PLANNING AND DESIGN OF BICYCLE FACILITIES: PITFALLS AND NEW DIRECTIONS

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This paper focuses on several recent failures in bikeway design in the hope that similar mistakes can be avoided in the future. Pros and cons of independent bicycle paths are listed, and the major deficiency is shown to be problems in design, inasmuch as they are usually designed for pedestrians rather than for bicyclists. This paper gives several questions that planners must answer when considering an independent right-of-way opportunity. These relate to safety, utility and linkage, and proximity to population centers. The use of sidewalks as bikeways is discussed, and unsatisfactory experience with such paths is presented. Some of the more obvious problems are poor sight distance, hazards from shrubs and signs, driveways, pedestrians, poor-quality surface, and curbs. Various attempts at curb cuts and ramps are mentioned. Signed bike routes are rarely used by cyclists because they usually do not serve desired activity centers and offer few if any safety advantages. Bike lanes, created from roadway space left over by motor vehicles, are shown to be basically unsatisfactory, though some negative behavior patterns have been modified by the provision of such lanes. The need to acquire accurate before and after data is discussed, as is the need for planners and designers to develop knowledge of good bikeway design. The way to acquire a sensitivity to bicyclists' needs and behaviors is to ride a bike.

•DRAMATIC INCREASES in bicycle activity during the last few years have spurred a considerable effort to develop facilities for utility and recreational bicycle travel. To date, a significant number of bicycle facilities have been constructed and placed in use. Although these facilities generally have been greeted by the public and in technical literature with adulation, the actual usage experience has been one of mixed success and failure.

The roots of the problem lie in the incomplete state of current technical knowledge in the field of bikeway planning and design and the facts that most work to date has been dependent on the intuitive judgment and sensitivity of the individual planners and designers responsible and that each undertaking has been an independent trial-and-error experience.

This paper critically focuses on some recent failures in bikeway design not for the sake of criticism but in the hope of identifying pitfalls to be avoided and sensitizing planners and designers to the subtle factors that affect the functionality and acceptance of bicycle facilities.

BICYCLE FACILITIES

Independent Bicycle Path

An independent bicycle path is a cycle facility in its own right-of-way, entirely separate from (except for inevitable crossings) streets and highways. It includes facilities specially provided for bicycling in parks and forest preserves or along greenbelts, abandoned (and possibly operational) railroad rights-of-way, service roadways in utility

rights-of-way, drainage and irrigation canals, and flood control levees.

Independent paths can be particularly attractive and effective for both recreational and utility riding. Independent paths are especially effective for utility riding when greenbelt paths are designed to penetrate neighborhood areas and provide accessibility independent of the motor vehicle roadways as has been done in new town and planned community developments. A frequent problem with the design of independent paths is that they are deficient in meeting bicyclist needs. Historically, the design of trails in parks and greenbelts has focused on pedestrian considerations and the trail as a feature of the landscape. Unfortunately, this has led to facilities with grade profiles, curvatures, sight distances, pavement widths, and pavement surfacing inappropriate for use by bicyclists. Fortunately, this problem is being resolved as literature on functional bikeway planning becomes available.

A more serious concern relates to the use of corridors of opportunity as rights-of-way for independent pathways. In many cases, corridors such as levees, utility line maintenance paths, abandoned rights-of-way, and the like afford unique opportunities for the creation of independent pathways. A number of bikeway facilities have been constructed in such corridors simply because the right-of-way was available, but there has been little regard for the potential usefulness of the ultimate facility. The cost of independent path facilities is generally of such magnitude that, if the funds were devoted instead to the construction of bypasses to bike travel barriers or links providing bikeway system continuity, significant results could be achieved. When considering an independent right-of-way opportunity, planners must answer the key questions that they have too often failed to address.

1. Does this corridor constitute an attractive place to ride a bicycle as a specific activity, or does it provide a useful transportation linkage for utility bicycling?
2. Is the corridor located in sufficient proximity to population centers that a level of facility use can be anticipated that reasonably justifies resources devoted to its provision?
3. Does the corridor offer sufficient benefits to safety or the bicycling environment to justify incremental cost over that of placing a facility in a parallel roadway corridor?

If these questions can be answered affirmatively, then an independent bike path is a reasonable choice for providing a recreational opportunity or a transportation linkage. Independent bike paths when properly sited are valid treatments and not wasteful extravagances, but the following questions of priority must still be addressed.

