated walking paths (which tend to be shared with bicyclists in most but not all situations). For obvious safety reasons, the least used facilities by far for walking are major streets and minor streets without any infrastructural provisions for walking. These results are intuitively clear and indicate an overwhelming desire for specific walking facilities.

Table 21. Frequency of Choice of Various Types of Walking Facilities

	Major Streets with Sidewalks	Minor Streets with Sidewalks	Major Streets	Minor Streets	Separated Walking Paths (or Trails)
All Respondents	84%	85%	17%	35%	52%
Prefer Walking	95%	95%	10%	32%	65%
Do not Prefer Walking	88%	85%	18%	36%	52%

Preference for Walking Facility Types

Table 22 is a summary of the ranking of the various types of bicycling facilities. Respondents consider major streets with sidewalks the most useful, followed by minor streets with sidewalks, and then separated walking paths and bicycle paths. The bottom-ranked facilities are major streets followed by minor streets. There is no significant response difference between those who do and who do not prefer to walk. Females place higher values on all types of walking facilities than males, except for perhaps the most dangerous options, major streets without walking facilities. Similar to the findings for bicycling, the results indicate both the implicit need for directness of route and connectivity of network, which are provided by major and minor streets (with sidewalks) and the desire for separation of pedestrians from vehicles.

Table 22. Stated Preference for Types of Walking Facilities

	Major Streets with Sidewalks	Minor Streets with Side-walks	Major Streets	Minor Streets	Sepa-rated Bicycle Paths	Separated Walking Paths (or Trails)
By Preference for Walking						
All Respondents	4.61	4.42	2.10	2.70	3.72	4.08
Prefer Walking	4.73	4.51	2.38	2.75	3.82	4.10
Do not Prefer Walking	4.58	4.39	1.93	2.62	3.66	4.03
By Gender						
Female	4.70	4.49	1.96	2.74	3.98	4.24
Male	4.54	4.37	2.22	2.65	3.50	3.94

Revealed vs. Stated Preferences for Walking Facilities

Figure 9 is a general comparison of the revealed and stated preferences for walking facility types presented in the previous two sections. It shows that pedestrian use of walking facilities is partially dictated by the choices available. Given the choice, users prefer facilities with designated walking paths to those without any. This again implies a desire for separation from mechanical means of travel. The relatively stronger preference for facilities along existing roadways is again a reflection of the need for the route directness and connectivity between activity locations. The analysis suggests that the ultimate walking facility would separate pedestrians from bicycles and automobiles, provide the most direct routing, and enable network connectivity. The ideal walking facility, therefore, would be physically separated but run alongside the major and minor street network, consistent with current international trends. While this structure is similar to a parallel bicycle lane, no case study has proposed its elimination, although issues exists about pedestrian conflicts with right-turning vehicles.

Walking Facility Type	Revealed Preference Rank	Change in Ranking	Stated Preference Rank	Walking Facility Type
Minor Streets with Sidewalks	1st		1st	Major Streets with Sidewalks
Major Streets with Sidewalks	2nd		2nd	Minor Streets with Sidewalks
Separated Walking Paths	3rd		3rd	Separated Walking Paths
Minor Streets	4th		4th	Separated Bicycle Paths
Major Streets	5th		5th	Minor Streets
Separated Bicycle Paths	N/A		6th	Major Streets

Figure 9. Differences in Revealed vs. Stated Preference Ranking of Walking Facility Types

Pedestrian Use of Crosswalks

When crossing a street, respondents overwhelmingly use a crosswalk when one is available or would divert their routes to use one. This reflects their particular concern for safety.

Pedestrian Use of Intersections

Consistent with the use of crosswalks, two-thirds of respondents obey the signals at intersections while more than half (54 percent) only cross when they consider it safe to do so. It is not hard to imagine that bicyclists on parallel paths would adopt similar levels of conformance if similar infrastructure was put in place to safeguard their safety at intersections.

Factors in Route Choice for Walking

Table 23 is a summary of how important various factors are to respondents when choosing walking routes. On a scale of 1 (not important) to 5 (very important), the four top-ranked factors are directness of route, potential for crime along the route, length of route and the speed of automobiles. Next in importance are visual perception (beauty) and traffic conditions (for example,, number of turning vehicles and wait time at signals). At a third level of importance are factors related to infrastructure (crosswalks, sidewalks and pavement conditions) and terrain. These results indicate that the most important factors for walkers relate to those that can directly impact personal well-being. Thus directness of route and length of route relate to the amount of physical exertion involved with the trip. Similarly, potential for crime on route and auto speed relate to personal safety.

Table 23. Ranking of Factors in Choice of Route for Walking

Factors	All Respondents	Prefer Walking	Do not Prefer Walking
Directness	4.02	4.08	4.01
Crime	3.96	4.06	3.93
Length	3.96	3.94	4.00
Speed of Autos	3.72	3.94	3.63
Beauty	3.48	3.57	3.44
Number of right-turning vehicles at intersection	3.34	3.41	3.30
Waiting time at signals	3.32	3.32	3.32
Availability of Crosswalks	3.18	3.31	3.13
Terrain	3.12	3.35	3.02
Number of bicycles on sidewalk	3.08	3.27	3.00
Condition of Pavement	2.94	3.15	2.83
Volume of pedestrian traffic	2.77	2.84	2.75

Factors in Walking Mode Choice

Table 24 shows how survey respondents ranked the importance of various factors when walking. On a scale of 1 (not important) to 5 (very important), the top-ranked factor (with 4.53 overall) is distance. The next highest ranked factor is weather-related (rain) which scored a 4.02. The third tier of factors includes connectivity to destination, comfort, temperature, availability of walking facilities, personal ability, and terrain. Those who prefer to walk rank most factors as being more important than those who do not, except for rain and distance. Ability becomes a more important factor with age while women generally give higher ranking to the factors than males. These results reinforce the findings that the most important factors for walkers relate to those that can directly impact personal well-being.

Table 24. Ranking of Factors in Choice to Walk as Mode of Travel

Factors	All Respondents	Prefer Walking	Do not Prefer Walking
Distance	4.53	4.52	4.52
Rain	4.02	3.86	3.98
Facilities connect to destination	3.65	3.86	3.71
Comfort	3.53	3.65	3.56
Temperature	3.51	3.54	3.52
Availability of Walking Facilities	3.23	3.49	3.31
Ability	3.19	3.45	3.27
Terrain	3.13	3.35	3.20

V. RECOMMENDATIONS FOR INTEGRATION

INTRODUCTION

This chapter highlights best practices and identifies program characteristics associated with high levels of non-motorized travel, with an emphasis on bicyclists and pedestrians, in the selected urban case study communities of Davis, Palo Alto, and San Luis Obispo in California. The goal is to illustrate how urban communities can better integrate non-motorized transportation modes into both their physical infrastructure and the education of and outreach to residents and employees.

These recommendations derive from a study process that involved collection and analysis of primary data from field observations; surveys of users of non-motorized, public transit and automobile modes; interviews of system operators and managers; and analysis of secondary data from previous study efforts in the case study cities. These findings are combined with those in related literature to determine recurring lessons or themes. The purpose of the study is to identify program characteristics associated with high levels of walking and bicycling in terms of user preferences for the various features to determine what could be improved in the development of plans to promote walking and bicycling in urban neighborhoods or communities.

WHAT USERS WANT

The themes that recurred throughout this study address issues related to public policy, infrastructure systems, and public education, all of which affect and are affected by user preferences. For municipalities interested in improving or expanding their existing programs, this study emphasizes the primacy of the following factors in program development.

1. Matching distance to desired activities with user willingness to bicycle or walk, with a particular emphasis on route directness and connectivity.
2. Safety, particularly the separation of motorized and non-motorized modes and targeted education and outreach.
3. Convenience, which largely relates to availability of support facilities, such as bicycle parking.

GUIDING PRINCIPLES

This study recommends a number of planning activities to capture the aforementioned factors that were identified as most important for users. The planning activities are arranged in chronological order to correspond with the cycle of trip making from the decision to engage in travel for a purpose through the choice of route to arrival at the destination. Each planning activity addresses one or more of what users want. Table 25 summarizes the planning activities and the primary factors addressed. Subsequent sections explain each planning activity and illustrate them with images. The images are pictures of example treatments found in the field. They are provided to illustrate what could be done within the various steps of the integration process.

Table 25. Planning Activities with User Preferences Addressed

Activity Step	Planning Activity (P)	User Preferences Addressed
P1	Place activity centers within the range for walking and bicycling	Acceptable distance to desired activities-Convenience
P2	Establish links between activity centers	Route directness
P3	Establish links to main public transportation (bus and railway) service stations	Connectivity among routes
P4	Select type of non-motorized link	Separation of motorized and non-motorized modes for safety and comfort
P5	Select appropriate crossing treatments along route	Traveling safety
P6	Provide storage at destinations	Convenience
P7	Provide sharing and rental facilities at centers	Connectivity among routes Convenience
P8	Educate, encourage and enforce	Education and outreach
P9	Monitor, evaluate and update system	All themes

P1: Place Activity Centers within the Range for Walking and Bicycling

This study revealed that the single most impactful factor in a person's decision to walk or ride a bicycle is the distance to desired travel destinations. Throughout history, human beings have been known to demonstrate the willingness to commute within a half-hour average time or walk for a quarter of a mile to a half-mile routinely. Results from this study indicate a willingness to travel by bicycle for typical periods ranging between 15 minutes and 30 minutes depending on trip purpose: 15 minutes for shopping, 19 minutes for work, and 26 minutes for recreation. Pedestrians indicated a willingness to walk for typical periods ranging between 10 minutes and 15 minutes depending on trip purpose: 10 minutes for shopping, 13 minutes for work, and 16 minutes for recreation.

The implementation of this activity can take a long time, since related projects can require changes in local land use planning. The activity suggests a shift away from the sprawling, segregated land use patterns of previous decades to more compact and mixed-use patterns. There is the need to identify those uses frequented by residents and to place them as close to residential areas and employment locations as are practical for walking and bicycling. Such uses may include grocery stores, schools, restaurants, neighborhood parks and beauty parlors. The convenience of being able to reach these types of uses easily can facilitate the choice to walk or ride a bicycle. This principle may be integral to new development or applied in the upgrade of built-up areas.

P2: Establish Links between Activity Centers

Once activity centers are identified or placed, the second principle helps to establish the most direct linkages between them. From an initial set of desired lines of travel, existing facilities can be identified for “Complete Streets” treatments. Where appropriate, corridors can also be identified for off-street paths. See the Copenhagen example in Figure 10.

P3: Establish Links to Main Bus and Railway Service Stations

Similar to the second, this principle establishes linkages to major public transportation service centers in a manner analogous to linking activity centers. The purpose is to provide opportunity to access distant activities and services with faster and more convenient modes of shared transportation at bus and rail public transit stations as well as bus and rail intercity transportation service stations. These public systems in turn need to connect with major terminals, such as airports. See the Copenhagen example in Figure 10.

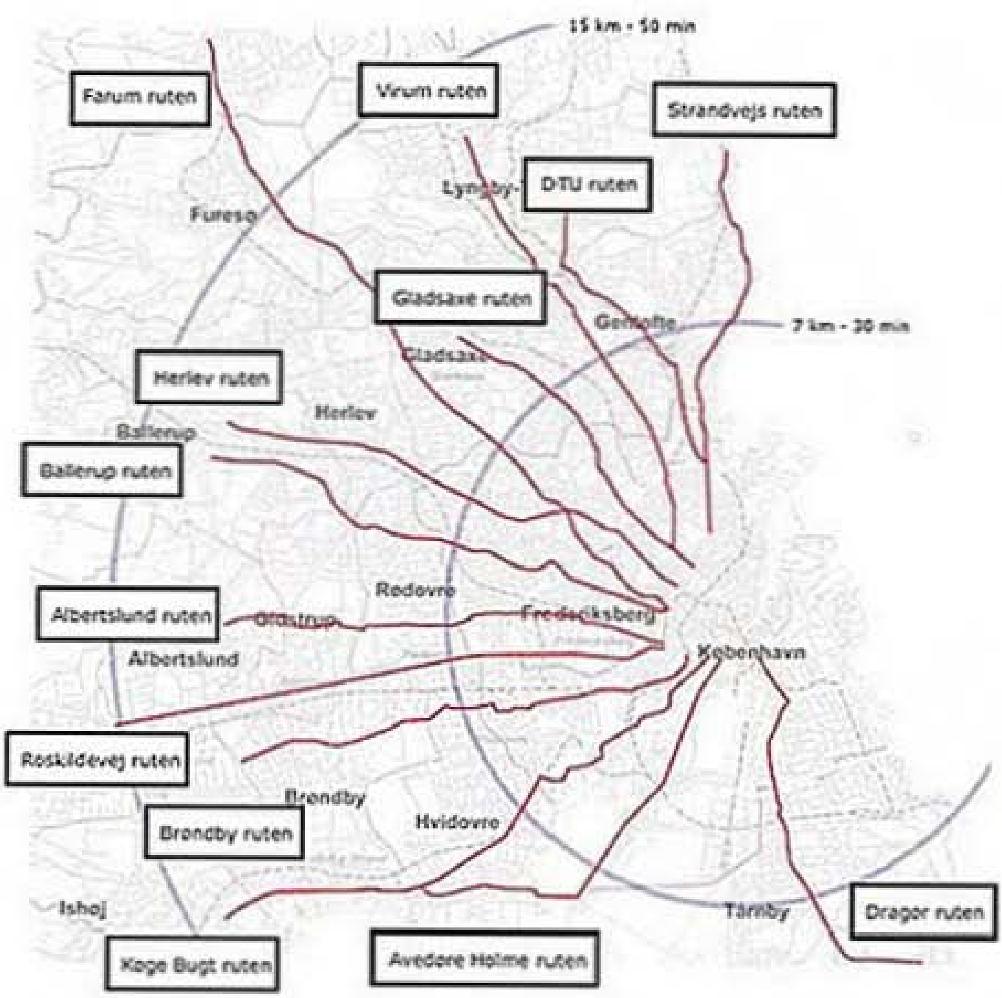

Figure 10. Demarcation of Links between Centers
A Map of Links (Bicycle Superhighways) in Copenhagen, Denmark

P4: Select Type of Non-Motorized Link

Once travel corridors are established, decisions need to be made about the manner of deploying walking and bicycling facilities to separate motorized and non-motorized modes for comfort and safety. Case studies revealed several choices that are appropriate under different circumstances. Going by the findings from this study, the general order of priority in choosing options is as follows (see figures following this section):

1. A three-way separated set of travelways (each for autos, bicycles and pedestrians) running alongside each other along a main street. See examples in Figures 11 to 17.

2. A bicycle lane striped on a street with a separate sidewalk for pedestrians. This is appropriate for built-up areas without sufficient room to implement the three-way separated travelways. See examples in Figure 22 to 30.

3. A bicycle path and trail combination in a separate right of way that may or may not run parallel to main streets. This path should be striped to separate bicycling and walking lanes. See examples in Figure 18 and 19.

4. Bicycle boulevards, which are existing minor (typically residential or central business) streets that permit through movement for bicyclists, but restrict automobiles to entry and exit only at intersections. Such a facility would normally have sidewalks for pedestrians. See example in Figure 20.

5. “Sharrows” are minor streets without room to demarcate separate bicycling lanes and on which bicycle symbols are carefully placed to guide bicyclists to the best place to ride on the road to avoid car doors and to remind drivers to share the road with cyclists. Such a facility would normally have sidewalks for pedestrians. See example in Figure 21.

