Listening to Bike Lanes: Moving Beyond the Feud

by Jeffrey A. Hiles, 1996

Abstract

One group of bicycle advocates insists that cities need special facilities to separate bicyclists from motor traffic and make cycling less intimidating. Another group argues that such an approach compromises bicyclists' safety by putting riders at odds with traffic, and that the best way to help cyclists ride safely and confidently is through cyclist training. In recent years, many in the first group have embraced bike lanes as their preferred type of facility. The second group rallies around a League of American Bicyclists' training program called Effective Cycling.

This paper critically reviews the claims of advocates on each side of this controversy and finds that what passes for hard fact is often conjecture and exaggeration, including assertions about car-bike crashes, and the potential of both bike lanes and education to affect bicyclist safety and behavior. In an effort to find a less one-sided viewpoint, the author employs concepts from the fields of cognitive psychology and environmental design to explore alternative ways of describing and explaining how bicyclists and motorists are influenced by the environments through which they move.

The author recommends steps that bicycle transportation advocates can take to help them move beyond simplistic beliefs that heat arguments over bike lanes: Move away from theories that equate bicyclists' skill and experience with their comfort in traffic, and toward a philosophy that respects as normal and natural a range of traffic tolerance. Realize that this "folk transportation" is guided by many intuitive factors and that advocacy philosophies that rely heavily on getting bicyclists to behave ideally are not in tune with this reality. Also, where bike lanes are employed, advocate the use of "hybrid" lanes and broken lines to encourage more fitting mental models of car-bike dynamics. Know that no single bike facility or program is a miracle cure. And finally, take a problem-solving approach to bicycle transportation planning and strive to enhance bicyclists' sense of

competence in getting where they want to go.

Disclaimer

This text is presented as I wrote it in 1996. I don’t intend to update it.

The opinions expressed here are mine and have no official connection to Wright State University.

-Jeff Hiles, February, 2002

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Chapter 1
The Problem: Bike Facilities and One-Eyed Prophets

It breaks your heart. You try your best to make the world a better place for bicycling. And what is your worst obstacle? It's not the entrenched motoring establishment, not skeptical planners and politicians, and not lack of public understanding and support. You find that your stiffest opposition comes from a most disheartening source: other bicycle advocates.

Different cyclists have different reasons for bicycling and different beliefs about what makes bicycling safe and fun. Some speed through city streets, keeping pace with heavy traffic. Some saunter along village sidewalks. Some prefer to drive their cars to the country or to a trail to ride where traffic is scarce. Some cycle solo, others join clubs and pedal in packs. Some ride for fun and exercise, others just to get somewhere. Being such a mixed lot, bicyclists naturally have their differences over how transportation planning should serve bicycling—and *who* it should serve.

Depending on your viewpoint, the Lycra-clad "advanced" cyclists represent the keepers of ultimate knowledge and wisdom about bicycling, or they comprise a cadre of athletic elitists who are out of touch with the wants and needs of the bicycling masses (in so far as there is such a thing as bicycling masses). Adherents of these opposing views have wrangled for decades over what to do, or not do, for bicyclists. The wrangling continues.

Bruce Epperson (1994), a senior transportation planner in Miami, Florida, says that the "elitists" who oppose facilities such as bike paths and bike lanes selfishly ignore those who need bicycle transportation most:

> Bicycle planning must return to an emphasis on specialized bicycle facilities. In the short and middle-term time frame, this is the critical factor. Only specialized facilities separated from the flow of motor traffic can accommodate the needs and wishes of those who bicycle because it is the only feasible method for them to

> increase their personal mobility. Safe and comfortable bicycle transportation (and yes, recreation) will be achievable only when the overall transportation system can accommodate cyclists of all abilities and strengths (p. 8).

If anyone is the voice of opposition to "specialized bicycle facilities," it's California engineer and bicyclist-education-manual author John Forester (1994), who disputes the idea that separated facilities are the best way to accommodate cyclists. The desire for bikeways, he contends, springs from a constellation of bogus beliefs and false fears, a kind of phobia even, that he has dubbed the cyclist-inferiority superstition:

> Most bikeways involve roadway prohibitions, encourage dangerous behavior by cyclists and by motorists, are poor to ride upon, and use space that should be used for roadway improvements, and all bikeways reinforce the superstition that cyclists should not ride on roadways if it is possible to ride elsewhere. Bikeway advocates are not motivated by admiration of bikeways as such; they want to get "everybody" cycling when "everybody" is frightened of riding on roads and acting like drivers of vehicles. The issue is not bikeways themselves; it is how best to arrange for cycling by deciding between two incompatible views...
>
> Society has not been an impartial judge between conflicting cyclists. Society, as embodied by the public, legislators, administrators, and even many scientists, has always taken an active part by believing in the cyclist-inferiority superstition, even though that superstition has never been formally stated as a hypothesis or supported by data (p. 21).