1. How do the needs for and potential benefits of this project compare with those associated with other potential projects within the jurisdiction?
2. Is this opportunity perishable, or will it remain a future possibility if currently available funds are used for other bikeway projects?

Too many planners are not asking themselves questions like these but are blindly attempting to seize available independent path opportunities. Until we begin to appraise opportunities with a critical eye, we will continue to build white-elephant bike paths and to divert funds from potentially more needed or useful facilities.

Sidewalk Bikeway

A sidewalk bikeway is a bike path that is within the road right-of-way but off the motor vehicle traveled way and that may or may not be used by pedestrians as well as bicyclists. Considerable unsatisfactory experience with sidewalk bikeways is now being reported. The reasons for this are quite evident.

1. At driveways the sight distances and visibility relationships are often poor. Landscaping, shrubbery, and fences tend to impair sight distances at driveways. Compounding the problem are the poor visual relationships that result when motor vehicles

back out of and turn into driveways.

2. Poor visual relationships between cyclists and motorists also occur at intersections. The emergence of a high-speed bicycle (as opposed to pedestrian speed) into the crosswalk area is often unanticipated by motorists, particularly those completing turns.

3. Sidewalk bikeways tend to be used bidirectionally despite signs and markings to the contrary. Bidirectional operations compound the sight distance-visual relationship problems at driveways and intersections noted above.

4. Sharing space with pedestrians creates a number of problems. Pedestrians are extremely mobile directionally and often change direction unpredictably. This factor, coupled with the difference in travel speed (average travel speed for a bicycle is 3 to 4 times the average walking speed), leads to a high conflict potential. Small children often use sidewalks as play areas, and they, together with their toys, can constitute an obstacle course. Older pedestrians and blind persons are particularly uneasy at meetings with cyclists along sidewalks.

Besides these safety considerations are convenience factors, which of themselves are enough to lead cyclists to eschew sidewalk bikeways in favor of the street. Sidewalk surfaces are often cracked or broken and offer a poorer quality ride than the pavement of streets they parallel. Encounters with pedestrians are inhibiting even when hazardous conflict is not evident. At times, existing sidewalks, which are too narrow to function effectively when shared with pedestrians and are uninviting even when no pedestrians are present, have been pressed into service as bikeways. Up and down curb designs are extremely inconvenient.

For these reasons sidewalk bikeways should be used only under special circumstances. One such circumstance is the opportunity for or the existence of a sidewalk path along a roadway that is uninterrupted by cross streets or driveways for long stretches. Another is when the bikeway must be placed in a high-volume roadway corridor where all available street space must continue to be devoted to motor vehicle traffic (no possibility for elimination of parking or a traffic lane or no possibility for narrowing traffic lanes) and motor vehicle speeds along the street are significantly higher than the bike speed range. In each of these cases, great care must be taken in marking intersection crossings and ensuring good sight clearances.

The subject of ramps or curb cuts merits attention. If sidewalk bikeways are to be used, curb cuts at intersections are essential because the low-profile tires and rims standard on lightweight bikes now in predominant use cannot jump curbs as could the older balloon-tired bicycles. A number of jurisdictions concerned with the accident hazard posed at intersections by rapid emergence of bicyclists from the sidewalk into the crosswalk area have attempted to provide sidewalk bikeways and to retard bicyclist entry to intersection crossings by maintaining unbroken curbs. It should be no surprise that this contrivance generally does not have the desired effect. Bicyclists, like most human beings, normally follow the path of least resistance, and, when they encounter barriers such as this, they do the natural thing: avoid the sidewalk facility completely and use the street.

Some jurisdictions have attempted to create makeshift ramps by placing small wedges of asphaltic materials in the gutter against the curb. The problem with this type of approach is that such ramps frequently still provide too abrupt a transition and still lead to potential tire and rim damage and pedal scrape, which may cause nasty spills. There are also problems with more formally constructed ramps. Some jurisdictions have attempted to retard cyclist entry to the crossing area in a more subtle way by offsetting the ramp a few feet from the direct line of the sidewalk. Unfortunately, this causes the cyclist to be involved in a turning movement while on the ramp, which can also lead to pedal scrape and spills. Moreover, for some cyclists the slight inconvenience involved in using the offset ramp is sufficient cause for them to forgo use of the sidewalk facility. One jurisdiction's well-intended effort in this vein is worthy of note. To reinforce the retarding effect of the offset, the ramp provided was made extremely narrow (about 1 ft, 0.3 m) and framed by vertical sides. Contrary to what the designer anticipated, cyclists who continued to use the sidewalk facility became so

preoccupied with negotiating the narrow curb ramps that they became oblivious to the hazards of crossing motor vehicle traffic.