Three-way Separation of Autos, Cyclists and Walkers

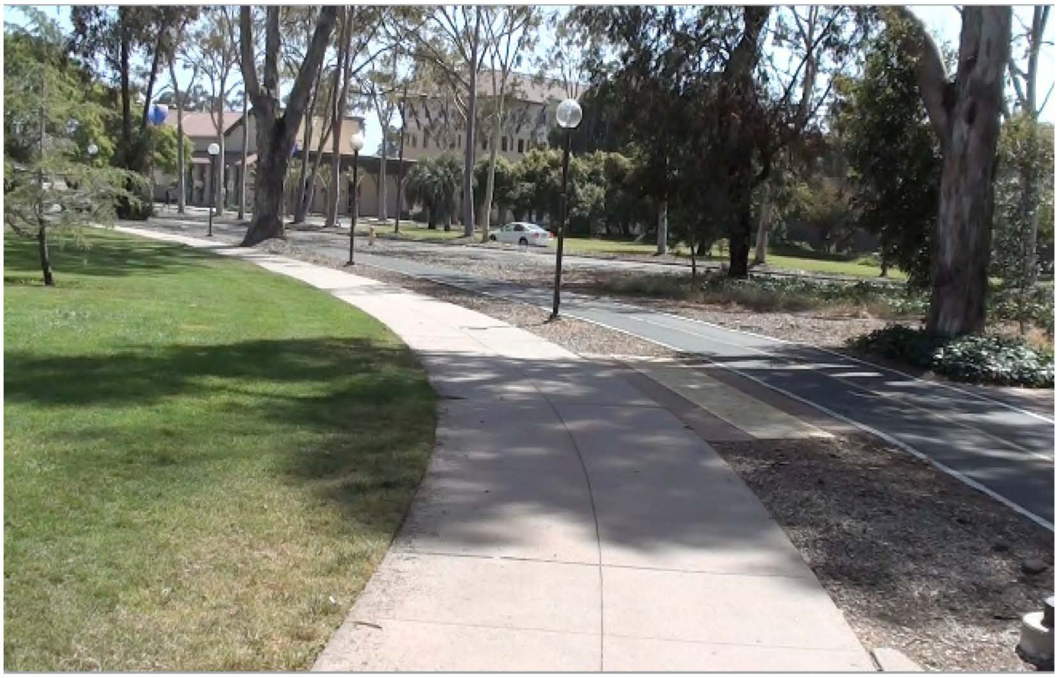

Figure 11. Separate Walking, Bicycling and Auto Facilities – UC SANTA BARBARA, CA

Notes: UC SANTA BARBARA, CA – University of California, Santa Barbara, California. Non-motorized facilities are parallel to, but physically separated from the street.

Figure 12. Separate Walking, Bicycling and Auto Facilities – Copenhagen, Denmark

Notes: Non-motorized facilities are adjacent to the arterial street, but buffered with parking lane from automobile travel lanes.

Figure 13. Separate Walking, Bicycling, Bus and Auto Facilities – Holland, Netherlands

Notes: Non-motorized facilities are adjacent to, but curb-separated from the arterial street.

Figure 14. Separate Walking, Bicycling and Auto Facilities – Montreal, Canada

Notes: Non-motorized facilities are adjacent to, but curb-separated from the arterial street.

Figure 15. Separate Walking, Bicycling and Auto Facilities – Santa Barbara, California

Notes: Non-motorized facilities are parallel to and physically separated from the arterial street.

Two-way Separation of Autos and Cyclists

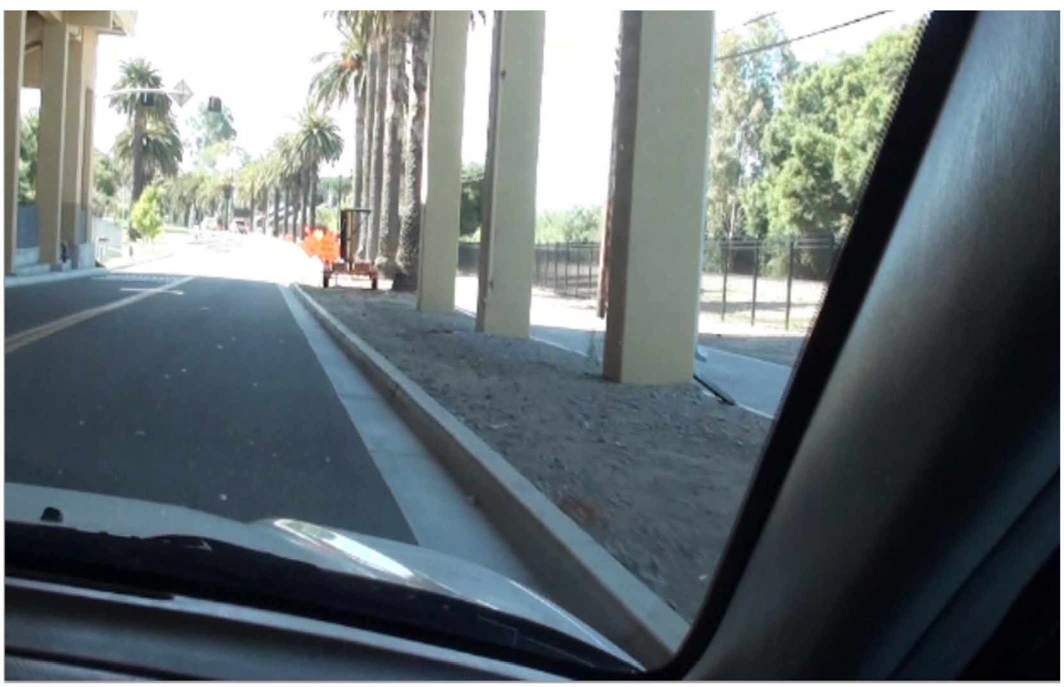

Figure 16. Separated Bicycling and Auto Facilities – San Luis Obispo, California

Notes: Bicycle side path on approach to California Polytechnic State University, San Luis Obispo, US

Dual Treatment: On-street Bicycle Lane and Separated Bicycle Path

Figure 17. On-street Bicycle Lane with Parallel Side Path – Santa Barbara, California

Separate Two-way Bicycle Path and Walking Trail

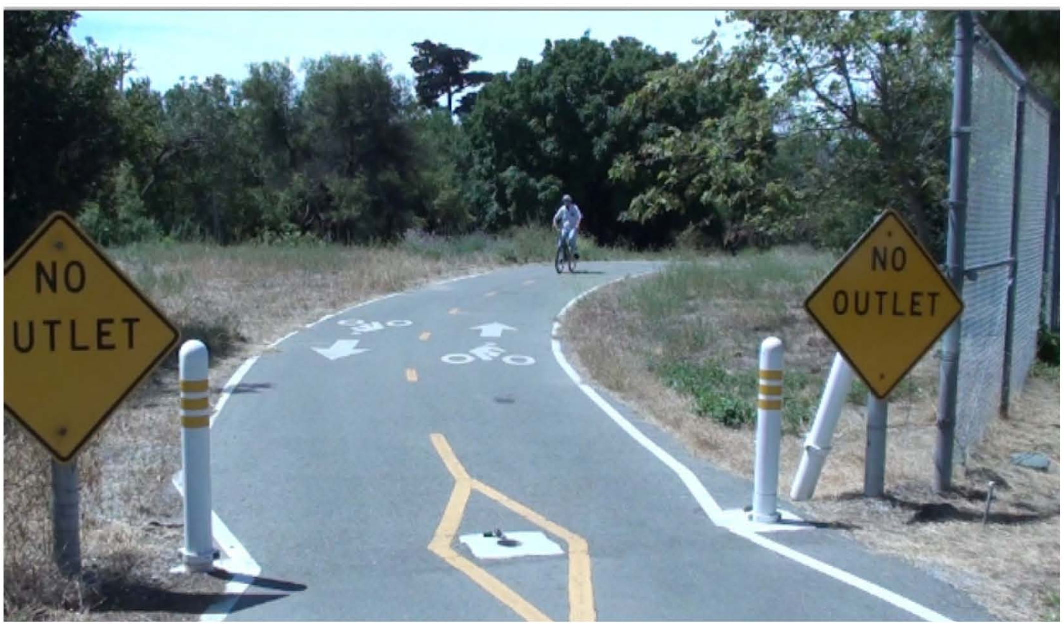

Figure 18. Bicycling Path – San Luis Obispo, California

Figure 19. Walking Trail/ Bicycle Path – Santa Barbara, California

Bicycle Boulevard

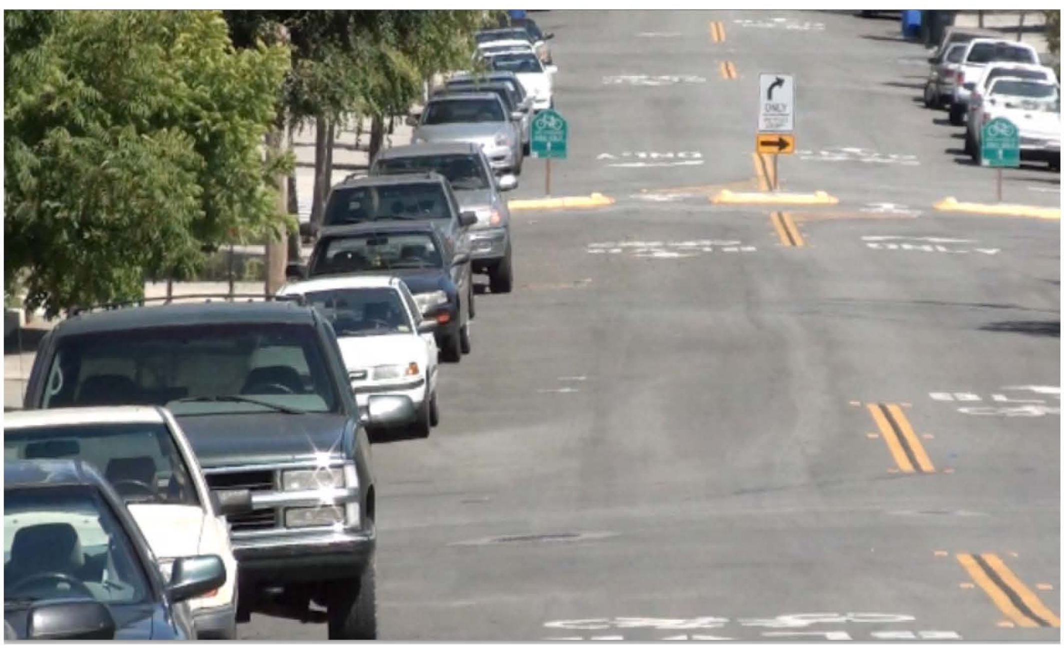

Figure 20. Bicycle Boulevard – San Luis Obispo, California

Street Shared by Autos and Bicycles ("Sharrow")

Figure 21. Shared Roadway (Sharrow) – San Luis Obispo, California

Bicycle Lanes: Wide Shoulder Lane for Bicycles and Parking

Figure 22. Shared Shoulder for Parking and Bicycling – Palo Alto, California

Bicycle Lanes: Divided Shoulder Lane for Bicycles and Parking

Figure 23. Divided Shoulder for Parking and Bicycling – Santa Barbara, California

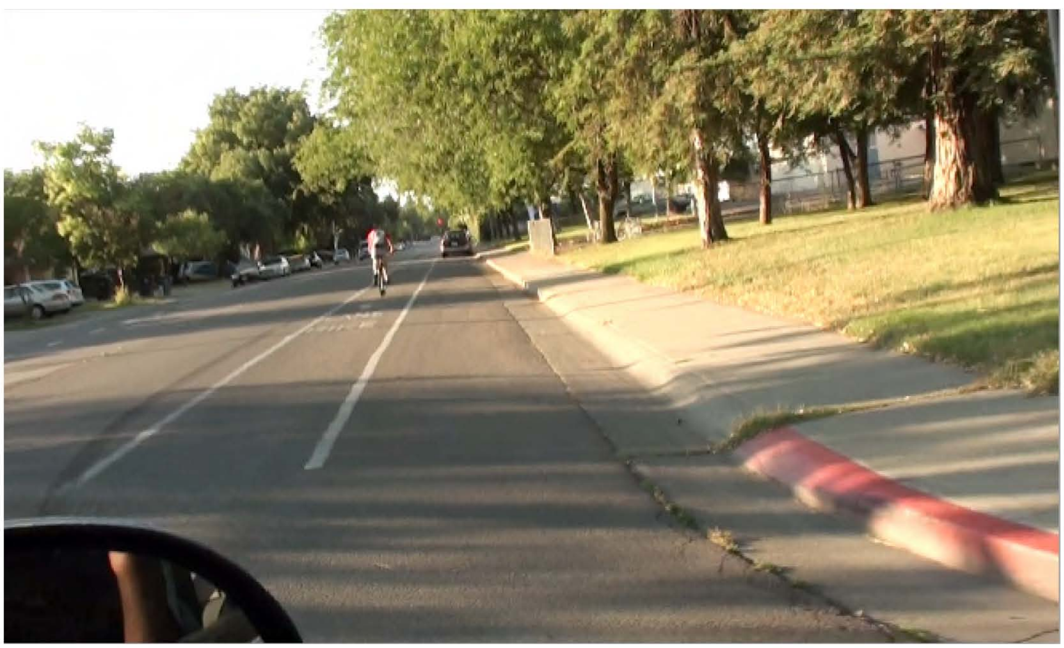

Figure 24. Divided Shoulder for Parking and Bicycling – Davis, California

Figure 25. Divided Shoulder for Parking and Bicycling – Palo Alto, California

Bicycle Lanes: Shoulder Bicycle Lane Without Parking

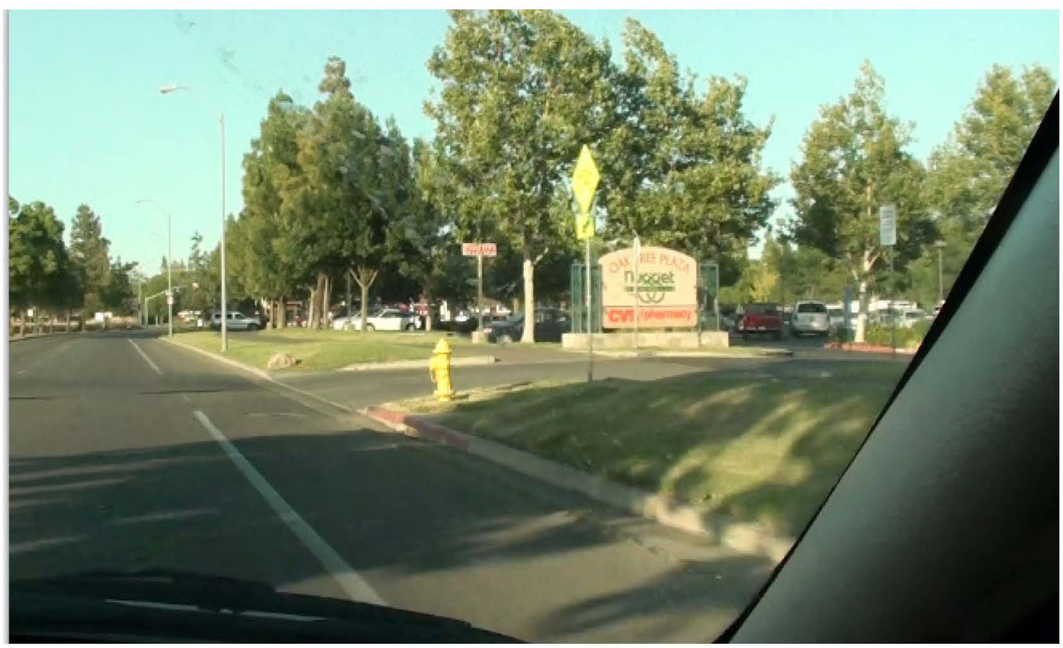

Figure 26. Shoulder Bicycle Lane #1 – Davis, California

Figure 27. Shoulder Bicycle Lane #2 – Davis, California

Walking Lanes: Wide Shoulder Lane for Walking and Parking

Figure 28. Wide Shoulder for Walking and Parking – San Luis Obispo, California

Walking Lanes: Sidewalks Next to Travel and Parking Lanes

Figure 29. Sidewalk along Arterial Street – Santa Barbara, California

Walking Lanes: Sidewalks and Bi-directional Bicycle Lanes Separated by Flower Beds from Travel Lanes

