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# BICYCLING AND BICYCLE FACILITIES RESEARCH PROBLEM STATEMENTS

## COMMITTEE ON BICYCLING AND BICYCLE FACILITIES

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### COMMITTEE ON BICYCLING AND BICYCLE FACILITIES

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subject areas

51 Safety
54 Operation and Traffic Control
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21 Facilities Design
55 Traffic Flow, Capacity, and Measurements

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### INTRODUCTION

Committee A3B07, Bicycling and Bicycle Facilities, published its first set of research problem statements in December, 1981. Twenty-three statements were included. This new set of statements includes 24 items, many of which are carried forward from the 1981 edition (albeit, with revised language). The process of developing this list of problem statements includes a public solicitation for input which brought suggestions from practitioners in all parts of the country. Initially, a list of 38 statements was circulated to committee members for review and comment. Members were asked to indicate a priority for each statement. The resulting input was used as the basis for revising the descriptions, consolidating redundant statements, and establishing the priorities which are indicated in this circular.

## PRIORITIES AND COST ESTIMATES

The presentation of this set of problem statements follows the format used in the original set published in 1981. It prioritizes the statements under three headings (high, medium and low) and provides no cost estimate or loading information. Yet, as other committees have learned, the priorities assigned by committees have little bearing on how the statements will fare when they are cast out to compete with all the other issues vying for the all-too-limited research dollars available. Also, the priorities assigned by the committee may not reflect the views held by Federal and state agencies, who will ultimately decide what projects are to be funded.

In recognition of these realities, Committee A3B07 is undertaking to solicit input from state transportation agency staff on what they perceive to be the priorities for bicycle-related research. Realizing that bicycle-related research will likely never garner quite the same level of support as, say, bridge construction, we are exploring methods by which small-scale, lower priority topics can be programmed for eventual funding.

- 1. TITLE: Analysis and Comparison of Various Bicycle-Compatible Highway Designs on Cyclists' Safety and Mobility.
- 2. PROBLEM: Over the past 15 years, much experience has been gained regarding the accommodation of bicycles on streets and highways. From the initial response of seeking to achieve the maximum possible separation of bicycle and motor vehicle traffic, typically through the provision of facilities separate from but parallel to existing streets, attention has shifted to the current focus on design treatments which acknowledge the presence of bicycles on virtually every highway facility at some time or another, by seeking to accommodate such use.

Recent studies have shown that widening the outside or curb lane to between 13 and 15 ft. (4.0 and 4.6 m) can provide positive benefits to both cyclists and motorists. It has also been noted that the effects of wide lanes on the lateral separation of bicycles and motorists varies with factors such as speed and volume. Some state and local highway agencies have adopted standards and policies which support and encourage such wide lane treatment. Some even provide for narrowing interior lanes in order to create wider outside lanes.

The purpose of marked bicycle lanes is generally to provide an environment for bicycling on the existing street system that is separated somewhat from the regular stream of traffic, thus increasing at least the perceived safety of the bicyclists and thereby encouraging use. It has also been suggested that bike lanes may lead to improved capacity by serving to channelize bicycle and motor vehicle traffic under conditions of high bicycle volumes. On the other hand, some experts contend that bicycle lanes do no more to reduce risk and to improve mobility than the regular widening of the curb lane, and in fact, may reduce safety because of the increased turning conflicts created. Agencies seeking to better accommodate bicycle traffic are often faced with conflicting "expert" opinions concerning what type of facilities really are the safest and the most attractive to bicyclists.

In many parts of the country, paved shoulders are routinely used by cyclists. Shoulders can provide cyclists with an alternative to narrow travel lanes and separation from high-speed motor vehicle traffic. Some state have acted to permit bicycle use of the shoulders of freeways and interstate highways, believing that the use of the shoulders along these routes provided either a lower risk than that associated with alternative routes, or that no viable alternative exists. On the negative side, at least one court decision has been against the claim of a cyclist involved in an injury-causing accident while riding on the shoulder by finding that the state vehicle code, which defines bicycles as vehicles, does not permit the regular operation of vehicles on shoulders.

There is no definite resolution of the question of how best to provide for shared use of streets and highways by bicycles and motor vehicles, given the wide range of potential conditions or factors which may define any given situation. Clearly, the provision of sufficient "space" for shared use of the highway is important in virtually all situations. What is less clear are questions related to (a) how much space is required under various sets of conditions, and (b) how this space is most effectively configured. The second question refers to the choices of adding additional width to the outside or curb lane, marking a bike lane, or allowing bicycle use on the shoulder.

- 3. OBJECTIVE: The objective of this study is to establish guidelines for determining the space requirements for shared use and for the selection of the most appropriate and effective street and highway design for providing space for bicycles and motor vehicles under various sets of conditions. In order to successfully accomplish this, it will be necessary to perform the following tasks:
  - Determine the optimum lane width for shared use by bicycles and motor vehicles, given various combinations of factors such as traffic volume, vehicle mix, posted speed limit and actual speed limit, grade, and frequency of intersections.
  - (2) Assess the effects of lane width on the lateral placement of motor vehicles and bicycles.
  - (3) Establish what the effects are on perceived and actual safety and operational efficiency/capacity when a bike lane is delineated with pavement markings. Also, compare the effects of bike lanes to those of wide curb lanes to determine if one treatment more positively affects cyclists' safety and highway capacity at intersections and at mid-block locations.
  - (4) Determine the extent of motor vehicle intrusion into bike lanes and the factors that contribute to it.
  - (5) Assess the effects of bicycle use on highway shoulders. Determine the magnitude and severity of safety problems, if any. Evaluate the potential for conflict between bicycle use and other intended uses of shoulders. Review shoulder pavement treatments to identify measures which might negatively affect bicycle use. Review the legal issues associated with bicycle use on shoulders, including the implications of signing shoulders as bike lanes or some other class of bicycle facility.
  - (6) Determine under what conditions it might be preferable to incorporate additional "width" into either the curb lane or shoulder (that is, to the left or right side of the edge stripe).
- 4. URGENCY: This is a high priority.