Inadequate width is a common deficiency in many types of sidewalk bikeway ramps. If all such curb breaks were constructed to at least the 4-ft (1.2-m) minimum operating space for bicycles, they would have the added value of being useful for wheelchairs, baby carriages, and shopping carts.

Signed Routes and Bike Lanes

Signed routes are streets or sequences of streets marked by signs denoting them as a bike route but with no other facility provisions for bicyclists. Typically, many jurisdictions have used the signed bike route as the first step in attempting to deal with the bicycle activity boom. Bike route signs may be the product of earnest efforts to indicate to cyclists utility routes with continuity to activity centers and low traffic volume or desirable grade profile. Or they may indicate recreational routes having scenic views and continuity to points of touring interest and recreational facilities. Although a limited measure of safety may be afforded when motorists see bike route signs and are alerted to anticipate cyclists, signed routes do little to ensure bicyclist safety. Moreover, signed routes have been used as a temporizing device that creates an illusion of positive action by public officials who are unconvinced of bicycle facility needs, uncertain how to implement more advanced facility treatments, or simply anti-bike.

Signed bike routes do have some utility in providing guidance to touring cyclists. However, their limited overall usefulness in urban and suburban system contexts is illustrated by the experience of Palo Alto, California, in the late 1960s. In 1967 Palo Alto implemented a 27-mile (43-km) signed bike route system (15 percent of the city's street miles) as a 1-year test demonstration. Results of this demonstration program were indicative of the inadequacies of the signed route system. In a survey of Palo Alto cyclists, more than 65 percent of respondents reported that they seldom or never used the signed routes and, where usage was reported, it was most frequently incidental and coincidental rather than intentional. One reason that cyclists gave for not using the routes was that in many cases the routes did not serve desired activity center destination points. But, more important, cyclists simply were unwilling to ride out of their way to use a signed bike route that appeared to offer no obvious travel or safety advantages.

A bike lane is an on-street treatment in which separate motor vehicle and bicycle travel lanes are designated by signs and street markings. A significant amount of criticism of bike lanes is now being heard because of experiences with the bad facilities that have been provided in many areas. This often happens when the planning process consists of designating as a bike lane whatever roadway space is left over after motor vehicle needs have been met. The result may be lanes too narrow for satisfactory riding because of either inadequate basic width, unridable quality of the surface in the lane area due to broken pavement or a poorly matched pavement-gutter pan joint, or site obstructions such as gaping drainage grates that narrow the effective width. A more serious situation caused by thoughtless planning results when a seemingly adequate bike lane suddenly terminates or leads the bicyclist into a point of hazardous conflict. Poor maintenance is another problem. When sand, gravel, bits of broken glass, weeds, other debris, or puddles or standing water are allowed to accumulate in bike lanes, the facilities become useless. These are not basic faults of the bike lane concept; they are the result of bad planning and poor follow-through on the part of individuals. But they have a tremendous impact on bikers who not only experience the hazards due to deficient facilities but also encounter hostility of motorists and occasional harassment of enforcement personnel when they quite reasonably choose to avoid the facilities. The problem here is a lack of sensitivity on the part of the planners and designers to the subtleties that are so critical to the success or failure of the bicycle facility. Probably more harm than good is done when a traffic engineer decides that bike lanes are a

cure-all and that the way to build them is to stripe the portion of the roadway not required for motor vehicle travel or parking as a bike lane.