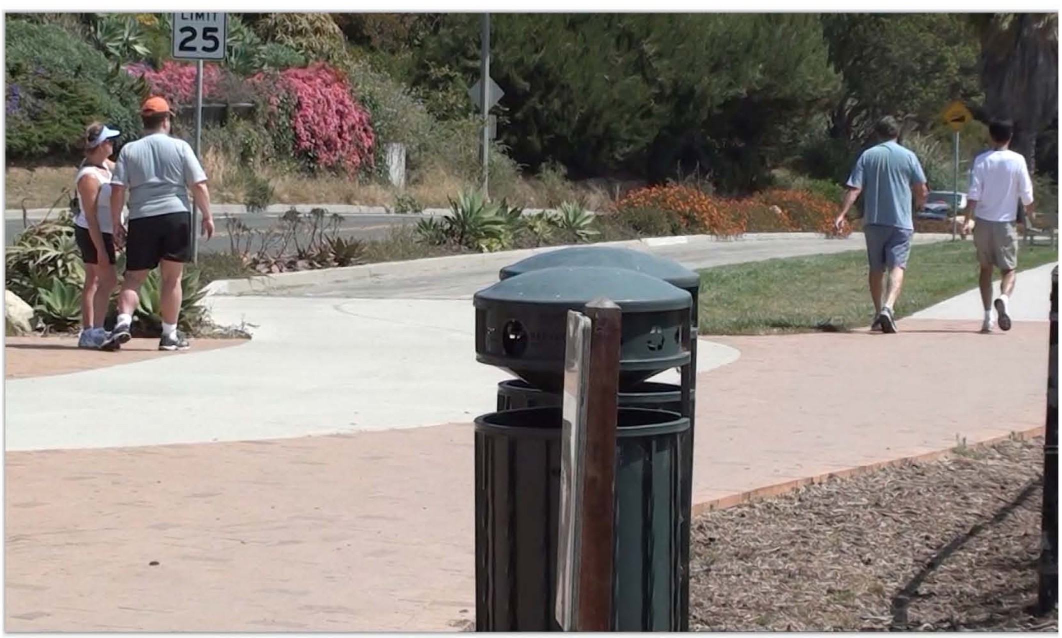

Figure 30. Separated Sidewalk along Arterial Street – Santa Barbara, California

P5: Select Appropriate Crossing Treatments along Route

In this phase of infrastructure development, several important decisions need to be made regarding safety. Points of conflict with cross-streets, railroad crossings and non-motorized traffic streams must be treated appropriately to ensure cyclist and pedestrian safety. Like the previous activity, case study cities have addressed these issues in a variety of ways that are specific to the unique context of their environments. The following list of options is presented in order from the generally lowest cost to the highest cost. Higher cost treatments tend to be most appropriate where there is a higher traffic flow and elevated safety concerns. (See examples in the figures that follow.)

1. Stop signs at intersections with marked crossings – these are the most common treatments available and serve pedestrians primarily. See example in Figure 39.

2. Raised crosswalks at intersections or mid-block crossing locations – these make pedestrians more visible to motorists and slow down the motorists as they navigate the speed table. See example in Figure 40.

3. Bulb-outs – these shorten the crossing distance for pedestrians and may be combined with marked crossings or raised crosswalks. See examples in Figures 37 and 38.

4. Bicycle and pedestrian phases at traffic signals – these are much more common for pedestrians than they are for bicyclists. They are provided at few main street traffic signals with noticeable volumes of bicycle traffic. They should be considered on main streets with parallel bicycling lanes to deal with the conflict between turning vehicles and cyclists. See examples in Figures 35 and 36.

5. Roundabouts – these are provided in areas where high volumes of non-motorized traffic streams cross each other. They are sometimes shared with public transit vehicles with exclusion of auto traffic. See examples in Figures 31 to 34.

6. Grade separation – is the ultimate and most costly type of crossing treatment and is provided for both bicyclists and pedestrians. In either case, they could be in the form of overpasses or underpasses. See examples in Figures 41 to 48.

At-Grade Crossings and Intersections: Bicycle Only Roundabouts for Bicycle Paths

Figure 31. Bicycle Only Roundabout – Santa Barbara, California

Bicycle & Bus Roundabouts (No Automobiles)

Figure 32. Bicycle and Bus Roundabout #1 – Davis, California

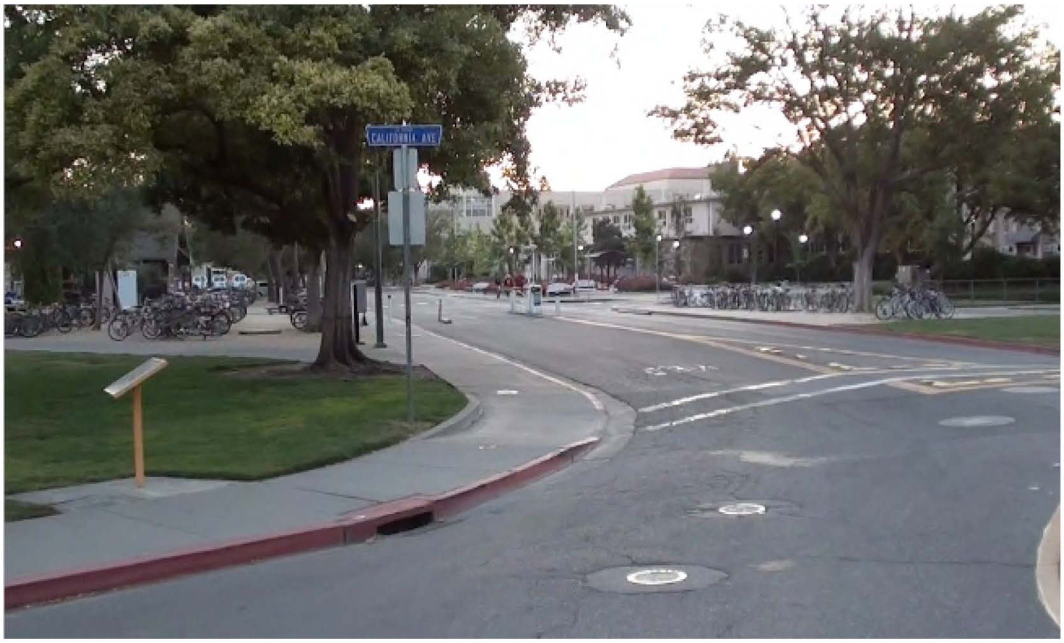

Figure 33. Bicycle and Bus Roundabout #2 – Davis, California

Separate Pedestrian Paths at Roundabouts

Figure 34. Demarcated Walking Paths at Bicycle and Bus Roundabout – Davis, California

Bicycle Signal Phase at Signalized Intersection

Figure 35. Bicycle Signal Integrated with Auto Traffic Signal– San Luis Obispo, California

Bicycle Signal at Intersection With No Automobile Traffic Signal

Figure 36. Bicycle Only Signal along Non-Motorized Route – Davis, California

Road Diet for Reduced Pedestrian Crossing Distance

Figure 37. Narrowed Pavement at Intersection to Shorten Crossing – Santa Barbara, California

Bulb-outs for Reduced Pedestrian Crossing Distance

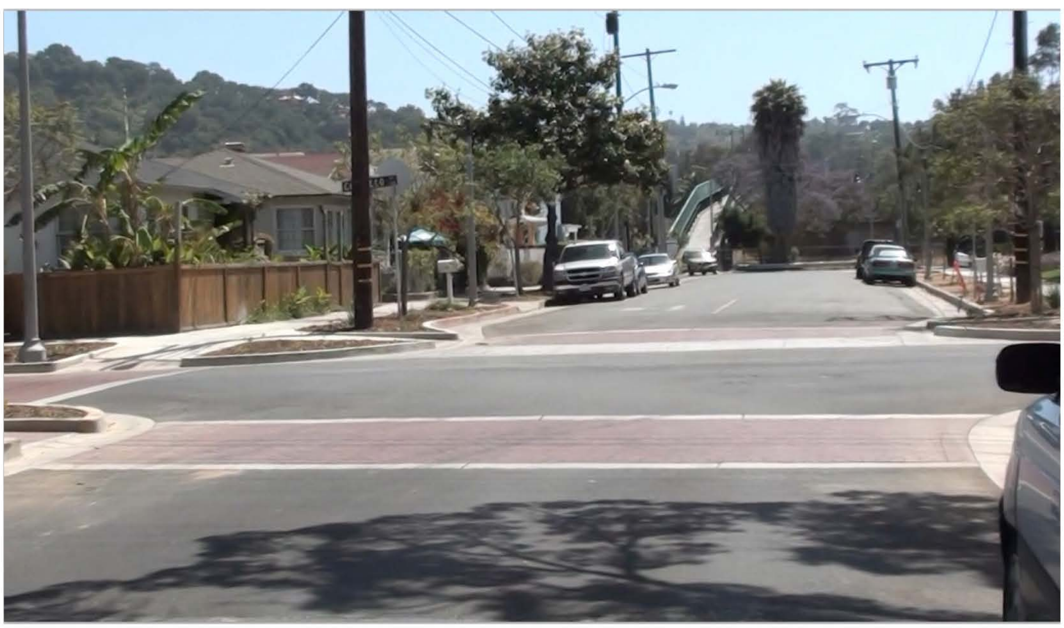

Figure 38. Bulb-out at Intersection to Shorten Crossing – Santa Barbara, California

Textured Cross-walks for Improved Visual Demarcation of Pedestrian Crossings

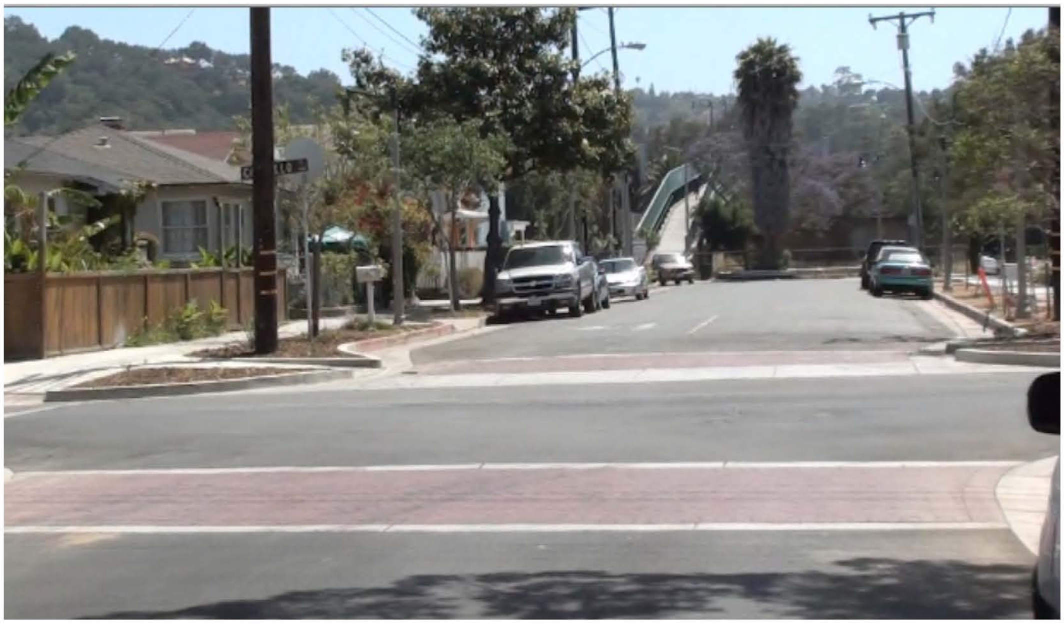

Figure 39. Brick Paving to Demarcate Cross-Walk at Intersection – Santa Barbara, California

Raised Cross-walks (Speed Table) for Improved Pedestrian Visibility and Auto Speed Calming

Figure 40. Raised Cross-Walk at Intersection for Pedestrian Safety – Tampa, Florida

Grade Separation: Bicycle/Pedestrian Overpass Over Freeways and Rail Lines

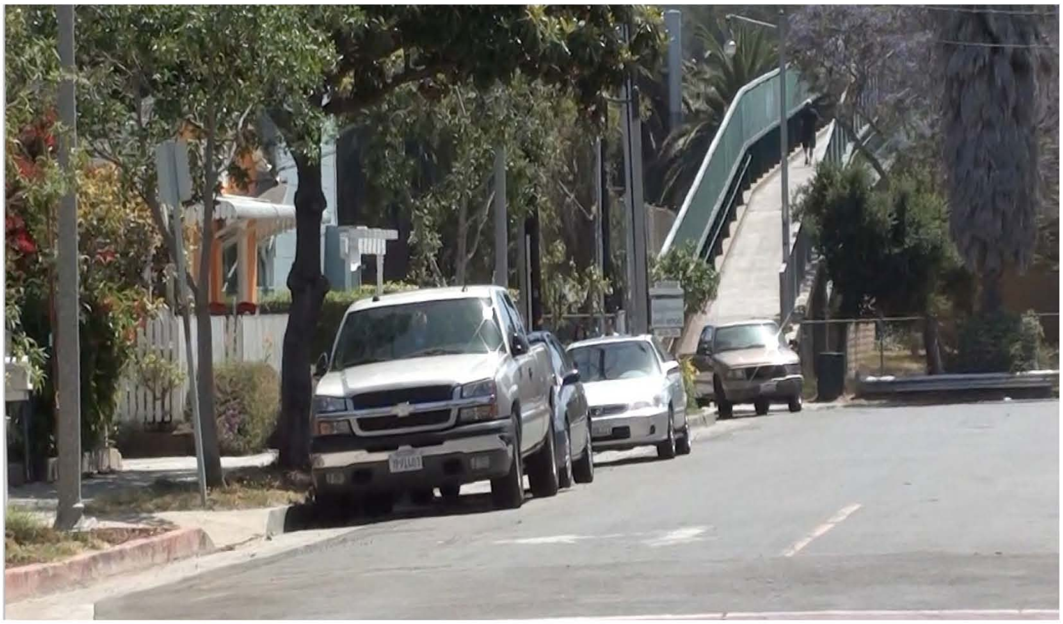

Figure 41. Pedestrian Overpass across US 101 – Santa Barbara, California

Notes: Stairs for climbing and descending overpass, SANTA BARBARA, CA

Figure 42. Pedestrian and Bicycle Overpass #1 – Davis, California

Note: Topography precludes steep ascension or descent of overpass; Davis, CA

Figure 43. Pedestrian and Bicycle Overpass #2 – Davis, California

Figure 44. Pedestrian and Bicycle Overpass over Railway Line – San Luis Obispo, California

Note: Spiral crossing permits riding up and down the overpass; SAN LUIS OBISPO, CA

Bicycle Underpass Concurrent with Road Underpass

Figure 45. Bicycle Underpass – Davis, California

Bicycle-only Under-pass

Figure 46. Underpass for Bicycle Path #1 – Santa Barbara, California

Figure 47. Underpass for Bicycle Path #2 – Davis, California

Bicycle Lane Across Highway Bridge

Figure 48. Bicycle Lane on Highway Bridge – Davis, California

P6: Provide Storage at Destinations

This recommendation applies primarily to bicycles and relates to such amenities as bicycle parking racks, lockers for both bicycles and helmets, and bicycle stations. Bike stations are analogous to parking garages for automobiles. These amenities enhance the convenience of bicycle travel. See examples in the figures that follow.