# PROBLEM NO. 2

1. TITLE: The Effect of Highway Design and Traffic Operations on Bicyclists' Risk and Mobility.

2. PROBLEM: The results from the study, "Highway Route Designation Criteria for Bicycle Routes" indicate that there is general agreement of the factors which have the greatest effect on bicyclists' risk and mobility: lane width, number of lanes, posted speed, traffic volume (motor vehicle and bicycle), traffic mix, pavement condition, parking, frequency and type of intersections, and shoulder condition.

What is noted, but not yet well understood, is the relationship between these various factors. For instance, while 11 ft. (3.3 m) wide curb lane may be "adequate" for shared use where the ADT is 1,000 and the posted speed is 25 mph (40 kph), it is less "desirable" where the ADT is 20,000 or the posted speed is 55 mph (88 kph).

- 3. OBJECTIVE: The objective of this study is to determine the relationships between the important design and operational variables, relative to bicyclists' risk and mobility. The types of questions to be considered include:
  - (1) How much space (lane width, shoulder, or total pavement width) is needed to accommodate shared use under various conditions (i.e., ADT, speed, etc.)?
  - (2) Is there a relationship between certain variables (i.e., traffic volume, frequency of intersections) and accidents?
  - (3) What is the effect of shoulder width and quality on bicyclists' risk and mobility?
  - (4) Are these factors different for urban and rural roads?

The results of this study will provide an empirical basis for assessing the quality of both existing and planned highway facilities for shared motor vehicle/bicycle use and for validating highway standards and guidelines.

4. URGENCY: This is a high priority project, the result of which will be input into other proposed research studies.

## PROBLEM NO. 3

- 1. TITLE: Analysis of Bicycle Exposure and Risk
- 2. PROBLEM: It is currently estimated that there are over 78 million people riding bicycles in the United States. At some time or another, most of these people will ride on the streets and highways. They include people of all ages, and their level of operating skills and knowledge varies. Yet very little quantitative data exists about either this use or these users.

In 1975, a study was conducted (Kaplan, 1975) which purported to compare the riding habits of experienced cyclists with the general bicycling population. The results suggest that the types of use, preferences, and accident experiences were very different for the two groups. If supported by additional study, this could be a significant finding in determining how to best reduce cyclists risk. Unfortunately, the original study was limited in scope, some potentially significant variables were not adequately controlled for, and the work has not been replicated on an acceptable scale.

Perhaps most problematic is the lack of good data on cyclists' exposure. The aforementioned study contains some preliminary efforts at quantification of some simple exposure measures, but the data does not establish the absolute significance of the variables assessed, nor does the data collection process insure an acceptable level of accuracy. Another study designed to develop an exposure measure was initiated by NHTSA but cancelled after several months, apparently because of difficulties with the study plan.

All this leaves highway planning and design operating in a vacuum as far as a real understanding of the characteristics and magnitude of cycling. It also means that we don't know what conditions constitute the greatest risk for various classes of cyclists.

Few jurisdictions conduct regular traffic counts of cyclists, or include cyclists in ongoing highway traffic counting. There is a need for better techniques for counting cyclists, standard procedures for instituting data collection and analysis, and the development of basic data on cyclists exposure.

- 3. OBJECTIVE: The objective of this study has several elements which will serve to establish a sound understanding of the scope and magnitude of bicycle use, exposure and risk. The following tasks should be performed:
  - Develop methodology for analyzing bicycle use: What should be the classes or categories of information, what breakdowns are significant, what techniques work best for data collection, etc.
  - (2) Develop a typology of bicyclists which takes into consideration such factors as trip purpose, average trip lengths, operating speeds, basic operating skills, knowledge of traffic cycling techniques including hazard recognition, age, experience, ability to handle a progressively more demanding set of traffic situations, compliance with the rules of the road, etc.
  - (3) Develop a model of cyclists exposure; test the model; collect data according to the design of the model, and produce an initial analysis of exposure.
  - (4) Develop predictive models for bicycle use under various sets of highway conditions, and risk for various sets of highway conditions, bicyclist "type" and exposure indices.
- 4. URGENCY: This is a high priority study.

- 1. TITLE: Detection and Elimination (or Mitigation) of Roadway Hazards for Bicyclists.
- 2. PROBLEM: Both as a result of design and as a natural consequence of wear and tear, many roadways have or develop features which constitute hazards for cyclists. Studies of highway liability have established that bicyclists have a right to expect that roadways will be free of hazards. Yet only limited work has been done to determine what conditions represent hazards for cyclists. No guidelines exist for routine highway maintenance schedules to identify and correct hazards for cyclists. Finally, no comprehensive analysis has been performed to establish what approaches work best for dealing with the various types of hazards which are found to exist.
- 3. OBJECTIVE: The objective of the proposed study is to provide positive guidance for state and local transportation agencies for the management of risk associated with roadway hazards for cyclists.

The successful accomplishment of this project will entail the performance of the following three tasks:

- (1) Review characteristics of bicycle operation, and identify the requirements for safe, comfortable use. Using this model assess the highway environment to identify what factors of design and operation are most critical to cyclists. Review current practices regarding these factors, including maintenance problems, that develop as a natural consequence of wear over time. Develop guidelines for hazard recognition.
- (2) Develop recommendations for revision of design standards to eliminate practices which presently result in hazardous condition for cyclists, (e.g., drainage grates, bridge rail heights, lighting levels, etc.). Develop guidelines for periodic review and maintenance to insure hazards are routinely anticipated or identified, and corrected.
- (3) Develop standard procedures for prioritizing and responding to existing hazards. Both immediate (short-term) treatments (e.g., warning sign, pavement markings) and permanent treatments should be provided for.
- 4. URGENCY: This is a high priority.