Are bike lanes effective treatments? Recent technical literature and some bicycle spokespeople have posed this question. It is true that the forms of midblock accidents, particularly sideswipe and rear-end bike-motor vehicle collisions, which appear to be the principal types of accidents bike lanes would minimize, compose a very small percentage of total bike-motor vehicle accidents. However, the argument that, because these types of accidents are such a small portion of the problem, bike lanes have little safety value does not logically follow. For this ignores the fact that bike lanes may have positive effects on behavior patterns that have been identified as causal factors in other types of accidents. For instance, riding against traffic has been identified as a significant causal factor in midblock and intersection bike-motor vehicle accidents. And provision of properly marked bike lanes has been demonstrated to have significant effect in decreasing wrong-way riding. In Santa Clara County, California, before and after observations on three bike lane facilities showed a 21 percent decrease in wrong-way riding during a period in which total bike traffic increased by 50 percent. In other words, against-traffic riding dropped from 25 to 13 percent of total bike activity when well-marked bike lanes were provided. This is only one example of how provision of bike lanes can induce behavior pattern modification to reduce behavior that causes accidents. Behavior modification must be viewed as a benefit of bike lanes; the limited view that bike lanes only affect sideswipe and rear-end collision incidence is not correct.

A real problem in evaluating the performance of bike lanes is the lack of convincing before and after accident experience data. One part of the problem lies in obtaining statistically significant data on accident incidence and causal factors in true before and after situations. A second stumbling block is the growth in bicycle activity. Some studies have attempted to account for the increased accident exposure rate resulting from increased bicycle and motor vehicle traffic, but this is done purely on the basis of the changes in traffic volume. What is not accounted for is the fact that the composition of the bicyclist population has changed as a result of its growth; a higher percentage of less experienced and presumably more accident-prone bicyclists are now on the road than before.

A third problem in assessing before and after data relates to the particular circumstances under which they were generated. If the data indicate a failure of the bike lane to improve accident experience, is this indicative of failure of bike lanes in concept or does it reflect specific deficiencies in the design or maintenance of the facility under consideration? Are the individual facilities simply bad bikeways suffering the types of faults discussed earlier? Too often cold statistics are used to condemn a concept without consideration of whether the test facilities constitute a good representation of that concept.

BIKEWAY PLANNING

The most obvious faults of bikeway planning and implementation activities to date are (a) design and construction of individual bikeway segments where opportunities are available rather than in a systematic framework, (b) leaving gaps in what should be continuous facilities, and (c) placement of facilities on tortuous routings and avoidance of areas where solutions are difficult or involve high (relative to other bicycle facilities) capital costs. Without question, more effort must be devoted to developing means for safe and convenient bicycle passage through the bottlenecks and barriers to bike travel that are a feature of urban areas. Planners and designers have been guilty of devoting a vast portion of their attention to providing linear segments of bikeways that have low costs, pose minimal implementation problems, and have high visibility, all of which have maximum public relations value. There has been considerable reluctance to deal with problem spots where construction costs are substantial or where other impediments to implementation are encountered. The results are fragmented bikeway systems that fail to provide areawide accessibility or even linear continuity and a failure to deal

with locations where bike travel is most hazardous or is completely obstructed. This does not imply, as some have contended, that linear bike facilities are unnecessary and that efforts to provide them should cease. It is simply an indication that more effort and a willingness to bridge the bikeway gaps where solutions are costly and there are obstacles to functional design and implementation are needed.

The most critical need is for planners and designers to develop a solid working knowledge of the principles of good bikeway design, a sensitivity to the subtle factors that affect bicyclist behavior, and a commitment to dealing with bikeways as part of the total transportation picture, not as an afterthought, a nuisance, or a public relations gimmick. Public demand for good bicycle facilities and increasing availability of technical literature are helping to resolve the problem. However, professionals working in the field tend to have a perspective shaped by training and experience dealing with motor vehicles and pedestrians. Although there are many parallels, bikes and bicyclists are quite different from motorists, motor vehicles, and pedestrians, and the designer is not likely to develop a sensitivity to the implications of these differences and to the often subtle factors affecting bicyclist behavior and the functional effectiveness of bicycle facilities without experiencing them from a bicyclist's perspective. Riding a proposed route on a bicycle brings details important to the cyclist to the designer's immediate attention—details that might be overlooked in a windshield tour and not even contained on a plan map.

The bikeway planner must be conscious of typical cyclist behavior patterns, particularly the tendency to rationalize and trade off safety for convenience and maintenance of momentum and the tendency to be less scrupulous in observing certain traffic ordinances and to avoid unnecessary grade climbing and out of direction travel. Cyclists will not go wherever the planner might find it convenient to place bicycle facilities unless these facilities offer obvious advantages over travel in mixed traffic. Cyclists consider themselves legitimate roadway users and reject facilities that provide inferior treatment.