1. Designs of bicycle racks in each case study city. See examples in Figures 49 to 52.

2. Bicycle stations are rare; they are expensive parking garages for bicycles with opportunities to service bicycles. See examples in Figures 53 to 56.

Bicycle Racks

Figure 49. Bicycle Parking Lot – Santa Barbara, California

Figure 50. Bicycle Rack Type A – Santa Barbara, California

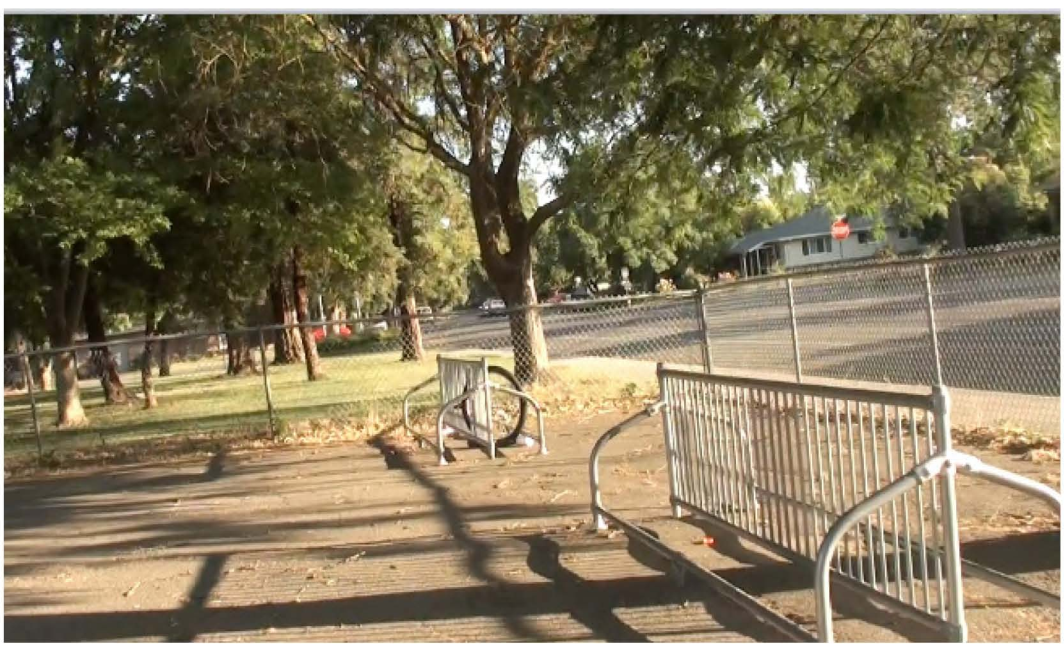

Figure 51. Bicycle Rack Type B – Davis, California

Figure 52. Bicycle Rack Type C – Davis, California

Bicycle Stations

Figure 53. Entrance to Bicycle Station – Santa Barbara, California

Figure 54. Upper Deck of Bicycle Station – Santa Barbara, California

Figure 55. View of Dual-Deck Bicycle Station – Santa Barbara, California

Figure 56. Repair Facility with Storage Lot at Bicycle Station – Davis, California

P7: Provide Sharing and Rental Facilities at Centers

This recommendation addresses additional amenities that can enhance both connectivity and convenience for pedestrians, bicyclists, and even motorists. Bicycle sharing through rental programs can complement the use of public transportation, walking, and even driving where there is the need to reach a final destination from a public transportation stop or travel between stops. They can be used for ingress to and egress from major public transportation service centers.

1. Electronic Rental Stations – these are self-serve stations that are becoming widespread in Europe and certain cities in the U.S. See example in Figure 57.

2. Manned Rental Stations – See example in Figure 58.

Figure 57. An Electronic Bicycle Rental (Velib Service) Station in Paris, France

Figure 58. A Manned Bicycle Rental Station in Santa Barbara, U.S.

P8: Educate, Encourage and Enforce

All the case studies identified "Safe Routes to School" as an important education, encouragement, and enforcement program. Because everyone is a pedestrian at some point, the basics of being a safe pedestrian are generally taught by parents or in school. A broad-based educational outreach and encouragement campaign is required via multiple outlets including the following:

1. Schools through the "Safe Routes to School" program, which is emphasized heavily in the Palo Alto Unified School District.
2. Colleges and institutions (as is the practice, for instance, in Stanford during new student orientation).

3. Advocacy groups and clubs (for example, League of American Bicyclists).

4. Violator training classes, which combine enforcement with education, similar to automobile drivers being ordered to engage in driver education training following citations for violations.

Enforcement is important for establishing a law-abiding bicycling culture, which in turn garners respect from motorists and pedestrians. Enforcement combined with education is even better.

P9: Monitor, Evaluate and Update System

It is important to exercise flexibility in choosing the most appropriate option for specific circumstances from the menu of treatments. For instance, sometimes the best bicycle connection between two locations may be a bicycle path rather than a bicycle lane along a major arterial. In addition, human populations, land uses and activity locations change over time. Thus the desire for travel varies with time. This principle recognizes these changes calling to monitor them, and to reevaluate conditions and to make updates or upgrades to the system as the future evolves. In so doing, the system will continue to address all themes and reduce inadequacies or obsolescence of its components.

VI. FINDINGS AND CONCLUSIONS

MAIN ISSUES AND BARRIERS

This research found that some of the main issues involved with creating a cyclist- and pedestrian-friendly community include safety, weather, distance, parking, lifestyle, and education. For different groups of people (for example, men versus women), the factors vary in importance. For people who cycle often, or would like to cycle more often, it is important to provide facilities that are both safe and allow them to reach their destinations easily. Bicycle lanes are often rated more highly than bicycle paths, possibly due to the fact that the lanes are designed primarily to connect people to destinations, whereas paths are designed for recreation as well. The fact that some cyclists ride on sidewalks, even though it is illegal, reflects the connection between the convenience of using connector roads and wanting to feel safe. Safety while cycling is a result of the quality of facilities as well as the experience of the cyclist. This factor is more important to women and adults in older age categories.

Many survey respondents noted the importance of providing enough parking for cyclists. Cyclists want parking to be available at destinations the same way automobile drivers do. Availability of bicycle parking can therefore provide an incentive to bike. Trip distance is important in deciding both route and mode choice. The distance a person travels for each trip purpose is not only a function of the mix of land uses, but also lifestyle. The demands of many daily schedules, particularly families, can make automobiles the most convenient travel option. This is partly why it is sometimes asserted that providing facilities alone does not change behavior. The convenience offered by the facilities, the awareness of the benefits of use and education on proper use are all important determinants in the choice to walk or ride a bicycle.

These issues also point towards an idea that is already well understood in Europe: rather than providing alternative mode infrastructure after development has taken place, plan for development to occur around alternative modes. Continuing to build roadways and large parking lots that serve medium density development steers funding away from alternative modes, as well as entrenches lifestyle patterns best served by the automobile. Some European cities have addressed this by not continuing to build roads, but instead focusing on a more balanced provision of mobility needs for other alternatives such as bicycling. Cyclists and pedestrians who use these modes for more than recreation want direct routes, wide lanes that allow for passing, and signal phases for cyclists—in other words, many of the same things automobile drivers want. Traffic calming elevates the importance of alternative modes.

PHYSICAL CHARACTERISTICS

Cities with high bicycling mode shares have more than one of the following characteristics: flat terrain, compactness of development with mixture of land uses, mild climate, interconnected network, and a bicycling culture. Davis has all of these features. Palo Alto is larger than Davis, but it also has all the characteristics. San Luis Obispo is very hilly and compact with a mild climate and a university population, which helps to add to the bicycling culture. It is noteworthy, however, that cities like Amsterdam and Copenhagen have cold climates and are not as small in area, but are flat, have mixed land use and have strong bicycling cultures. In terms of urban character, even cities with heavy traffic and auto-oriented design can transform into bicycle and pedestrian-friendly environments with modifications to infrastructure. These modifications relate to directness of connectivity between activity centers with separation of travelways for bicycles and pedestrians from automobiles.

LOCAL INVOLVEMENT

Davis offers a lesson on the importance of local involvement. It originally had a strong city official who was a bicycling advocate, and it developed a culture of bicycling. When this official retired and many newcomers came to the city, the mode share dropped, but more recently a bicycling advocacy group has been created, which has helped to increase the bicycling mode share again. It is not surprising that many bicycling communities have at least one organizational characteristic that includes bicycle advisory committee or commission, bicycle advocacy groups, bicycle clubs, and elected officials or city engineers and planners who advocate bicycling.

PLANNING AND EVALUATION

The Complete Streets movement provides examples, legislative options and ideas for retrofitting streets to accommodate all users. While the Complete Streets approach may be desired for an entire city, sometimes the best bicycle connection between two locations may be a bicycle path rather than a bicycle lane along a major arterial. Thus it is important to exercise flexibility in choosing the most appropriate option for specific circumstances from the menu of treatments identified in the generalized typology. Thus a system wide Master Plan is important to encompass and integrate alternative mode facilities.

Responses from officials of case study cities indicate that having staff who know about cyclist and pedestrian issues is very important in creating change within the communities. This allows for each infrastructure project, large and small, to be planned in a way that benefits alternative modes. The Complete Streets program recommends taking advantage of each opportunity for road improvement or development to create a more pedestrian and cyclist friendly environment. City engineers and consultants need to update modeling techniques to better accommodate short trips. The use of large traffic analysis zones to monitor travel over distances that are most likely to be made using an automobile does not capture the full picture of mobility in a given area.

ENGINEERING

Engineering should ensure that the city has the appropriate infrastructure to meet certain objectives: connect land uses and activity centers in the city; make cyclists and pedestrians feel and be safe; provide the appropriate amount of bicycle parking and other amenities. Having a comprehensive network of infrastructure, such as in Davis, does not automatically guarantee that people will use bicycles, but it provides the opportunity. Adding safety features with the appropriate types of crossings and traffic control instills confidence in potential users. Ancillary facilities, such as lockable bicycle parking, sufficient parking spaces and stations add to the convenience for users.

EDUCATION, ENCOURAGEMENT, AND ENFORCEMENT

Because everyone is a pedestrian at some point, the basics of being a safe pedestrian are generally taught by parents or in school. This is not the case with bicycling. Thus a more broad-based educational outreach and encouragement campaign is required via multiple outlets such as bicycling groups (as done by the League of American Bicyclists through workshops), and institutions (as done by Stanford during student orientation). Enforcement is important for establishing a law-abiding bicycling culture, which in turn garners more respect from auto drivers and pedestrians. The research reveals that the best type of enforcement is that which is combined with education, similar to automobile drivers being ordered to engage in driver education training following citations for violations.

Safe Routes to School, which is an education, encouragement, and enforcement program, was named in each case study city as an important program to promote cycling and walking to school. Cities should take advantage of this program to educate young students and begin a culture shift in their communities.

BEHAVIOR

The fact that many cyclists in the case studies ride through an intersection likely shows the high degree of comfort, and possibly education, that cyclists have in these communities. Some people will ride on the sidewalk, though generally only under conditions where they do not feel safe on adjacent streets because facilities are lacking or traffic is heavy. Many survey respondents indicate they obey the signals at intersections and divert their routes to crosswalks. This means many people find obeying the laws important, possibly either because they feel the laws are important or because it would be dangerous not to obey them. Thus consistency in the treatment of control is paramount to avoid confusion and foster obedience.

UTILITARIAN VS. RECREATIONAL USE

Cities need to make a strong distinction between utilitarian or recreational cycling and walking. The literature review showed that many people were willing to walk further for commuting purposes (for example, walking to a train station) than normally expected. People will also take the shortest route whether or not there is any sort of infrastructure provided for pedestrians. While many cites may focus on creating welcoming environments with street furniture and trees, this is not an extremely important variable in encouraging more commuters to walk for at least a portion of their trip. Variables such as directness and length of the route, as well as having facilities that easily connect to a destination, are more important factors.

RESEARCH CONCLUSIONS

Though there is perhaps a specific type of community layout that is best suited for cyclists and pedestrians, having a few of the general characteristics (flat terrain, compact development, mixture of land use, mild climate, inter-connected network) can allow a city to develop into a cycling and pedestrian friendly community. Many communities, specifically in California, have good climates despite being hilly or low-density. Though geography cannot be changed, every city can create a bicycling culture through advocacy groups, clubs, school programs, and involved city officials or planners. Conversely, even if a city is a perfect candidate geographically, without any sort of advocacy, alternative travel options may not be provided for thereby creating opportunity for choice. Because the case studies each have a university, the differences in planning management for the city and university are evident. The universities were designed over time to have high levels of alternative mode access and, as a result, have very high alternative transportation mode shares.

There is an abundance of treatments available to towns and cities to suit various circumstances. Careful choice through deliberation can aid in the optimal use of funding to achieve user-friendliness. If cities want to create a better bicycling culture, the cities must develop extensive educational opportunities for children and adults in safe bicycling practices.

The Complete Streets movement provides examples, legislative options and ideas for retrofitting streets to accommodate all users. However, as most people will not be walking or cycling throughout an entire city, it is important to provide infrastructure in places where walking and cycling to destinations are most feasible. Cities should determine areas that could attract cyclists and pedestrians and focus on providing the best possible network in those areas.

So, what does it take to create a bicycle- and pedestrian-friendly community and what does the ideal community look like? Our study shows that although there are no “one size fits all” answers to these questions, a variety of options exist that communities can tailor to their own specific needs. The results of the user preference survey indicate that bicyclists and pedestrians alike desire auto-separated facilities on major (and for walkers, minor) streets. This suggests that perhaps these kinds of projects merit priority over purely recreational paths. These routes should also be designed knowing that the average resident is willing to walk 10-16 minutes (for all trip purposes) and bicycle 15-20 minutes (for commute purposes). Our interviews with program managers show that creating a culture of biking and walking takes community effort. Even in the face of limited resources, an engaged citizenry and bicycling coalitions can work in concert with city staff, school officials, and police department to pool efforts that create effective programs.