- 1. TITLE: Determine the Causal Parameters of Bicycle Use.
- 2. PROBLEM: The potential benefits of bicycle transportation will prompt public and private campaigns to encourage bicycle use. Bicycling can be promoted by emphasizing its advantage concerning health, energy conservation, pollution control and enjoyment. However, these

campaigns will be purely informational unless they address the factors that keep people from riding bicycles irregardless of the advantages. Once the personal barriers to riding bicycles are removed, people will listen to what they can gain from bicycling. Therefore, the foundation to bicycle promotion is learning what factors most directly affect a person's choice to ride a bicycle; creative solutions to obstacles can then be developed.

- 3. OBJECTIVE: Attitude surveys could identify the factors that contribute to a person's choice to ride a bicycle. The surveys should address attitudes toward convenience, fear, comfort, habit, physical motivation and strength, and time use. Different populations could be compared to determine the influence of demographic and socioeconomic factors, regional differences and land-use policies on attitudes towards bicycling. A conceptual model could then be developed to identify the stages people progress through to arrive at various acceptance levels of bicycling. Each stage would have obstacles that commonly constrain bicycle use. Different populations might be influenced by contraints at different states of the model. Once each population's obstacles had been identified, solutions could be developed to help those people move to the next attitudinal step.
- 4. URGENCY: This is a high priority study, as it provides the foundation for effective educational programs as well as facilities development.

- 1. TITLE: Identification of Bicyclists Characteristics.
- 2. PROBLEM: The study on the energy conservation potential of bicycle transportation, Bicycle Transportation for Energy Conservation --USDOT, 1980, examined the current levels of bicycle use in the United States. The data available for the study, however, was rather limited and did not provide information on several key aspects of bicycle use. A solid data base on current levels of bicycle use is essential for evaluating progress in the implementation of this comprehensive energy conservation program, as well as necessary to provide a trustworthy data base for other related studies. Not only is a solid national data base needed, but a method of continually updating the data is also important. Otherwise a comprehensive information collecting project of this type becomes a one shot effort that is out of date within a few years. Since the data would be collected on a national level, local governments may find a need to collect similar data for their particular locality to aid them in planning their activities. The development of a simple methodology that local governments could use would be valuable as an offshoot of the major project.
- 3. OBJECTIVE: This project will develop an ongoing national survey program to collect data concerning bicyclist social and economic and demographic characteristics. Alternatively, this could be accomplished by including the bicycling surveys in a currently operating survey system. The survey should focus particularly on those who use their bicycles for transportation; the various types of bicycle trip purposes

and the average trip length for these purposes; the effects of such factors as weather, climate, and terrain on the choice of the bicycle over other modes; the relationship of city size to volume of bicycle travel; the frequency at which a bicycle is used on a daily, weekly, or monthly basis; seasonal variations in bicycle use; the accident experience of those who ride bicycle regularly; the mode which the bicycle replaces on regular commuting or personal business trips; the degree of satisfaction that is experienced with the bicycle as a mode of transportation; the average duration of bicycle trip; the maximum time willingly allocated to any particular bicycle trip; the number of autos owned by people who ride bicycles; and finally, the principal obstacles and disincentives that various individuals encounter on their regular bicycle trips.

The results of these surveys would provide information that could be used by transportation agencies to accurately project the consequences of various solutions to accommodate bicycle traffic. The results could also be used to identify the trip characteristics that differentiate classes of bicyclists in terms of their facility needs. The results concerning the obstacles and disincentives encountered by bicyclists could be used as a basis for education and promotion programs.

4. URGENCY: This project is a high priority.

## PROBLEM NO. 7

- 1. TITLE: Analysis of Signing Needs or Alternatives.
- 2. PROBLEM: Over the past 15 years, of the efforts to address the facility needs of the growing population of bicyclists, no treatment has been more widely adopted than to use the white-on-green, BIKE ROUTE sign, (MUTCD D-11-1). Yet, today one of the first projects undertaken by many newly-appointed agency bicycle specialists is to arrange to have the BIKE ROUTE signs removed. The rationale given for this action is that the BIKE ROUTE sign alone has as much utility as putting up a sign on a highway facility that said AUTO ROUTE.

The typical justification for placement of bike route signs has been to indicate to cyclists streets that are "better" for cycling, or in some way preferred, and to indicate to motorists that they should expect the presence of cyclists on these facilities. However, both of these notions have come under question. First, what makes one street "better" than another (and better for whom?), and second should motorists pay any less attention to the possible presence of cyclists on any other street?

Still all this discussion does not address the basic goal intended for the BIKE ROUTE sign: to provide directional information. From the cyclists perspective, the current widespread use of the signs has not served this purpose. Directional information to cyclists through the use of signs is not being effectively provided. The other functions of signs are to warn of unexpected conditions and to regulate use. With the increased concern for liability, the need to warn cyclists of possible hazards has become much more important. Yet, little has been done to define what conditions should be signed as hazards, nor how this signing might best be effected.

Regulation of bicycle use most often involves bicycle use of special or separate facilities. These facilities are often under the jurisdiction of an agency other than transportation (typically park or recreation) which may or may not be aware of or familiar with the MUTCD. It is not surprising then, that the signing on such facilities rarely conforms to the MUTCD, and is frequently inadequate. Further, some of the regulatory needs for such facilities are unique, and therefore not addressed by the MUTCD.

Finally, bicycles have certain characteristics which clearly distinguish them from other vehicles, such as slower operating speeds. This would suggest that the design of signs for cyclists should be based in part on different requirements. For instance, size specifications for cyclist-oriented signs might be reduced.

3. OBJECTIVE: The purpose of this study is to establish updated guidelines for cyclist-oriented signing which reflect both the needs of cyclists, and the sometimes unique conditions which are associated with bicycling and bicycle facilities.

To accomplish this objective, the following tasks should be performed:

- Assess the information needs of cyclists, and of motorists interacting with cyclists, and the operational characteristics of cyclists which might be significant in establishing design and use parameters related to signing.
- (2) Develop a procedure for effectively presenting directional information with signs. This should include consideration of the possible need to coordinate directional signing with maps. Also, a variety of types of routes (e.g., recreational) should be identified, and the possibility of varying sign requirements should be addressed.
- (3) Identify the conditions which should be treated with warning signs. Develop appropriate sign designs and procedures for the optimum placement of such signs.
- (4) Identify the regulations which may apply to cyclists on various types of facilities. Review existing signs, and develop recommendations for such new sign designs as may be needed
- (5) Develop guidelines for a complete system of bicycling-oriented signs, including information on warrants and standards for treatment of various situations. Assure new signs are consistant with MUTCD sign design guidelines.