APPENDIX A: SUMMARY OF FACILITY CHARACTERISTICS AND USER BEHAVIOR

	Time Value	% Travel Time	$ Value	Ranking	Distance	Source	Type
Facility Characteristics							
Type of Cycling Facility							
Mixed with traffic	1 minute cycling 'in mixed traffic' is as onerous as 4.1 minutes on 'bicycle lanes' or 2.8 minutes on 'bicycle paths.'					Hunt, 2007	SPS
			Reducing travel time on an arterial road is valued at $17/hr			Abraham, 2002	SPS
Bicycle lane	Using a base value of 20 minutes, cyclists will travel an additional 16.41 minutes to use an improved bicycle lane.					Tilahun, 2007:298	SPS
	Davis has a 14% bicycle mode share for journey to work with 50 miles of bicycle lanes (on 95% of arterial streets) and 50 miles of Class 1 bicycle paths					Buehler, 2008:3	Case Study

An on-street bicycle lane is worth an 16.3 minutes of additional cycling time					Krizek, 2006:313	SPS
		Cyclists value an on-street facility at $3.26 for each way of travel for a typical 20 minute commute			Krizek, 2006:318	SPS
			For factors affecting use of a bicycle and ride facility, the highest utility (1.71) increase is the addition of a bicycle lane (from the point of view of inexperienced cyclists).		Taylor and Mahmassani, 1996	SPS
			The top request from by far from commuter cyclists responding to a survey in Calgary was to improve the bicycle lanes both inside and outside of the downtown.		Calgary, 2007	SPS

				Miles of bicycle pathways (lanes, paths, or grade-separated) per 100,000 people in an urban area helps predict the percent of commute mode share comprising cyclists.		Nelson and Allen, 1997	
Cycle path				Between 45 and 60% say presence of cycle path important for route choice		Bernhoft, 2008:90	SPS
Bicycle path					Cyclists will travel .5 to .75 miles to use an off-road bicycle trail	Tilahun, 2007	SPS
	Using a base value of 20 minutes, cyclists will travel an additional 5.13 minutes to use an improved bicycle path.					Tilahun, 2007	SPS
			Reducing travel time on path is valued at $4/hr			Abraham, 2002	SPS
	An off-road bicycle path is worth 5.2 minutes of additional cycling time					Krizek, 2006:313	SPS

Nature of Roadway							
Class		Cyclists will add an additional 10% to their travel time to use routes on residential streets				Stinson and Bhat, 2003:11	SPS
Sight distances							
Turning radii							
Lane/median configuration				Stress level decreases as curb lane width increases. Stress level is high (4.5) with 11 ft. lanes. Stress level is (2.5) with 18 ft. lanes.		Sorton and Walsh, 1994	SPS
On-street parking	Using a base value of 20 minutes, cyclists will travel an additional 9.27 minutes where on-street parking has been removed.					Tilahun, 2007	SPS
	Absence of parking is worth 8.9 minutes of additional cycling time					Krizek, 2006:313	SPS
	A cyclist will travel 6.21 minutes more to avoid parallel parking					Sener et al, 2009:42	SPS

	A cyclist will travel 2.79 minutes more to avoid angle parking					Sener et al, 2009:42	SPS
	A cyclist will travel 8.29 minutes more to avoid 2-4 continuous city blocks of parking					Sener et al, 2009:42	SPS
	A cyclist will travel 9.28 minutes more to avoid 5-7 continuous city blocks of parking					Sener et al, 2009:42	SPS
Pavement type/quality				About 30% say smooth surface is a factor in route choice.		Bernhoft, 2008:90	SPS
Grades							
Intersection spacing							
Cycling treatments at signals				Between 35 and 60% find the presence of a signalized crossing is important in route choice.			
Completeness of infrastructure							
Directness of infrastructure				Between 25 and 45% say directness of route is a factor in route choice.		Bernhoft, 2008:90	SPS

Availability of showers							
Availability of secure parking	To have individual bicycle lockers, cyclists will ride additional 8.5 minutes on an arterial road, 18.8 minutes on a residential road.					Abraham, 2002	SPS
	To have secured parking, cyclists will ride additional 26.5 minutes in mixed traffic.					Abraham, 2002	SPS
				For factors affecting use of a bicycle and ride facility, providing bicycle lockers has a high utility (1.47), and is a 2.5 times greater incentive than covered/lockable parking.		Taylor and Mahmassani, 1996	SPS
Stop signs, red lights and cross streets	A cyclist will travel 7.54 minutes more to avoid 3-5 stop signs, red lights or cross streets					Sener and others, 2009:42	SPS

	A cyclist will travel 25.03 minutes more to avoid more than 5 stop signs, red lights or cross streets					Sener and others, 2009:42	SPS
Non-cycle Traffic Characteristics							
Motor vehicle speeds	A cyclist will travel 10.91 minutes more to avoid motor vehicle speed of 20-35 mph					Sener and others, 2009:42	SPS
	A cyclist will travel 22.93 minutes more to avoid motor vehicle speeds higher than 35 mph					Sener and others, 2009:42	SPS
				Cyclist stress level increases as vehicle speed increases. Stress level is medium (2.5) at 25 mph. Stress level is high (4.2) at 45 mph.		Sorton and Walsh, 1994	SPS

				The most important and understand-able factor that contributes toward bicycle suitability is traffic volume and speed.		Davis 1995	Quantitative evaluation and test routes
Driver Behavior				Women were more likely than man to say that ag-gressive driv-ing behavior is a constraint in cycling.		Garrard and others, 2006, quoted in Gar-rard and oth-ers, 2008	SPS
Volume or mix of vehicles				Between 25 and 45% say less traffic is a factor in route choice		Bernhoft, 2008:90	SPS
				The most important and understand-able factor that contributes toward bicycle suitability is traffic volume and speed.		Davis 1995	Quantitative evaluation and test routes
				Stress level increases as curb lane vol-ume increases. Stress level is low (2) when there is 50 vphpl and high (4) when there are 650 vphpl.		Sorton and Walsh, 1994	SPS

Pedestrian interaction							
Individual and Trip Characteristics							
Gender				Women choose off-road facilities most often when they are available, and more often than men.		Garrard and others, 2008	OPS
				Women in general commute shorter distances by bicycle.		Garrard and others, 2008	OPS
				Safety, scenery, terrain, and bicycle safety education were more important to women on average than to men.		Antonakos 1994	
Age				Older cyclists say cycle path and less traffic are most important factors in route choice		Bernhoft, 2008:90	SPS

				Younger cyclists say direct or fastest route are most important factors in route choice		Bernhoft, 2008:90	SPS
				"Age was positively correlated with preference for on-road facilities... and negatively correlated with preference for bicycle paths separated from the roadway."		Antonakos 1994	SPS
Income							
Cycling experience				Experienced cyclists have lower stress levels based on curb lane volume, curb lane width, and speed.		Sorton and Walsh, 1994	SPS
Private vehicle ownership				For factors affecting use of a bicycle and ride facility, selling all cars has a high utility value (1.01), and is twice as high as owning a commuting bicycle.		Taylor and Mahmassani, 1996	SPS
Safety concerns							

Personal security concerns							
Trip Length, time or distance				Between 20 and 60% say fastest route a factor in route choice		Bernhoft, 2008:90	SPS
Environmental/Situation Characteristics							
Nature of abutting land uses							
Aesthetics along route							
Degree of political and public support							
Level of public assistance							
Education and enforcement				Percent of college students in an urban area helps predict the percent of commute mode share comprising cyclists.		Nelson and Allen, 1997	
Availability of public transport							
Cost or other disincentives							
Terrain grade	A cyclist will travel 5.19 minutes more to avoid steep terrain					Senner, 2009:42	SPS

				Based on a generalized terrain score for an urban area, terrain does not predict the percent of commute mode share comprising cyclists.		Nelson and Allen, 1997	Census Data
Climate				Climate is not a major factor affecting the percent of commute mode share comprising cyclists.		Goldsmith, 1992 (in Nelson and Allen, 1997)	
				Mean high temperature for an urban area does not predict the percent of commute mode share comprising cyclists.		Nelson and Allen, 1997	Census Data
				Number of rainy days in an urban area helps predict the percent of commute mode share comprising cyclists.		Nelson and Allen, 1997	Census Data

APPENDIX B: CASE STUDIES

Case Study One: City of Davis and UC Davis, California

The City of Davis, California is awarded "platinum," the highest ranking, by the League of American Cyclists. Table 26 summarizes sources of information and officials interviewed for the background to this case study.

Table 26. Information Sources – City of Davis, California

Source	Item
League of American Cyclists	Bicycle Friendliness Ranking = Platinum Bicycle commute mode share = 14% Area = 10 square miles
Officials Interviewed	Tara Goddard – City Bicycle/Pedestrian Coordinator David Takemoto-Weerts – UC Davis Bicycle Coordinator Will Marshall – Assistant City Engineer
CA Department of Finance[1]	Population = 66,570 (January 2010)

1 State of California, Department of Finance, E-1 Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2009 and 2010. Sacramento, California, May 2010

City of Davis

General Characteristics

Davis has been a bicycle friendly college town for many years.[86] This city has a population of 66,570 and is 10 square miles large.[87] In other words, the longest trip across town is approximately 6 to 7 miles.[88] Out of 344 miles in the total road network, 97 miles accommodate cyclists. The average temperature is between 46 and 77 degrees fahrenheit throughout the year. The city has a high median income of $74,501, and a large percentage of the population is college age because there is a large university, the University of California (UC) at Davis, in town. Most of the neighborhoods are within a quarter mile of retail or business areas, and many have community-friendly amenities such as parks, benches, and greenery. These conditions make it attractive to walk and bicycle.

In Davis, California, the high amount of bicycle use is attributed in part to location characteristics such as the flat topography, mild climate, and the university center.[89] It is also a small town with wide streets, which makes bicycling easy.[90] Good planning and bicycle infrastructure are also recognized as important factors. In particular, Davis has compact neighborhoods with 6,500 people per square mile that make walking and bicycling practical.[91] In the 1950s, when the University became a separate unit from UC Berkeley, the city began to grow rapidly. Bicycling remained a good way to get around.[92]

Conflicts between motorists and bicycles in the 1960s led to the development of bicycle lanes. At that time, bicycle lanes became a key issue in elections. Bicycle lane standards were developed because there was no precedent in the U.S. Today, there are bicycle lanes along all streets that are collector streets or larger. The city even took out parking to provide for bicycle lanes. There are, in addition, bicycle paths along all major arterials, grade separations for bicycles at all major crossings, and a greenbelt network. Davis had an influential Public Works Director, Dave Pelz, who saw many European examples and encouraged bicycle friendliness in the City. In 1994, Davis created the first Bicycle/ Pedestrian Coordinator position and around the same time Davis developed its first Bicycle Plan.[93] The Public Works directors, both Fred Kendall and Dave Pelz, and a few community members were the most overtly influential, however, it has taken the efforts of many people in the city, staff, and elected officials to create the community Davis has become today. The directors trained staff members who have in turn become influential.[94]

As of 1995, 25 percent of all person trips were made by bicycle and 10 to 20 percent of all trips were made by pedestrians. In the 1990s, about 25 percent of the commute mode share was made up of cyclists and about 44 percent of the UC Davis mode share comprised cyclists. The campus functions as a traffic cell, where bicycles have full access to the site but cars only have access to the periphery.[95] The bicycle infrastructure in Davis consists of 41 miles (out of a total of 130 miles) of streets with bicycle lanes,[96] and 60 miles of off-street facilities as part of an interconnected bicycle network.

In more recent years, the bicycling mode share dropped to approximately 15 percent for commuters.[97] As of 2008, this increased to 17 percent.[98] Takemoto-Weerts speculates that the reason for the drop from 25 percent mode share is that in the past, most residents lived and worked in Davis. More recently, there has been a demographic change where many of the people who moved into Davis work in Sacramento or sometimes the Bay Area. In general, the newcomers were not involved in the Davis culture and cycled mostly for recreational purposes. Many liked the culture, but were not used to it.[99] In addition, much of the staff and faculty cannot afford to live in Davis today as they could in the past.[100] Will Marshall speculates that the community and college students have become more affluent overall, which means more families can afford cars. The increased presence of cars creates a more dangerous environment for cyclists and pedestrians, and thus a safety concern.

However, the city continues to provide for bicycling needs, and national trends such as increasing obesity and rising gas prices have brought focus back to alternative modes.[101] Issues such as climate change have created more awareness of bicycling, and advocacy in the community has led to more people bicycling for utilitarian purposes.[102] Additional surveys by the city show that bicycling mode share for non-work trips could be as high as 20 to 40 percent.[103] The city recently spent $2.1 million to create a bicycle/pedestrian underpass of a major arterial as part of developing a complete bicycle network. UC Davis also spent $250,000 to provide 400 bicycle racks.[104] Bicycling is part of the community identity, and is acknowledged by the fact that a year ago, the U.S. bicycling Hall of Fame chose Davis to be its new home.

Local Involvement

There are various bicycling clubs and advocacy groups in the city of Davis in addition to a generally active community. One community group, the Old North Davis group, was important in the development of the 5th St. Road Diet, which will change the street from four lanes to two lanes.[105] Davis Bicycle Club has had a long history.[106] A bicycle Coalition (Davis Bicycles) has a three-year history, and there is a Bicycle Advisory Commission. The relatively recent development of these groups can be in response to the retirement of Public Works Director Pelz who was a strong advocate for bicycling or the general change in demographics, which has reduced the bicycling culture.

Engineering

Engineering involves the two main areas of design standards and the approach to developments. Davis pioneered many facilities, such as bicycle lanes. In the 1970s, the city created bicycling side paths, which run along roads in a similar way to sidewalks. These are not considered successful because they have been shown to be an intersection hazard.[107] It was considered better to keep cyclists in the sight of autos, or nearer to the street. Davis also designed many bicycle roundabouts. Now certified engineers are used for most of the work, mostly due to liability issues.[108] Engineers are expected to understand how to accommodate cyclists. For all road construction and resurfacing, bicycles must be accommodated. The city therefore makes a yearly effort to maintain all roadways and fix them whenever necessary. The city has a policy for providing bicycle parking and other amenities, such as showers, at destinations. As a result, bicycle parking is provided at most of the major destinations such as schools, offices, or government buildings.[109] Today, Davis generally deals with maintenance and upgrades because much of its infrastructure was put in place years ago. This includes upgrading to new standards, changes and adapting to needs, as well as replacing facilities.[110]

Communications with Will Marshall and Tara Goddard offered insight into the history of Davis's bicycling infrastructure.[111, 112] There are 3 to 4 grade separated passes which were built in the late 1990s and early 2000s, which were very large projects. Davis has 25 bicycle underpasses or overpasses, ample bicycle parking, and valet parking for bicycles at special events. Engineers must always find a balance between the amounts of space devoted to parking versus other street amenities. There are eight traffic signals with a bicycle phase, but these are only used at locations where the bicycle volumes are similar to car volumes. One such signal near a school is essentially a scramble phase. All signals have an extended green phase when activated by a cyclist or pedestrian. The city does not have bicycle stations, though it has attempted to create one at the train depot, and they do not have bicycle boulevards. However, many businesses provide showers and bicycle parking in place of a city-run bicycle station, and many of these facilities are encouraged in the development review process for new projects. There are three locations that provide air compressors, and the city has bicycle left turn lanes in locations where there is a high volume of cars.

Bicycle projects are funded through the Capital Improvements Plan budget, Roadway Impact Fees, the Pavement Program, and grants.[113] Less than $10,000 of the total bicycle budget is intended for administrative purposes. The city reviews all projects in development review to be sure they are bicycle and pedestrian friendly. Developers must pay for all cycling and walking improvements within subdivisions.[114] The Interstate 80 crossing was paid for by a Mello-Roos Tax.[115] The Gas tax is used for maintenance, but the funding is running low.[116] The city now has trouble getting money for data collection. Out of $836,000 for the 5th Street Road Diet project, $80,000 for data collection related to the project was not authorized.[117]

Education, Encouragement, and Enforcement

The city administration supports bicycle education and safety programs for adults and children. The main goal is getting people to understand how to ride their bicycles on the road, such as not originating a left turn from the bicycle lane.[118] The city encourages events such as National Bicycle Month, Bicycle to Work Day, community bicycle rides, and bicycle rodeos for kids. There are many bicycling clubs, bicycle retail shops, and bicycle rental shops.[119] The city has a Street Smarts coordinator, which is funded through the Safe Routes to School program.[120] Citizens can attend Bicycle Advisory Commission meetings and contact the city or university to provide input. For enforcement, there is a bicycle patrol officer, who is specially trained, and works to enforce laws where there are high volumes of bicycling traffic. In the last five years, there have been 247 cyclist-motor vehicle crashes and one fatality.[121] The main goal of education is to change behavior, because many people already cycle.[122]

The main goal of enforcement is facilitating relationships between cyclists and other groups. The city has two part-time officers who focus on educating people when they are pulled over.[123] The officers generally work in the downtown area and treat cyclists as drivers; however, with current budget issues, enforcement is not the highest priority.[124] Only 10 to 20 percent of people who are pulled over are given citations. Also, fix-it tickets can be used for a 10 percent discount at local bicycle shops.[125]

Planning and Evaluation

In 1994, Davis created the first Bicycle/Pedestrian Coordinator position and developed its first Bicycle Plan. Ten years later in 2004, Davis created its first Bicycle Advisory Commission. This is not what is expected of one the most bicycle-friendly communities in the U.S.; however, there had been enough community or official support up until relatively recently for bicycling to be promoted without a Bicycle Plan. Marshall confirmed that the Bicycle Plan reflected what was already being done in the city, but became an official document to support decisions. The city's Bicycle Plan was passed in 2006 at a time when most of the plan was already implemented. The plan allows most cyclists to travel seamlessly throughout the city. The city is also working on new striping and signage. Though many in the city are proud of the high volume of bicycle use, there is still a strong automobile culture that can be addressed through better land use and housing decisions.[126] In the current plan, there are many goals to trigger a mode shift to bicycling and walking.[127]

The city has a Bicycle and Pedestrian Coordinator, but the main focus of the work is bicycling issues.[128] The city has been fairly weak in terms of evaluation of bicycling facilities. Officials conduct 1-, 3-, and 5-year bicycle counts at important locations. These counts are important in creating warrants for reducing auto speed limits in certain areas.[129] The city has also added a fifth ‘E’ for ‘Equity’ (to the original four for education, encouragement, enforcement and evaluation) and aims to create equity in terms of funding and attention to bicycling. In 2010, bicycling captured about 25 percent of the mode share, but only received 4 percent of the funding.

Some good examples cited by officials are the San Jose Street Smarts program, and many small cities with encouragement programs, such as Louisville, KY. Other good examples are Portland, Boulder, Reno, and recommendations included in the work of Kittleson Engineering.[130] Davis wants to try Sunday Streets as in San Francisco. It also currently does not have a Safe Routes to School program.[131] Sharrows (that is, bicycle symbols carefully placed to guide bicyclists to the best place to ride on the road to avoid car doors and to remind drivers to share the road with cyclists) have also been considered, but the city is not sure they are needed. Bicycle paths along arterials cause problems when they intersect with roads, so the city is considering removing them.[132]

UC Davis Campus

General Characteristics

According to the UC Davis website, the institution enrolls roughly 32,000 students, and most students live within three miles of the campus. About 15,000 bicycles are present on campus every day. Bicycle parking facilities are located at almost every building and in some auto parking facilities. Notable facilities include: 14 miles of bicycle paths, bicycle traffic and safety school, and summer bicycle storage.

Bicycles are very useful at the university because it is a large campus. In the 1960s, the chancellor decided there should be bicycle racks at every building so that people would have a place to park their bicycles rather than leave them on the grass. The campus also created greenbelt bicycle paths to connect the perimeter of campus to the center, in order to provide a vehicle-free route for cyclists. During this time, the campus introduced the prohibition of cars in the campus core area. The campus and the city of Davis still continued with these same controls. The current campus mode share is about 50 percent bicyclists. In the 1970s, Unitrans, the student-run transit service, was created. In 1993 or 1994, the service increased in popularity as transit fees for students were rolled into overall tuition/student fees.[133]

Campus Involvement

The Transportation and Parking Services Department is highly influential on campus. The department was in charge of enforcement for a while, but for the last year, there has been a full time bicycle officer from campus police. The department also conducts an annual survey in addition to dealing with carpools, vanpools, transit, and a train-pool program.

Engineering

There are no specific bicycle stations at UC Davis, but some buildings have showers, and all commuters can use the gym to shower. The core of campus is cut off to public vehicle access, which essentially creates bicycle boulevards. There are bicycling bridges and underpasses, ample bicycle parking, and valet parking for special events. The Putah Creek underpass is a recent city improvement that connects South Davis to the rest of the City and cost approximately $5 million. Projects are funded generally through Caltrans grants, and a major source is the Bicycle Transportation Account, which provides $7 million for bicycle projects throughout the state. There are specific architects and engineers who design campus projects and evaluate all projects for bicycle-friendliness.

Education, Encouragement, and Enforcement

Education, encouragement and enforcement tends to be difficult because many students are not avid cyclists when they arrive at UC Davis. The university does not allow cars for freshmen, but is not able to reach all students. At orientations, the police meet with students and talk about bicycling. The Bicycle Coordinator is no longer part of new student orientation, but he does meet with counselors and give them information. There is also information given with student housing information, such as the city and campus bicycle map. At registration there are posters about bicycles. The campus has the “Go Club.” To join the club one must be affiliated with the university and not have a parking permit. Part of the bicycle “Go Club” includes getting 12 ‘A’ permits (that is, permits for several interior bicycle parking spots), because it is hard to find parking on rainy days. The campus provides free parking for all cyclists.

Enforcement is taken very seriously because of liability. In a case at CSU Chico, a pedestrian was severely injured on a bicycle path, but the campus was still considered liable because the bicycle path was never enforced as a bicycle-only path. At the moment, campus Transportation and Parking Services (TAPS) is worried about the police having the sole power to give tickets for violations. All bicycle violations are 175 dollars, so police officers are reluctant to give tickets. When TAPS handled enforcement, fines were lower than they are now. The campus is looking into a program at UC Irvine where fines are lower for cyclists (at 20 to 40 dollars per citation) and there is a separate bicycle traffic school.

Planning

The first campus plan was prepared just 10 years ago because Caltrans began to require a plan to apply for funding. Plans must meet 11 requirements and be updated every four years. The plans bring up important points that need to be addressed, are a guide to improvements, and also help to hold the city accountable.[134] TAPS tracks mode share. Graduate students at the Institute of Transportation Studies conduct bicycling surveys, and in 2010 produced a section focusing on bicycle theft. The students also do bicycle parking utilization counts, and conduct a bicycle parking inventory. However, they have not conducted bicycle counts for 10 years because they are complicated. A bicycle transportation network project (conducted 3 years previously) studied the whole system. At a public workshop, users tagged a large map of the city with post-it notes for different categories of issues. It was a very effective way of visualizing problems, and magnitudes of problems, in the city. This information was used for the new Bicycle Plan.[135]

They have considered a bicycle sharing program, but companies have decided there is no money to be made in Davis. The city might still implement bicycle sharing to the train station. The city is also considering bicycle counters, like in Copenhagen, which show the popularity of bicycling, and is also studying lighted crosswalks.

Factors in developing a bicycle and pedestrian friendly city and campus

Davis has had good results because bicycling is a way of life.[136] The California law that requires planners to plan for all modes and abilities when updating the general plan will help cities in this manner.[137] Cities should reach out to the business community because they are a good ally. Planners can help businesses to realize that bicycling may be good for business. According to Dill and Carr, cyclists may spend more time downtown because they made an effort to be there. They recommend that cities provide on-street bicycle parking and outdoor dining.[138] Some barriers to bicycling include the fact that people are really busy and there are some stores are far away. People cannot be expected to cycle every day, but maybe occasionally. Cities should realize that not everyone's schedule is flexible. Some people don't like change.[139] There is also a perception, and part reality, that bicycling is unsafe. When car use increases, bicycling does become less safe. The weather is sometimes a barrier to bicycling. Many people do not recognize the health benefits of bicycling.[140]

Marshall emphasizes that creating a bicycling community took a community effort in which no one particular group was the most important. He considers elected representatives, city and university staff, community activists, and ordinary residents equally influential. Goddard considered the community activists, ordinary residents, and city staff the most influential in supporting bicycling. Local business owners are considered equally influential but in a generally negative sense. Elected representatives have also been highly influential. Transit agency staff and MPO staff have had some influence, but the MPOs are particularly important for providing money. Consultants are rarely used in the city of Davis.[141] The local MPO staff asks Davis for advice on standards.[142]

Davis is considered a unique community because of its long bicycling history, but some of the important steps all cities could take are:

- Create a grassroots movement involving community, staff, and elected officials
- Engage the community in a forum, finding their needs and their barriers
- Make bicycle facilities more convenient
- Go through the process of creating a Bicycle Plan so there will be concrete steps for implementation

On the campus, influential people are campus Transportation and Parking Services (TAPS), the campus planner at Resource Management and Planning, and the architects and engineers who review projects.[143] Takemoto-Weerts thinks that evaluating what you already have is important in creating a bicycle-friendly community.

Some important steps cities can take are:

- Make sure transportation engineering staff understand the importance of bicycle/pedestrian planning and the principles of design
- Tap into the will of community activists
- Find influential people who are cyclists who can talk to the council. Professors usually have clout
- Find people in city departments who are sympathetic to the cause
- Do research to find grants. Many cities will already have a Grants Administrator

Case Study 2: City of San Luis Obispo and Cal Poly San Luis Obispo, California

The City of San Luis Obispo, California is awarded "silver," the third highest ranking, by the League of American Cyclists. Table 27 summarizes sources of information and officials interviewed for the background to this case study.

Table 27. Information Sources – City of San Luis Obispo, California

Source	Item
League of American Cyclists	Bicycle Friendliness Ranking = Silver Bicycle commute mode share = 7% (ACS, 2006-08) Area = 11 square miles
Officials Interviewed	Peggy Mandeville – Principal Transportation Planner, City of San Luis Obispo Susan Rains – Commuter and Access Services Coordinator, California Polytechnic State University Dan Rivoire – Executive Director, SLO Bicycle Coalition
CA Department of Finance[1]	Population = 44,948 (January 2010)

1 State of California, Department of Finance, E-1 Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2009 and 2010. Sacramento, California, May 2010

City of San Luis Obispo, California

General Characteristics

The City of San Luis Obispo had a 2010 population of 44,948 and encompasses 11 square miles. Out of 154 miles in the total road network, 40 miles accommodate bicyclists. The average temperature is between 52 and 63 degrees Fahrenheit throughout the year. The city has a median income of $31,926, and a large percentage of the population is college students because of the presence of the California Polytechnic State University. Most of the neighborhoods are within a quarter-mile of retail or business areas, and many have pedestrian-friendly amenities such as parks, benches, and greenery.[144]

Approximately 3.6 percent of the population commuted to work by bicycle as of the year 2000.[145] According to the American Community Survey for 2006-2008, approximately 7 percent now commute to work by bicycle. Some deterrents to bicycling in San Luis Obispo are safety, distance, and terrain. The city has an odd street pattern and many key corridors traverse steep hills. US 101 and the railroad each bisect the city thereby fragmenting it.[146,147]

The city's non-motorized transportation infrastructure consists of a bicycle boulevard, a bicycle bridge, bicycle and pedestrian phases at traffic signals, bicycle friendly loops or cameras, considerable bicycle parking, valet parking at some locations, and shared lanes. However, the city does not have core lanes or a bicycle station.[148, 149] The infrastructure is funded by the Bicycle Transportation Account along with the State Highway Account Fund.[150] The city recently built the Bill Roalman Bicycle Boulevard. This is a $20,000 project that created a safe and fast route into downtown from the south side of town, allowing cyclists to avoid a high volume, narrow right-of-way arterial. It included tree plantings, intersection/signalization improvements, stop sign flips (to favor cyclists) and pavement markings.[151] The city is also trying to ensure minimum sidewalk widths of eight feet while providing ADA (Americans with Disabilities Act) compliant ramps and bicycle loop detectors.[152]

Engineering

There is a requirement by the city for the accommodation of cyclists on new roads and on roads slated to undergo reconstruction and resurfacing. The city's bicycle transportation planner briefs engineers and planners about best practices in bicycle transportation planning. There are bicycle parking ordinances in place, and many of the public and downtown facilities including the Transit Center, Library, and recreation centers have bicycle racks nearby. All public buses are equipped with bicycle racks. A Bicycle Boulevard was recently added on Morro Street, and bicycle paths like the Railroad Safety Trail and the Bob Jones City-to-Sea Trail were created specifically for bicycle/pedestrian travel.[153] However, all these trails are not yet finished. The City Traffic Operations Manager keeps up on innovative technologies and is open to trying new ideas.[154] Bi-annual bicycle counts and before and after road studies help to evaluate the City's progress,[155] but there is little information on the usage of bicycling trails.[156]

Local Involvement

There are groups such as the SLO Bicycle Coalition, with approximately 450 members,[157] Cal Poly clubs like the Cal Poly Wheelmen, a Bicycle Advisory Committee, and various other advocacy groups in the area that have helped to get approval for new bicycle paths, provide bicycle education to the public, and provide valet parking at events. There has also been a push by local bicycling groups for more bicycle racks in the downtown area.[158]

Rivoire believes that demands like these from local groups have led to an increase in bicycling facilities and therefore an increase in the bicycling mode share.

Education, Enforcement, and Encouragement

The “SLO Bicycle Coalition” has a bicycle education and confidence program, which is taught by professionals licensed by the State.[159] This is funded by the City Council.[160] The local League of Certified Instructors (LCIs) offers free classes every other month, and the city police department receives an Office of Traffic Safety (OTS) grant that supports the cost of presentations at each elementary school throughout San Luis Obispo. Students are provided basic information about safe riding techniques and vehicle code requirements. Additionally, the SLO Regional Rideshare hosts safety assemblies as part of an after-school program at schools in the area,[161] and Rideshare also distributes bracelets and bicycle bells to encourage bicycling.[162] There is a Bi-monthly Road 1 class taught by LCIs, and weekly bicycle valet service at the Thursday night Farmer’s Market where there is active promotion and education.[163] Bicycle month, rideshare month, and rideshare week also help promote bicycling.[164]

The city and the university have bicycle enforcement officers.[165] The city staff and police department meet quarterly to discuss enforcement issues.[166] Rivoire believes that enforcement of traffic speed limits and ticketing cyclists is insufficient to protect cyclists and pedestrians. The “Coexist Campaign” is put on by the bicycle coalition and SLO Regional Rideshare, which encourages greater respect between bicyclists and motorists countywide through ad campaigns, resulting in safer conditions.[167]

Planning

According to communications with Peggy Madeville and Dan Rivioire, the city first established a plan for alternative transportation in 1982.[168, 169] The first Bicycle Plan was adopted in 1985, amended in 1985, 1993, 2002 and 2007, although only a few measures have been implemented.[170] In 1994, the city also incorporated methods for reducing automobile usage into the Circulation Element. The Bicycle Plan helps shape infrastructure improvements by making the city eligible for state funding,[171] prioritizing projects, and creating policies the city must follow.[172] The city’s traffic model is upgraded to include bicycle modal splits.[173]

The Railroad Safety Trail extends from Orcutt Road northward to the railroad station. The northward extension along the railway has to be reevaluated due to difficulty with negotiations about right of way. The extension further north along California Boulevard is built between Hathaway Street and the Cal Poly Mustang stadium near Foothill Boulevard. Approximately 80 percent of the construction of the Bob Jones City-to-Sea trail between Prado Road and Los Osos Valley Road is completed. The Bicycle Transportation Plan 2007 identifies and prioritizes over $53 million in projects. The city of San Luis Obispo has a strong commitment to developing new bicycle facilities for recreation and utilitarian transportation, as well as parking. In the past 10 years the city has spent 3.5 million dollars on major facilities. The city’s Bicycle Transportation Plan proposes 31 new miles of bicycle paths (Class I facilities) including six major bicycle ways. It also proposes bicycle lanes on the remaining 3.2 miles of arterials that are currently without facilities, thus achieving

100 percent bicycle-friendly arterial streets.[174] Additional ideas that have been considered but not yet implemented include bicycle boxes, colored bicycle lanes, among others.[175, 176]

California Polytechnic State University Campus, San Luis Obispo

General Characteristics

According to the Cal Poly Master Plan, Cal Poly is primarily an undergraduate institution with an enrollment of roughly 17,000 students, with 3,000 staff and faculty members. The campus has undergone many phases of physical growth as the student population has grown from roughly 4,000 in 1949. Table 28 shows that in 2001, 40 percent of staff and students use alternative modes to get to campus. Fifty percent of students use alternative modes. Bicycling has dramatically increased in the last six years according to Susan Rains, the Rideshare Coordinator.