4. URGENCY: This is a high priority.

- 1. TITLE: Effect of Population Type on Cyclist Behavior.
- 2. PROBLEM: Research in the past few years has indicated that different populations of cyclists exhibit markedly different cycling behaviors. In order for any program to be effective, it is important to be aware of the population the program is intended to serve. This is true for all types of bicycling programs, such as education, engineering, or enforcement. Different methods or objectives may be needed to achieve the same goal for different populations. Research is needed to determine the bicycling behavior among different groups of cyclists, so that communities can design facilities, capital projects, marketing, and educational programs that will be effective in changing the type of unsafe behavior that is actually occurring in that area, and promote safe bicycle use for personal transportation.
- 3. OBJECTIVE: The purpose of this study is to determine the incidence of safe and unsafe behavior among different categories of cyclists such as children, bicycle messengers, students on college campuses, club riders on tour, bike path riders, and city commuters. The results would then be catalogued into an easy-reference form that pointed out the performance problems and needs, as well as strong points, of each group. In this way a community that is planning to implement a bicycling program could first determine the types of riding population that the program is meant to serve, and then tailor their plans and objectives to needs of those populations as outlined by this study.
- 4. URGENCY: This project is of high priority, since it provides a foundation upon which many different type of programs should be based.

- 1. TITLE: Development of a Road Safety Index.
- 2. PROBLEM: Although a great deal of effort has been spent in recent years planning and designing bicycle facilities, there has been no formal identification of the factors that make an existing street safe or unsafe for bicycling. Planners and officials that want to designate certain roads as preferable for bicycle travel have to base their decisions on intuitive or unsubstantiated criteria. The development of on-street bike routes is the most inexpensive method to provide a good bicycle route system. However, there are many factors that affect the safety and efficiency of a particular road for bicycle travel. The identification of these factors will aid in the development of more bike routes, and will add to the safety and pleasure involved in using those routes.
- 3. OBJECTIVE: This project would involve the identification of critical road safety factors, the determination of their relative importance, and the establishment of bicycle safety thresholds for each factor. These factors would include such items as lane width, number of lanes, sight distance, surface conditions, number of intersections, land use,

and lighting. These factors would then be organized into a series of criteria for use by local planning officials in judging the suitability of any particular road, reflecting the varying degrees of bicyclist experience. For example, a particular road could be graded as safe for experienced cyclists, demanding for a cyclist with moderate experience, and unsafe for children and novice cyclists.

4. URGENCY: This project is of high priority.

### PROBLEM NO. 10

- 1. TITLE: Determination of the Effect of Bicycles on Highway Capacity.
- 2. PROBLEM: TRB Circular Number 284 (October, 1984) includes the final text for portions of the Third Edition of the HIGHWAY CAPACITY MANUAL. Chapter 14, "Bicycles", for the first time, attempts to provide some information related to highway capacity and bicycles. However, as the Introduction to the Chapter states:

"While the state of knowledge concerning specific impacts of bicycles on the capacity and level of service of highway facilities is not advanced, this chapter presents some insights and procedures for approximately analyzing the effects of bicycles in the traffic stream."

The not quite four pages of text which comprise Chapter 14 reflect this lack of good data on bicycle use and highway capacity. (This contrasts markedly with the 40-page chapter on pedestrians.)

Since bicycle use is increasing, it is reasonable to anticipate that this use will have an increased impact on the capacity and level of service of highway facilities. Yet the design engineer is not today in a position to accurately assess the potential impacts of this bicycle use, to consider how it would vary under a different set of conditions (i.e., lane width, speed, ADT, etc.), and to effectively plan facilities which will both accommodate such use and maintain the desired capacity and level of service.

- 3. OBJECTIVE:: The purpose of this study is to develop appropriate data and procedures for routinely incorporating bicycles into capacity analyses. The following topics should be addressed by this study:
  - Establish what has been learned regarding the effects of bicycles on capacity and level of service under varying sets of conditions, including high bicycle volumes.
  - (2) Conduct tests/research as needed to complement the existing data, and to determine how bicycle and motor vehicles interact in various situations: mid-block and intersection with varying lane widths, traffic volumes, speeds, and vehicle mix; and on different classes of facilities. Assess the degree to which cyclist' ability (skills and knowledge) affect capacity.

- (3) Develop procedures which will permit the findings of this effort to be readily incorporated into the routine processes for highway capacity analysis.
- 4. URGENCY: This is a medium priority project.

- 1. TITLE: Analysis of the Hazards and Traffic Generating Capabilities of Bicycle Accommodations.
- 2. PROBLEM: The conditions bicyclists face, whether on a city street or on a bicycle path, have a great deal to do with their enjoyment and acceptance of bicycling as a mode of transportation. Every bicycle facility poses potential hazards. Similarly, many roads pose hazards or barriers to widespread bicycle use. It is only by recognizing these hazards that bicyclists can be taught to deal with them, and planners can develop solutions to them. A city or locality that is attempting to accommodate bicycle traffic must choose the particular facility by weighing such factors as potential hazards, money available, and public acceptance. Some hazards that are generally thought of as very dangerous may not actually cause many accidents at all. Alternatively, there are many hazards that the average bicyclist is not even aware of. Local governments need to make intelligent choices between various options and provide solutions that are based on the real causes of accidents. Therefore, it is necessary to conduct research into the various hazards bicyclists encounter and the effect of those hazards on their overall safety. Furthermore, a related element of the relative advantages and disadvantages of bicycle improvements is the power of these improvements to attract or generate additional bicycle traffic. This should also be considered by planners when choosing the most cost-effective bicycle improvement.
- 3. OBJECTIVE: This project will analyze bicycle hazards and traffic generating capabilities of each different type of bicycle improvement in use today. The project will assess such hazards as surface irregularities, maintenance problems, maneuvering hazards (such as left hand turns), visibility problems, and hazards encountered upon entering and exiting the facility. This could be approached both through accident analysis and bicyclist and motorist surveys or interviews. The project could use several examples of designated bicycle facilities from the USDOT bikeway Demonstration Program and various "on road" improvements designed to accommodate bicycle traffic, suitably matched with control facilities, to evaluate both the traffic generating power and the safety of each.
- 4. URGENCY: This project is of medium priority.