Cal Poly has bicycle boulevards, bicycle and pedestrian phases at traffic signals, considerable bicycle parking, and shared lanes. It does not have core lanes, bridges or underpasses, valet parking, or full bicycle stations. Some deterrents to bicycling are safety, weather, and the terrain.

Table 28. 2001 Modal Split for Trips to Cal Poly – San Luis Obispo, California

Mode	All Travelers	Students Only
Automobile	60%	50%
Foot	22%	29%
Public Transit	10%	12%
Bicycle	8%	9%
All Modes	**100%**	**100%**

Engineering

Bicycle parking has almost doubled over the past three to four years and more pedestrian zones are demarcated throughout campus. The university has converted the section of Via Carta across central campus and South Perimeter Road to bicycle and pedestrian malls, and closed off South Perimeter Road to automobile traffic. Bi-annual bicycle counts help to evaluate bicycling around campus.

Local Involvement

Students have helped to implement changes on campus through pressure and influence. The facilities planning staff have also worked towards achieving more bicycle use and bicycle safety.

Education, Enforcement, and Encouragement

SLO bicycle coalition is also important to bicycle education on campus, as well as to the Commute and Access Services Coordination Program. Campus police deal with bicycle enforcement and administer a diversion program for bicycle safety offenders.

Planning

The new Master Plan for the Campus will be more influential in guiding bicycling and pedestrian improvements. An idea that has been considered, but has not yet been implemented is bicycle sharing to include use of electric bicycles.

Factors in developing a bicycle and pedestrian friendly city and campus

Some of the key players in bringing about change have been the general public, bicycle clubs, the Bicycle Advisory Committee, the pro–alternative transportation city council, and the Public Works Department.[177, 178] Increased community interest along with increased funding for alternative transportation has allowed for improvements to facilities.[179] Students, facilities planning staff, and commuter and access services at Cal Poly have produced good bicycle and pedestrian results.

Both Peggy Mandeville and Dan Rivoire believe elected officials and metropolitan planning staff are the most influential stakeholders. Consultants are considered the least influential. Other groups such as community activists, residents, employees, business owners, and transit agency staff fell between these two groups. Dan Rivoire believes that university staff and community activists are influential.

Peggy Mandeville and Dan Rivoire consider the following the most important steps for a city to get started:

- Have policies that support goals in the Circulation Element
- Adopt a Bicycle Plan
- Work with advocacy groups, develop community support, and fundraising
- Include bicycle projects in the budget program
- Develop partnerships
- Apply for grants
- Set-up a Bicycle Advisory Committee
- Provide adequate staffing
- Provide education and enforcement
- Celebrate success
- Monitor progress

On the campus, community activists, residents, and planning staff were the most influential. Consultants were also influential. University staff and elected representatives were the least influential. Susan Rains says inter-agency cooperation is vital to improving facilities for alternative modes.

Susan Rains says the most important steps to getting started are:

- Marketing
- Support and Encouragement for bicycling and walking infrastructure
- Working with activists

Case Study 3: City of Palo Alto and Stanford University, California

The City of San Luis Obispo, California is awarded “gold,” the second highest ranking, by the League of American Cyclists. Table 29 summarizes sources of information and officials interviewed for the background to this case study.

Table 29. Information Sources – City of Palo Alto, California

Source	Item
League of American Cyclists	Bicycle Friendliness Ranking = Gold Bicycle commute mode share = 6% (City estimate) Area = 23.6 square miles
Officials Interviewed	Yoriko Kishimoto, Former Mayor (2001-2009), City of Palo Alto Rafael Rius (PE), Project Engineer, City of Palo Alto Ariadne Scott – Bicycle Program Coordinator, Stanford University Parking & Transportation Services Department
CA Department of Finance[1]	Population = 65,408 (January 2010)

1 State of California, Department of Finance, E-1 Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2009 and 2010. Sacramento, California, May 2010

City of Palo Alto, California

General Characteristics

The city of Palo Alto was originally designed to serve Stanford University and encompasses nearly 25 square miles.[180] Its population in 2010 was estimated at 65,408. The average temperature is between 50 and 70 degrees fahrenheit.[181] The city had a median household income of $90,377, as of 1999.[182] Regarded at one time as a college town, Palo Alto is now the headquarters of many major technology firms. High home prices mean that many students of Stanford University cannot afford to live in the city. Because Palo Alto’s street network essentially continues into neighboring communities, building relationships with these cities is important.[183] A key difference between this case study city and the other two, Davis and San Luis Obispo, is that it is a dense urbanized area surrounded by other cities.

According to the 1990 Census, 8.5 percent of residents cycled to work and 3.5 percent walked.[184] Kishimoto estimates that bicycle commute is currently close to 6 percent. Though the city is relatively flat and has good weather, many of the major arterials carry heavy vehicular traffic and do not have bicycle facilities. The Oregon Expressway, a 1960s controversial expansion involving eminent domain of the two-lane Oregon Avenue,[185] continues to divide the community.[186] Some advantages for the city, however, are numerous wide residential streets laid out in roughly a grid pattern, which can accommodate cyclists.

The city's non-motorized transportation infrastructure includes one bicycle station at the Cal-Train station, three bicycle boulevards (with the third in progress), at least ten bridges/underpasses, some traffic signals with bike phases, ample bicycle parking with still unmet demand, valet parking for special events, and one shared zone with plans for a second. There are no buffered bicycle lanes or protected bicycle ways. Some recent projects are "Road Diets" on parts of Charleston and Arastradero to reduce the number of lanes from four to two and accommodate cyclists.[187] In addition to the recently added bicycle boulevards, there are projects such as the Homer Tunnel undercrossing, a $5.1 million project that allows cyclists and pedestrians to cross under the Cal-Train tracks, and a bridge over Embarcadero Road.[188]

Engineering

Engineering is the starting point for changes in the community and was originally focused on access to schools.[189] The city's priority is to formulate policy around bicycles; however, the time spent on cycling projects is roughly equivalent to a part-time job.[190] The city has explored the possibilities of day and night parking and tandem parking for bicycles in areas to be zones for transit-oriented development.[191] The city has instituted stricter bicycle parking requirements for new developments.[192] Projects are coordinated between re-paving and share the road markers. The new minimum width for bicycle lanes is five feet. In previous years, concerns were about auto safety, but now the focus also includes cyclist and pedestrian access at each site.[193]

Local Involvement

According to Rafael Rius, there is a high level of community awareness about alternative mode issues, but bicycle advocates would like a higher mode share percentage. Schools and advocates have played important roles in creating change. The city's School Traffic Committee was established and is very active.[194] There are commute incentive programs for city employees. Palo Alto Walks and Rolls is a coalition designed to encourage alternative modes.[195]

Education, Enforcement, and Encouragement

The schools in Palo Alto are making a significant effort at education and encouragement to ride bicycles, especially for students from the third grade upward.[196] The Safe Routes to School program is important for education, enforcement, and encouragement. It involves monthly meetings, bicycle safety classes for kids and families, and increased enforcement around schools.[197] Bicycle ridership to school has increased in recent years.[198] There are additional youth and adult bicycle education courses provided through the city's recreation programs.[199] The city has also established bicycle to work days and valet bicycle parking for events at Stanford. The city would like to provide more bicycle facilities and access to showers for employees who cycle to further encourage cycling.[200] The city has collaborated with Stanford to develop a Bicycle Map.[201]

Planning

City officials recognize that planning for cyclists and pedestrians is important because these modes are good for health, increase the sense of community, and are less expensive than projects for automobiles.[202] The city has therefore prepared a Bicycle Master Plan. The city's plan encourages the use of funding and education programs to promote cycling and walking while creating a more connected network. The plan also encourages traffic calming and the reduction of single-occupant vehicle (SOV) trips. The development of a bicycle sharing program was conceived but is now under the jurisdiction of Valley Transportation Authority.[203]

The city does not perform before and after studies of projects to determine the impacts of Bicycle projects.[204] However, city officials would like a study to determine the association between money spent on parking versus mode share.[205] The city does have related information from the Bay Area Air Quality Management District.

Stanford University Campus, Palo Alto

General Characteristics

Stanford is one of only three Universities with a full-time bicycle program coordinator (Cornell and UC Davis are the others). While many colleges have personnel who work on bicycle programs, bicycle program coordination is not a full time job as established at Stanford. This reflects the importance Stanford accords the bicycling program. The university registers bicycles and distributes bicycle lights and safety information during freshman orientation. 85 percent of a typical freshman biker population of 1,635 students registers their bicycles.

Engineering

Stanford uses a standardized bike rack system manufactured by Creative Pipe Company in southern California. The university has established a new program termed the Bicycle Safety Invention Challenge. The program began in 2008 and continues to be held every other year. The program awards cash prizes of $5,000, $2,500, and $1,000 to the top three proposals for new inventions for bicycle safety. The top prize in 2008 went to a medical student who came up with an LED headband light that could be worn over a bike helmet to increase visibility.

Local Involvement

Stanford maintains data from an annual commute survey that has been ongoing for ten years. The university has a “commute club” that encourages students to participate by offering cash incentives worth $282 per participant with about 7,000 students participating. Incentives include Cal train GO passes, bicycle lockers and equipment (such as helmets) at reduced prices.

Education, Enforcement, and Encouragement

During the school year, the university offers bicycle safety classes and road shows at the campus quad and dorms. At the dorms, the road show includes free bicycle tune-ups by a mechanic following educational outreach presentations. The campus employs positive reinforcement to promote bicycle safety by having a super-hero character, “Sprocket man,” hand out recognitions and awards, and promote wearing helmets and riding safely.

As part of enforcement, Deputy Allen James, a Stanford Public Safety Officer, created the bicycle traffic school a few years ago. The classes are offered twice a month, and after attending the class the $160 ticket can be dismissed. The most common causes for tickets on campus are: 1) Stop Sign Violations, 2) No Light at Night, and 3) Having both ears obstructed (headphones). During a school year there are 30 traffic school classes that over 1,000 students attend.

Planning

The bicycling community and the coordinator are directly involved with campus planning on where to provide additional bicycle parking spaces with new buildings. The campus had a storage capacity for 12,000 bicycles in 2010.

Factors in Developing a Bicycle and Pedestrian Friendly City and Campus

The city council has been important in bringing about change in the community. It supported updating the Bicycle Master Plan, increasing bicycle parking downtown, and the Safe Routes to School program. The school districts and parent-teacher association (PTA), the Silicon Valley Bicycle Coalition, Western Willow, neighborhood groups, and individual advocates have also been influential.[206] The Palo Alto Bicycle Advisory Committee, the Planning and Transportation Commission, and various officials are important players as well.[207]

The elected representatives, city and university staff, and advisory groups are considered most influential.[208, 209] Community activists, consultants, and residents are also highly influential, but employers, transit agency staff, MPO staff, and schools are slightly less influential.[210] According to Rius, these secondary groups are only moderately influential.

There is a bicycle valet service during football games at Stanford that is run by volunteers from the Silicon Valley Bicycle Coalition. The free service parked about 1,000 bicycles per home game during the 2009-2010 season, and served as a fundraiser for the organization (which received some funding from the school for providing the service).[211]

APPENDIX C: STRUCTURED INTERVIEW QUESTIONS FOR SYSTEM MANAGERS

Mineta Transportation Institute Project #2906:

Integration of Bicycling and Walking Facilities into the Infrastructure of Urban Communities

Interviewee Name:	Interview Time:
Title:	Interview Location:
Affiliation(s):	Follow-Up Contact Information:
Interview Date:	
Interviewer Name:	Transcribed:

Introduction:

This interview is being done as part of a research project under the Mineta Transportation Institute. We are investigating “best practices” in three highly recognized California communities where cycling and other non-motorized transportation choices are significantly above comparable communities. The research is focused specifically on the communities and colleges in:

1) San Luis Obispo, CA (and Cal Poly SLO)
2) Davis, CA (and UC Davis)
3) Palo Alto, CA (and Stanford)

The Questions are divided into six sections and will start with some background about you and your knowledge about bicycling and walking in your community and end with some questions about good examples elsewhere we could look at or other people we could contact to learn more.

Your participation will be used in part to help document some of the lessons learned and contribute information that can be of use by others trying to improve their communities. Are you willing to participate in this interview and allow us to use your comments and responses in the final report?

Interview Questions:

Q1.1: What is your name and title (if any)?

Q1.2: What is your professional affiliation(s) or role with bicycling and walking in your community?

Q1.3: Do you also live in this community or just work on these issues for the community?

Q1.4: Is cycling or walking a mode choice you make as part of your commute?

Q1.5: How long have you been involved in bicycle and pedestrian issues for this community?

Q2.1: Please describe the history of cycling and walking in this community?

Q2.2: How has cycling and walking changed in the community in recent history (the last decade)?

Q2.3: How has the community changed in relationship to transportation choices over the last decade?

Q3.1: Could you describe today's state of cycling and walking in this community?

Q3.2: How are alternative commutes working in the community (for both residents and workers commuting into the area for jobs)?

Q3.3: Who are the main players in shaping and implementing changes that support cycling and walking in this community?

Q3.4: The five 'Es' are used frequently in studying non-motorized transportation. Could we ask you to speak about each of these areas in your community?

Engineering – Designing and building safe infrastructure:

Education – educating users on safe and appropriate behavior:

Enforcement – enforcing existing traffic laws:

Encouragement – encouraging the use of sustainable travel modes:

Evaluation – monitoring the results to ensure goals are met:

Q3.5: Focusing specifically on infrastructure, could you identify which of the following features currently exist in your community to support non-motorized transportation?

Bicycle Stations	Present	Not Present	Don't Know
Bicycle Boulevards	Present	Not Present	Don't Know
Bridges/Underpasses (Bicycle/Ped)	Present	Not Present	Don't Know
Traffic Lights-bicycle/ped phase	Present	Not Present	Don't Know
Ample bicycle parking	Present	Not Present	Don't Know
Valet Parking for Bicycles	Present	Not Present	Don't Know
Shared Zones	Present	Not Present	Don't Know
Core Lanes	Present	Not Present	Don't Know

Q3.6: Could you speak about how these features work, including how they are funded and how usage is tracked?

Q4.1: What are the probable reasons for the good results in this community?

Q4.2: What are some specific programs or built infrastructure improvements undertaken to address the needs of non-motorized (cyclist and pedestrian) travelers in this community? How is usage tracked?

Q4.3: What are some of the specific approaches used to increase cycling and walking as a transportation mode choice in the community?

Q4.4: On a scale of 1 to 10, with 10 being the highest, could you rank the impact of various stakeholders on bicycle and pedestrian policy in your community?

Elected Representatives	1 2 3 4 5 6 7 8 9 10
City/University Staff	1 2 3 4 5 6 7 8 9 10
Community Activists	1 2 3 4 5 6 7 8 9 10
Consultants	1 2 3 4 5 6 7 8 9 10
Ordinary Residents	1 2 3 4 5 6 7 8 9 10
Employers/Business Owners	1 2 3 4 5 6 7 8 9 10
Transit Agency Staff	1 2 3 4 5 6 7 8 9 10
Metropolitan (Regional) Planning Agency Staff	1 2 3 4 5 6 7 8 9 10

Q4.5: Could you speak of the past and current role of various stakeholders in shaping and implementing policies for cyclists and pedestrians?

Q4.6: If you are familiar with the community's comprehensive plan (general plan) and/or bicycling plan, could you speak about the role these policy documents play in shaping cycling and walking infrastructure improvements and mode choice?

Q5.1: Could you make some suggestions for others trying to improve bicycling and walking in the communities?

APPENDIX D: THE USER SURVEY INSTRUMENT

Survey of Bicycling and Walking Conditions and Facilities

Dear Sir/Madam:
We ask for your help in a research project to evaluate the features of the bike and pedestrian facilities in your community to create cities that are cycling and pedestrian-friendly for all users. Please take about 15 minutes to fill out this survey. Your participation involves no risk and is entirely optional; any answers you give will be kept anonymous in order to protect your privacy. If you choose to voluntarily participate, please hand your completed survey to the attendant at this survey station; or you may fill and mail it back postage-free. In some multiple-choice questions, more than one reply may be given. If you have any concerns or would like additional information, please contact one of the following:

Research Professor - Cornelius Nuworsoo | 805.756.2573 | cnuworso@calpoly.edu
Chair of Cal Poly Human Subjects Committee - Steve Davis | 805.756.2754
Dean of Research and Graduate Programs - Susan Opava | 805.756.1508

Note: **A trip** is defined as a one-way journey from origin to destination. A **walking trip** is one minute or more (do not include walking to your car parked on your street, etc)

A. Participant Characteristics (check one)

1. Age:
☐ under 18 ☐ 25-34 ☐ 45-54 ☐ 65-74
☐ 18-24 ☐ 35-44 ☐ 55-64 ☐ 75+

2. Gender:
☐ Male
☐ Female

3. Personal Income:
☐ None ☐ $40k-59k ☐ $100k-149k
☐ Under $20k ☐ $60k-79k ☐ Over $150k
☐ $20k-39k ☐ $80k-99k

4. Employment type
☐ Student ☐ Education
☐ Retail ☐ Office
☐ Agriculture ☐ Financial
☐ Information ☐ Other ______________

B. Travel Characteristics (check all that apply)

1. How many vehicles of each type are normally available for your use?

	1	2	3	4
Automobile	☐	☐	☐	☐
Motorcycle	☐	☐	☐	☐
Bicycle	☐	☐	☐	☐
Other	☐	☐	☐	☐

2. Which modes of transportation do you use for your trip to work or school each week?

	Number of days						
	1	2	3	4	5	6	7
Automobile	☐	☐	☐	☐	☐	☐	☐
Motorcycle	☐	☐	☐	☐	☐	☐	☐
Bicycle	☐	☐	☐	☐	☐	☐	☐
Walk	☐	☐	☐	☐	☐	☐	☐
Transit	☐	☐	☐	☐	☐	☐	☐
Other: ______							

3. How many times in an average week do you use each of the following modes of transportation?

For shopping:	1-2	3-4	5+
Automobile	☐	☐	☐
Motorcycle	☐	☐	☐
Bicycle	☐	☐	☐
Walk	☐	☐	☐
Transit	☐	☐	☐
Other mode	☐	☐	☐

Recreation/Health:	1-2	3-4	5+
Automobile	☐	☐	☐
Motorcycle	☐	☐	☐
Bicycle	☐	☐	☐
Walk	☐	☐	☐
Transit	☐	☐	☐
Other mode	☐	☐	☐

For business:	1-2	3-4	5+
Automobile	☐	☐	☐
Motorcycle	☐	☐	☐
Bicycle	☐	☐	☐
Walk	☐	☐	☐
Transit	☐	☐	☐
Other mode	☐	☐	☐

For other purposes:	1-2	3-4	5+
Automobile	☐	☐	☐
Motorcycle	☐	☐	☐
Bicycle	☐	☐	☐
Walk	☐	☐	☐
Transit	☐	☐	☐
Other mode	☐	☐	☐

C. Local Environment

1. Which neighborhood do you live in?

City:______________________

Name:______________________ Or nearest major intersection: ______________________

Bicycle and pedestrian friendly places have clearly designated pathways, available bike parking, and clear crossing places.

2. Is your neighborhood bicycle friendly?

Very much	Somewhat	Not quite	Not at all	No opinion
☐	☐	☐	☐	☐

3. Is your neighborhood pedestrian friendly?

Very much	Somewhat	Not quite	Not at all	No opinion
☐	☐	☐	☐	☐

For places you frequent for daily activities:

4. Are they bicycle friendly?

Very much	Somewhat	Not quite	Not at all	No opinion
☐	☐	☐	☐	☐

5. Are they pedestrian friendly?

Very much	Somewhat	Not quite	Not at all	No opinion
☐	☐	☐	☐	☐

6. Rate the following infrastructure for places you visit often:

6.1. Availability of Bicycle/Pedestrian Facilities	Fully available	Generally available	Minimally available	Not available
Major streets with bicycle lanes	☐	☐	☐	☐
Separated Bicycle paths	☐	☐	☐	☐
Minor streets with bicycle lanes	☐	☐	☐	☐
Bicycle priority streets (or bicycle boulevards)	☐	☐	☐	☐
Crosswalks	☐	☐	☐	☐
Sidewalks	☐	☐	☐	☐

6.2. Quality of Bicycle/Pedestrian Facilities	Excellent	Good	Fair	Inadequate
Major streets with bicycle lanes	☐	☐	☐	☐
Separated Bicycle paths	☐	☐	☐	☐
Minor streets with bicycle lanes	☐	☐	☐	☐
Bicycle priority streets (or bicycle boulevards)	☐	☐	☐	☐
Crosswalks	☐	☐	☐	☐
Sidewalks	☐	☐	☐	☐

D. Cycling Behavior (check all that apply)

1. Is cycling your preferred mode of transportation? ☐ Yes ☐ No

<u>If you do not use a bicycle, please skip to question D.11.</u>

2.Are you involved in any of the following? ☐ Cycling Coalition ☐ Cycling team

3. Which cycling facilities do you use when you cycle? (check all that apply)

- ☐ Major streets with bicycle lanes
- ☐ Minor streets with bicycle lanes
- ☐ Major streets
- ☐ Minor streets
- ☐ Bicycle priority streets
- ☐ Separated bicycle paths

4. How many minutes are you willing to bicycle to a destination?

minutes	0	1-10	11-20	21-30	30+
For shopping	☐	☐	☐	☐	☐
For recreation/health	☐	☐	☐	☐	☐
For work/school	☐	☐	☐	☐	☐
For business	☐	☐	☐	☐	☐
For other purposes	☐	☐	☐	☐	☐

5. As a bicyclist, which of the following features are most useful to you?

	Very useful	Useful	Not very useful	Not at all	No opinion
Major streets with bicycle lanes	☐	☐	☐	☐	☐
Minor streets with bicycle lanes	☐	☐	☐	☐	☐
Major streets	☐	☐	☐	☐	☐
Minor streets	☐	☐	☐	☐	☐
Bicycle priority streets (or bicycle boulevards)	☐	☐	☐	☐	☐
Separated Bicycle paths	☐	☐	☐	☐	☐

6. Do you ride on the sidewalk?

Always	Sometimes	Rarely	Never
☐	☐	☐	☐

7. If you do ride on the sidewalk, what are the main reasons (check all that apply).

- ☐ Auto traffic is heavy
- ☐ You are moving considerably slower than road traffic
- ☐ Streets lack bicycle facilities
- ☐ You are with children
- ☐ Other

8. How do you typically deal with intersections?

- ☐ I take the route with the fewest intersections
- ☐ I ride through the intersection (like a car)
- ☐ I go to places where I know there is a crosswalk (unsignalized)
- ☐ I go places where I know there is a signalized crossing
- ☐ I do not think about this in advance

9. How comfortable do you feel sharing pathways or sidewalks with pedestrians?

Very much	Somewhat	Not quite	Not at all	No opinion
☐	☐	☐	☐	☐

10. **Route Choice:** How important are the following factors in choosing your regular bicycling routes?

	Very Important	Important	Somewhat Important	Little Importance	Not Important
Safety from crime	☐	☐	☐	☐	☐
Speed of auto traffic	☐	☐	☐	☐	☐
Condition of pavement	☐	☐	☐	☐	☐
Length of route	☐	☐	☐	☐	☐
Directness of route	☐	☐	☐	☐	☐
Beauty of route	☐	☐	☐	☐	☐
Difficulty of terrain	☐	☐	☐	☐	☐
Density of parked cars	☐	☐	☐	☐	☐

11. **Cycling versus other modes of transportation:** How important are the following factors in choosing to cycle somewhere versus using other types of transportation?

	Very Important	Important	Somewhat Important	Little Importance	Not Important
Distance you are traveling	☐	☐	☐	☐	☐
Difficulty of terrain	☐	☐	☐	☐	☐
Physical ability	☐	☐	☐	☐	☐
Quality of facilities for bikes	☐	☐	☐	☐	☐
Bike facilities connect you easily to destination	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Rain	☐	☐	☐	☐	☐
Temperature	☐	☐	☐	☐	☐
Bicycle maintenance	☐	☐	☐	☐	☐
Shower available at your destination	☐	☐	☐	☐	☐
Individual lockers available at destination	☐	☐	☐	☐	☐
Covered bicycle parking	☐	☐	☐	☐	☐
Lockable bicycle parking	☐	☐	☐	☐	☐
Other:________________	☐	☐	☐	☐	☐

E. Pedestrian Behavior (check all that apply)

1. Is walking your preferred mode of transportation? ☐ Yes ☐ No

2. Which pedestrian facilities to you use when you walk?

- ☐ Sidewalks on major streets
- ☐ Sidewalks on minor streets
- ☐ Major streets without sidewalks
- ☐ Minor streets without sidewalks
- ☐ Separate trails or bike paths

3. How long are you willing to walk to a destination?

minutes	0	1-5	6-10	11-20	20+
Shopping	☐	☐	☐	☐	☐
Recreational/Health	☐	☐	☐	☐	☐
Work/School	☐	☐	☐	☐	☐
Business	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

4. As a pedestrian, which of the following features are most useful to you?

	Very useful	Useful	Not Very useful	Not at all	No opinion
Sidewalks along major streets	☐	☐	☐	☐	☐
Major streets without sidewalks	☐	☐	☐	☐	☐
Separated bike paths	☐	☐	☐	☐	☐
Sidewalks on minor streets	☐	☐	☐	☐	☐
Minor streets without sidewalks	☐	☐	☐	☐	☐
Separated walking paths	☐	☐	☐	☐	☐

5. When crossing a street:

- ☐ I never use a crosswalk
- ☐ If it is on my route, I use a crosswalk
- ☐ If nearby, I divert my route to a crosswalk
- ☐ I only cross at crosswalks

6. At an intersection:

- ☐ I obey the signals
- ☐ I cross when I think it is safe
- ☐ I cross when I cannot see any cars
- ☐ I only cross at the crosswalk
- ☐ I cross before I reach the intersection

7. **Route Choice:** How important are the following factors in choosing your regular walking routes?

	Very Important	Important	Somewhat Important	Little Importance	Not Important
Safety from crime	☐	☐	☐	☐	☐
Speed of auto or bike traffic	☐	☐	☐	☐	☐
Condition of pavement	☐	☐	☐	☐	☐
Length of route	☐	☐	☐	☐	☐
Beauty of route	☐	☐	☐	☐	☐
Directness of route	☐	☐	☐	☐	☐
Difficulty of terrain	☐	☐	☐	☐	☐
Availability of crosswalks	☐	☐	☐	☐	☐
Long waiting time at traffic lights	☐	☐	☐	☐	☐
High volume of turning vehicles	☐	☐	☐	☐	☐
Bicycles on the sidewalk	☐	☐	☐	☐	☐
Heavy pedestrian traffic on the sidewalk	☐	☐	☐	☐	☐
Other:____________________	☐	☐	☐	☐	☐

8. **Walking versus other modes of transportation:** How important are the following factors in choosing to walk somewhere versus using other types of transportation?

	Very Important	Important	Somewhat Important	Little Importance	Not Important
Distance you are walking	☐	☐	☐	☐	☐
Difficulty of terrain	☐	☐	☐	☐	☐
Physical ability to walk	☐	☐	☐	☐	☐
Quality of facilities for pedestrians	☐	☐	☐	☐	☐
Walking facilities connect you to destination	☐	☐	☐	☐	☐
Comfort	☐	☐	☐	☐	☐
Rain	☐	☐	☐	☐	☐
Temperature	☐	☐	☐	☐	☐

9. If you do not bike or walk what would make you more inclined to bike or walk?

___

___

___

Your participation is greatly appreciated!

APPENDIX E: DISTRIBUTIONS AND WEIGHTING OF SURVEY DATA

Age Distribution of 2008 ACS Population vs. Sample Survey

	American Community Survey[1] (2006-08)			Bicyclist-Pedestrian Survey (2010)		
Age	**All**	**Male**	**Female**	**All**	**Male**	**Female**
under 18	30969	15427	15542	8	5	3
18-24	43008	21593	21415	227	138	89
25-34	24197	13604	10593	112	57	55
35-44	21230	10779	10451	81	51	30
45-54	21828	10544	11284	93	59	34
55-64	16019	7626	8393	85	52	33
65-74	9532	4368	5164	37	28	9
75+	10707	4269	6438	11	4	7
Total	**177490**	**88210**	**89280**	**654**	**394**	**260**
	Percentages					
under 18	17%	17%	17%	1%	1%	1%
18-24	24%	24%	24%	35%	35%	34%
25-34	14%	15%	12%	17%	14%	21%
35-44	12%	12%	12%	12%	13%	12%
45-54	12%	12%	13%	14%	15%	13%
55-64	9%	9%	9%	13%	13%	13%
65-74	5%	5%	6%	6%	7%	3%
75+	6%	5%	7%	2%	1%	3%
Total	100%	100%	100%	100%	100%	100%
Gender	100%	50%	50%	100%	60%	40%

Two-Stage Weighting

Age	All	Male	Female
Weights to correct for age distribution bias			
under 18	14.26	13.78	15.09
18-24	0.70	0.70	0.70
25-34	0.80	1.07	0.56
35-44	0.97	0.94	1.01
45-54	0.86	0.80	0.97
55-64	0.69	0.66	0.74
65-74	0.95	0.70	1.67
75+	3.59	4.77	2.68
Total	1.00	1.00	1.00
Weights to correct for gender distribution bias			
	1.00	0.82	1.27

Weight Products *(age and gender)*

	Age/Gender Unknown	Male	Female
under 18	14.26	11.37	19.09
18-24	0.70	0.58	0.89
25-34	0.80	0.88	0.71
35-44	0.97	0.78	1.28
45-54	0.86	0.66	1.22
55-64	0.69	0.54	0.94
65-74	0.95	0.57	2.11
75+	3.59	3.93	3.39
Total	1.00	0.82	1.27

[1] *Note:* Census survey data summed for three case study cities (Davis, Palo Alto, and San Luis Obispo)

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