## PROBLEM NO. 12

1. TITLE: Evaluation of the Safety of Separate Bicycle Facilities.

- 2. PROBLEM: There has been a tremendous amount of controversy in recent years over the relative merits of the on-street vs. "separated" bike facility. There was once a presumption that off-street bikeways are both preferable and safer, since they provide the maximum separation between the bicyclist and the automobile. However, through experience in the use of separated bike paths, bicyclists have become aware of many unique hazards; such as poorly maintained and lit paths, as well as paths that suddenly end and leave the unsuspecting bicyclists in the middle of a busy intersection. Furthermore, the paths often do not provide bicyclists with direct routes to their destination. Though there are many speculations concerning the merits of separated paths, there has not been a major quantitative study concerning accident occurrence on bike paths vs. on-street facilities in the United States. Considering the tremendous investment bike paths often demand, communities could benefit by having statistical information concerning the relative safety and merits of separated vs. on-street bike paths.
- 3. OBJECTIVE: This project will determine relative exposure measures for bicyclists on shared facilities and on separate facilities, and will establish an accident rate for the two types of facilities. The study will cover all type of bicycle accidents: bike/motor vehicle, bike/pedestrain, bike/bike, and bike only. Accident severity should also be examined and considered in any conclusions drawn. Accident causation should be assessed (by sorting into accident types) so that a community can decide whether it can do anything to prevent the common accident types. This study could be combined with a use survey, to determine whether people prefer a certain type of facility, and why. It should also include a review of European research in this area.
- 4. URGENCY: This study has a medium priority.

- 1. TITLE: Identification of Hazards to Bicyclists at Intersections.
- 2. PROBLEM: Previous studies have found that the majority of serious bicycle accidents occur at or near intersections. There are a number of known factors that cause intersections to be potentially dangerous, including bicyclist's lack of knowledge, awareness and skill; motorist uncertainty of safe procedures; and inadequately designed bicycle facilities. There are many possible responses to these problems, but first the full range of intersection hazards must be identified. The evaluation of the relationship between accidents and intersection design will provide a basis for modifying intersections for reduced bicyclist risk.
- 3. OBJECTIVE: The purpose of this study is to identify specific hazards occurring at intersections and to use the results to develop guidelines for the modification of existing intersections and intersection design. The study should address the interaction of bicyclists behavior and the physical characteristics of the intersection; for example, potential hazards during left hand turns; the ability of bicyclists to cope with signal phasing; the relative lane positioning

of bicyclists and motorists; and bicyclist visibility and conspicuity. Once these hazards are identified, the study would then develop proposed solutions. A simulation model could be developed to determine and present optimum designs for different types of intersection.

Special topics which should be addressed during the course of the study include:

- (1) A thorough assessment of the effects of free-flowing right turn lanes and freeway access/egress ramps.
- (2) An investigation of the extent and severity of right-of-way conflicts associated with stop, yield, and signal-controlled intersections (both with and without Right-Turn-On-Red).
- (3) An investigation of curb lane width as it relates to conflicts associated with right turns.
- (4) An investigation of the effect of marked bike lanes on bike/motor vehicle flow.
- (5) An assessment of various European intersection treatments designed to incorporate bicycle traffic. designs incorporating bicycle paths at or near the intersection with bicycle traffic signal phases and bike priority treatment should be included.
- 4. URGENCY: This project has a medium priority.

- 1. TITLE: Identification and Incidence of Non-Motor Vehicle Related Bicycle Accident Types.
- 2. PROBLEM: While the National Highway Traffic Safety Administration has conducted extensive research into the causes of accidents involving bicycles and motor vehicles, there has been no national effort to identify the factors included in non-motor vehicle related bicycle accidents. Although these types of accidents are generally much less severe than accidents involving motor vehicles, they do account for the vast majority of accidents in which bicyclists are involved. A study of the types on non-motor vehicle accidents that occur, as well as an identification of the causal factors, would provide a basis for the development of educational programs as well as "rules of the road" for bike paths. The limited studies that have been conducted in this area indicate there are specific skills that bicyclists can learn which will prevent some accidents; for instance, handling a bicycle on a hill. Most of the educational programs currently available do not cover these specific skills. In order for future bicycle education programs to be effective, they must be founded on quality research that indicates where the problems actually occur.
- 3. OBJECTIVE: The purpose of this study is to develop a methodology to gather information on the nature and causes and number of non-motor

vehicle related bicycle accidents. A classification system will be necessary so that the frequency of certain types of accidents with common surrounding circumstances can be assessed. Once the method is developed and tested, it could be used by any community in the country to evaluate specific problem areas. If this data were gathered on a national basis, or if there was a central clearinghouse for the results of several studies, many communities could benefit by the results without having to conduct an entire study. Knowledge of the incidence of various types of non-motor vehicle bicycle related accidents will assist in the allocation of resources and the setting of priorities in the development of countermeasures.

4. URGENCY: This project has a medium priority.

#### PROBLEM NO. 15

- 1. TITLE: Education Needs for Bicycle Planners and Engineers.
- 2. PROBLEM: The increase in bicycling in the last 5 years has produced the need for planners and engineers to develop solutions for bicycle transportation needs. The problems unique to bicycle transportation demand specialized training for their creative and competent solution. The people presently in the planning and engineering field can be trained for bicycle planning, but the only way to guarantee a broad based sensitivity to bicycle transportation issues by transportation professionals is to include bicycle transportation planning as part of the course content in education programs for transportation professionals.
- 3. OBJECTIVE: The purpose of this research is to:
  - (1) Determine to what extent bicycle facility planning and engineering is currently being taught.
  - (2) Determine whether qualified teachers are available.
  - (3) Determine the knowledge level of current planning and engineering students concerning bicycle facilities.
  - (4) Develop a workable model course or unit for bicycle planning and engineering.
  - (5) Develop methods for the incorporation of bicycle facilities planning and education into current curricula.
- 4. URGENCY: This project has a medium priority.

- 1. TITLE: Effects of Bicycle Parking Technology and Marketing Strategies on Express Transit Passenger Access and Ridership.
- 2. PROBLEM: Recent research and the experiences of a number of transit agencies have shown that improving bicycle access to transit is one of

the most cost-effective ways to boost suburban express transit ridership, cut access system costs, and increase suburban transit productivity. By providing secure bicycle parking at transit stops to overcome the bicycle theft problem, transit agencies can attract many new riders to transit and free up space in costly and often crowded park-and-ride lots. Because bicycles can be used for egress as well as access, transit stop bicycle parking often attracts new reverse-commute trips to public transportation, boosting non-peak direction load factors.

Bicycles play a major and often predominant role in access to suburban Japanese and European express transit services, accounting for 20-55% of access trips. High crime rates and lack of secure bicycle parking at US transit stops, however, has served as a major barrier to greater bike-and-ride travel in America. Where secure bicycle parking has been provided in the US, it has attracted substantial use.

Recent comparative international research has pointed out key differences between US approaches to providing bicycle parking and those use in Japan and Europe. This research suggests that the provision of guarded bicycle parking facilities at major suburban express transit stops can attract more new passengers to transit at a lower cost than the construction of less space-efficient bicycle lockers and secure racks.

While guarded bicycle parking facilities at transit stops are very common in Japan and Europe, they have not been developed anywhere in the U.S. This concept needs to be implemented and evaluated in a suburban American context to demonstrate its transferability and cost-effectiveness.

Little attention has been paid to marketing strategies for the promotion of bike-and-ride travel in America. The demonstration of a guarded bicycle parking facility would be a highly appropriate context to test market segmentation promotion strategies related to bike-and-ride travel.

3. OBJECTIVE: Identify and evaluate several potential sites for the demonstration of bike-and-ride promotion strategies, using criteria suggested by recent research on bicycle-transit linkage.

Select two similar communities for semi-controlled evaluation of the impact of different bicycle parking technologies (bicycle lockers & secure racks vs. guarded parking) on demand, access mode choice, transit ridership, and costs.

Prepare detailed evaluation plans, project designs, and marketing strategies for the two demonstration sites. Collect baseline evaluation and data collection.

Install new bicycle parking facilities at demonstration sites and begin marketing campaigns. Monitor system performance through interim evaluation and data collection. After one-year of semi-controlled testing of the influence of technology on bike-and-ride demand, introduce site-specific variations in marketing strategies (including pricing policies) to evaluate elasticity of demand with respect to technology and to assess the effectiveness of different marketing tactics. Collect final evaluation data after 2 years of operations.

Prepare final evaluation report and disseminate research findings to transit agencies and local governments.

4. URGENCY: This project has a medium priority.

## PROBLEM NO. 17

- 1. TITLE: Evaluation of Bicycle Parking Systems.
- 2. PROBLEM: Along with the increased use of bicycles as a method of daily transportation comes attendant problems such as parking. In recent years, a number of new locking devices have been developed and marketed, and new systems have been created such as a fenced-in area for bicycle parking. However, the new systems that are available vary widely as to their adequacy for bicycle security, as well as their appropriateness for various uses. A city or company will be thwarted in the attempt to encourage bicycling by providing parking, if bicyclists view the parking facility as providing inadequate security. This means not only that bicyclists may be frustrated in their parking attempts, but also that attitudes will be developed by city officials and company officers that it is not worthwhile to provide bicycle parking, since bicyclists will not use it anyway. With adequate information on parking facilities, expenditures for parking facilities could be made wisely and effectively.
- 3. OBJECTIVE: The objective of this study is to evaluate the wide variety of bicycle parking facilities currently in use in this country and abroad regarding level of security and appropriateness for various locations.

This type of evaluation should be potentially ongoing since more and more new devices will be appearing. An evaluations instrument could be developed based on the facilities available now. The findings could then be publicized to aid planners and businesses immediately. Then, a simplified form of the instrument could be disseminated in a check-list form, so that anybody in need of parking facilities would have a standard width which to evaluate what is the best and most appropriate facility of all those available at the time. The use of these evaluation standards could be commenced as a requirement for the expenditure of Federal funds for parking facilities.

4. URGENCY: This project has a medium priority.

# PROBLEM NO. 18

1. TITLE: Bicycle Maps -- User Needs and Cartographic Standards.

2. PROBLEM: Mapping efforts for bicyclists have been increasing in recent years. Many state and municipal agencies are producing maps for bicyclists, emphasizing the suitability of the various elements of the street system for bicycling. However, in order for further refinement and sophistication of these mapping efforts to be effective, it is necessary to determine whether bicyclists are actually using the maps, whether use of the maps positively affect cyclists' risk, and what problems are encountered in the use of maps. In this way the updating of maps and the development of new maps can be based on factual information concerning what works and what is needed.

For either route or suitability maps, it is necessary to gather and analyze street information, which may be primarily subjective or objective in nature. Volunteers who ride city streets and rate them according to perceived safety characteristics typically provide the more subjective type of data base. Alternatively, many maps are based primarily on objective roadway characteristics which are collected from written records or on-road measurements.

There is currently no accepted set of standards or model which prescribes how best to use these various types of data to produce desirable route systems or meaningful street suitability codes. Some maps are based almost entirely on user perceptions, while others are based solely on physical roadway characteristics.

Perhaps more importantly, there are no standard procedures to guide the collection of street data. This is most apparent with respect to the more subjective types of information. Some states and cities have employed (and paid) one or a few cyclists to ride and evaluate the streets, while others have obtained the assistance of groups of volunteers with varying degrees of bicycling experience. Such volunteers may be trained or untrained with regard to the street evaluation procedures (and, if untrained, their "instructions" may bear little resemblance to those suppled in other cities).

Since individual settings and situations vary widely, some flexibility in the types of data and collection procedures used is desirable. Nevertheless, there appear to be many ways in which city and state approaches to bicycle map development vary, not due to needed flexibility, but rather because project overseers are unaware of what measures actually work best.

- 3. OBJECTIVE: The purpose of this project is to develop a better understanding of the role and function of maps in meeting the needs of cyclists and in promoting bicycling, and to provide guidelines for the efficient preparation of high quality, useful maps. This will be accomplished by the completion of the following three tasks:
  - (1) A study should be made of user needs, desires, abilities and experiences associated with maps for cycling. Some preliminary work has been done on this topic which will provide a starting place. Of particular interest would be the users assessment of existing maps. Also, it should be determined exactly what

purposes users look to maps to serve and how maps are in fact used. Finally, the level of sophistication and detail potential map users are capable of handling should be established.

- (2) The majority of urban bicycle cartography today focuses on the presentation of information on the relative suitability of various streets and highways for cyclists with varying skill levels. Therefore, this topic should receive detailed consideration in order to develop guidelines for the assessment of route suitability, including the recommendation of typical categories for the classification of routes.
- (3) Guidelines should be developed for the design and production of the several basic types of bicycle maps: suitability maps, urban route guides, long-distance route maps, touring route maps, etc. The purpose of these guidelines would be to make it relatively simple for state and local agencies to produce standardized, high quality bicycle maps.
- 4. URGENCY: This is a medium priority project.

#### PROBLEM NO. 19

- 1. TITLE: Attitudes About and Incentive to Increase Helmet Use.
- 2. PROBLEM: It seems axiomatic that the use of hardshell bicycle helmets could prevent or reduce the severity of bicycle accidents. Yet many bicyclists do not wear them. There is a need to find out why bicyclists do not wear helmets and what incentives might be effective in getting people to wear them.
- 3. OBJECTIVE: Attitude surveys could identify the factors that contribute to a person's choice to wear or not to wear a helmet. The survey should elicit attitudes regarding convenience, expense, comfort, habit, appearance, knowledge of their existence and utility, etc. In addition the study should examine a variety of incentives to determine which ones might be effective in increasing helmet use.
- 4. URGENCY: This project has a lower priority.

#### PROBLEM NO. 20

- 1. TITLE: Review and Update of Existing Standards and Policies.
- 2. PROBLEM: The ultimate goal of bicycle facility efforts is to see the highway system functioning in such a way that shared use by motor vehicles and bicycles can take place with minimum risk and maximum mobility and efficiency. This will be accomplished by bringing the highway system into conformance with the design characteristics which have been identified as best serving the needs and requirements of all modes.

With the results of recent and proposed research there would be adequate information to support the update of the standards, guidelines and policies which govern the design and operation of streets and highways. The incorporation of this information is absolutely essential in order to insure that future projects are planned and constructed to accommodate all vehicles in a compatible cost-effective manner.

- 3. OBJECTIVE: The objective of this study is to review the various standards, policies and guidelines pertaining to the design and operation of highways and recommend appropriate revisions to bring them into conformance with the state-of-the-art on bicycle-compatible facilities. The documents to be reviewed would include the following:
  - (1) AASHTO Policy on Geometric Design of Streets and Highways
  - (2) AASHTO Geometric Design Guide for Resurfacing, Restoration, and Rehabilitation of Highways and Streets
  - (3) AASHTO Standard Specifications for Highway Bridges
  - (4) AASHTO Guide for Development of New Bicycle Facilities
  - (5) FHWA Standards and Regulations
  - (6) Highway Capacity Manual
  - (7) ITE Manual and Specifications for Traffic Control Devices
  - (8) Manual on Uniform Traffic Control Devices
  - (9) Selected State Design Standards
- 4. URGENCY: This project has a lower priority.

### PROBLEM NO. 21

- 1. TITLE: Evaluation of Bicyclist's Use of Controlled Access Freeway Shoulders.
- 2. PROBLEM: Most states prohibit bicyclists from all portions of their controlled access freeways (including Interstate highways). However, some permit bicyclists to use the shoulders of such facilities having concluded either that there is no viable alternative to the particular route (as with a mountain pass or a bridge), or that the available alternate routes, because of geometrics or other conditions, would put cyclists at greater risk than would use of the freeway.

California, which allows bicycles on certain controlled access freeway segments, conducted an analysis of bicyclists' use of the shoulders of these facilities and concluded that there are no major safety problems. Colorado has expanded on the California experience and developed a set of criteria and procedures for assessing the need and suitability of opening sections of controlled access freeways. 3. OBJECTIVE: The objective of this study is to identify the conditions which might warrant the use of the shoulders of controlled access freeways by bicyclists. This would be accomplished, in part, by comparing the accident experience of areas that permit bicyclists to use the shoulders of controlled access freeways to states that do not, and to the accident experience and/or potential of alternate routes. This would include consideration of the risk associated with bicycle use on non-freeway type facilities with a posted speed limit of 55 mph (88 kph).

The results of this study would be guidelines for evaluating the need and suitability of permitting bicyclists to operate on the shoulders of controlled access freeways.

4. URGENCY: This is a lower priority project.

- 1. TITLE: Review and Evaluation of the State-of-the-Art of Bicycle Program Development and Implementation.
- 2. PROBLEM: There has been a great deal of demand in recent years for documentation of "success stories" in the development of comprehensive bicycle transportation programs. Once difficulty encountered in the development of these success stories is that the prime motivation for the development of a program has been the initiative of a single individual or group of individuals within a community. These types of situations have not been transferable to other communities. A study conducted in 1974 by the National Highway Traffic Safety Administration revealed a low level of effort accorded to promoting bicycling safety. This was due to a lack of motivating individuals as well as a general lack of awareness of what was essential to increase bicycle safety and transportation in the entire population. However, in the past few years there have been significant increases in the number of people who are dedicated to the improvement of bicycling promotion efforts in the U.S. Consequently, more attention has been paid to what are the most effective ways to promote bicycling transportation and safety. There has not, however,, been a significant review of what progress has been made in these areas by state and local government. A community interested in developing a comprehensive bicycle transportation program is still faced with the time consuming and frustrating job of trying to find out what works and what does not work.
- 3. OBJECTIVE: The purpose of this study would be two-fold:
  - To find out what caused the recent increase in effort and motivation of government officials to develop bicycling programs, and
  - (2) To identify the wide variety of approaches to bicycle programs that are being implemented at the state and local level.

The first stage would be to determine the effects of efforts to encourage local governments to improve bicycle transportation. These efforts include such activities as:

- The NHTSA Study of pedestrian and bicycle safety programs, required by Section 214 of the Highway Safety Act 1973
- (2) The Bicycle Safety Education Conference (NHTSA)
- (3) The Regional Bicycle Safety Workshop (NHTSA)
- (4) Activities in the Office of Transportation
- (5) Activities of the Environmental Protection Agency

In those areas in which no apparent progress has been made, it would be important to identify the reasons given by state and local officials for their lack of attention or interest paid to bicycling transportation. Improved promotion strategies could then be suggested. The second stage of the project would include identifying the critical elements of the program approaches that have been taken at the local and state level. These approaches should be catalogued to reflect the varying levels of effort and financial support required. Furthermore, circumstantial factors, such as environment and demographics, that might affect the success of the particular approach would be determined. The study would also include the evaluation of the programs in terms of increased safety and increased volume of ridership. In this way, a community considering the initiation of a comprehensive bicycle transportation program would be provided with a means to choose an effective approach that most suits local needs.

4. URGENCY: This project has a lower priority.

- 1. TITLE: Motor Vehicle Operator's Response to Bicycle in the Traffic Mix.
- 2. PROBLEM: Many motorists in the United States have little training or experience in sharing the road safely with bicyclists. This is not surprising, since the addition of a substantial number of bicycles to the traffic mix is a fairly new phenomenon. In order to integrate bicyclists into the traffic system, it is important not only to educate bicyclists concerning the skills necessary for safe and efficient operation in traffic, it is also necessary to teach motorists a uniform method to interact with bicycles. However, little is known about motorists expectations of bicyclist behavior on the road, about their understanding of what constitutes a hazardous situation for bicyclists. Once this type of information is assessed, it will be possible to evaluate the needs for motorist education.

- 3. OBJECTIVE: The purpose of this study is to assess motorists' knowledge and expectations of bicyclists' behavior. The project will survey motorists knowledge of the correct behavior for bicyclists on the road, their awareness of potential hazards for bicyclists and hazards caused by bicyclists, and motorists' attitudes toward bicyclists on the roads. This information would provide a basis not only for evaluating motorist educational needs, but also for possible improvements in street design to safely and efficiently accommodate bicyclists. The second stage of the project would be to develop and test various methods to improve motorists' understanding of bicyclist behavior, and to train motorists in avoiding the creation of hazardous situations for bicyclists.
- 4. URGENCY: This project is of lower priority.

- 1. TITLE: Evaluation of Enforcement Techniques and Campaigns for Bicyclists.
- 2. PROBLEM: The widespread violation of traffic laws by bicyclists, and the general lack of enforcement of these laws, has been instrumental in the development of a negative image of bicycle users. There are several possible reasons for the number of violations that commonly occur: lack of bicyclist knowledge and skill; inconvenience and impracticality of the law for bicyclists; bicyclist attitudes of being immune from the traffic laws; and repeated occurrences of bicyclists "getting way" with the violations. These reasons can be attacked by a combination of education, awareness of bicyclists needs in the development and modification of traffic laws, and enforcement. The area of enforcement has not received much evaluative effort. Communities all over the country are using various methods and philosophies of enforcement. There is a need for an evaluation so that programs can be developed based on models that have proven to be effective.
- 3. OBJECTIVE: The purpose of this project would be to identify several apparently successful approaches for dealing with bicyclist violations, documenting the nature of the techniques, and evaluating their effectiveness. The evaluation would include assessment of costs and man-hours, the degree to which enforcement officers accept and support the program, public acceptance of the program, and behavior change induced by the program. The results of the study would be developed into guidelines for the implementation of a successful enforcement program, including methods to encourage officer acceptance and participation, and public awareness and support. These guidelines could then be distributed to local police jurisdictions.
- 4. URGENCY: This project has a lower priority.

### PROBLEM NO. 25

1. TITLE: Evaluation of Observational Tools for Measuring Cyclist Behavior.

- 2. PROBLEM: Evaluation is an element of program planning and implementation that is often neglected. Every new program, whether it concerns education, engineering, or enforcement, should include an evaluation procedure as an integral component. The evaluation results of each program could then be used by other communities to improve methods and plans. However, there is a need to develop effective evaluation procedures that can be incorporated into many types of programs. The need often arises for an observational tool to evaluate the effect of program on bicyclists behavior. Once the elements that make an observational tool effective, accurate, and reliable are determined, the best available tool could be identified, or an improved tool could be developed.
- 3. OBJECTIVE: The purpose of this study is to identify the procedures that have been developed for observing and evaluating bicyclists behavior, and to determine the most effective, accurate, and reliable tool. For instance, one well-known evaluation method is John Forester's Effective Cycling Proficiency Evaluation Technique. This study might attempt to validate Forester's technique as a means of accurately identifying behavioral errors and determining their relationship to accident causation. The evaluation methods would be assessed in several areas:
  - Accuracy in identifying certain behaviors as incorrect (unsafe or inefficient);
  - (2) Practicality and complexity regarding implementation;
  - (3) Complexity of data collection and recording methods; and
  - (4) Form of results

The tools would be tested in a controlled environment, with each tool receiving the same tests, for comparison purposes. In this way, the elements of the best observational tool could be identified, and program planners could choose the tool that would be most effective for their purposes.

4. URGENCY: This project has a lower priority.