Epperson, on the other hand, argues that the "society" of which Forester speaks, far from being partial to bikeway advocates, has been held hostage by an anti-bikeway clique:

> ...the (bicycle planning) field reacted to legitimate criticisms of its early shortcomings by embracing the position of its most extremist critics for reasons having little to do with the veracity of their arguments. As a result, bicycle planning now advances the interest of an elite minority of cyclists while it ignores the needs of the majority, including the young, the old, and especially the poor. It has adopted positions that have left it open to charges of racism, sexism, and classism. Worst of all, bicycle planning is ignored as irrelevant by the majority of municipal residents. A captive of special interests, it is no longer able to capture the imagination or stimulate the enthusiasm of the average citizen and tax-payer. In a time of increasing financial stress for cities and states, it may not survive the decade (p. 4).

For the would-be advocate, joining either of these camps could make bicycle transportation planning feel less messy: the ends, means, friends, and enemies become more clear when you religiously adhere to a narrow point of view. Strength flows from clear vision. Yet it seems that both sides are spinning their wheels, arguing the same points decade after decade, and making the collective vision for bicycling far from clear. At various times, in various places, one side has spoken louder than the other and seemingly won out; but the feud goes on. While individual advocates draw sustenance from hardened convictions, bicycle advocacy as a whole suffers from in-fighting and presents a divided front that confuses outsiders.

One reason bicycle planning is so messy is that, like many technologies, nearly every type of bicycle facility has both good and bad attributes. Neil Postman (1993) has examined how we, as a culture, have trouble dealing with technology's dual nature:

> Every technology is both a burden and a blessing; not either-or, but this-and-that.
>
> Nothing could be more obvious, of course, especially to those who have given more than two minutes of thought to the matter. Nonetheless, we are currently surrounded by throngs of zealous ... one-eyed prophets who see only what new technologies can do and are incapable of imagining what they will *undo*.... They gaze on technology as a lover does on his beloved, seeing it as without blemish and entertaining no apprehension for the future. They are therefore dangerous and are to be approached cautiously. On the other hand, some one-eyed prophets ... are inclined to speak only of burdens ... and are silent about the opportunities that new technologies make possible.... For a bargain is struck in which technology giveth and technology taketh away. The wise know this well, and are rarely impressed by dramatic technological changes, and never overjoyed (p. 5).

The goal of this paper is to look at bicycle facilities with both eyes open. It is not to choose sides, but to treat various viewpoints as windows, each with its own revelations and limitations.

In *Listening to Prozac*, Peter Kramer describes insights into depression and the biochemistry of the human mind that the medical community has gained from patients who have been put on Prozac, despite the ethical controversy surrounding that popular antidepressant. Like Prozac, bike lanes have been described as immoral emotional bandages that remove incentive for true knowledge and healing. Also like Prozac, bike lanes have been heralded as minimum-side-effect wonder remedies for all sorts of illusive ailments. In the spirit of *Listening*, I have tried to step out of the bike-lane fray to see what insights we might gain from our experience with these popular facilities.

To be as fair to the reader as possible, I will say right here and now that I am not an impartial observer of the bike lane saga. I am wary of bike lanes, to say the least. Nevertheless, I recognize that, as Postman puts it, "it is inescapable that every culture must negotiate with technology, whether it does so intelligently or not." This paper is a quest for intelligent negotiation.

The next two chapters look at some of the car-bike crash statistics that people use to paint scientific-sounding facades on their arguments. The chapters after that cover bicyclist behavior. One describes what some prominent bicycling advocates consider to be ideal behavior. The other shows the ways cyclists more commonly get around in the real world. Next, a brief introduction to environmental design concepts precedes two chapters that examine the ways that physical settings affect bicyclist behavior and motorist-bicyclist interactions; the second of these chapters focuses on bike lanes and alternative bike lane designs.

The final chapter summarizes conclusions drawn from the preceding chapters and includes a list of recommendations for bicycle transportation advocates and planners. These are philosophical recommendations, not warrants for what kind of facility to use where. This is not an engineering guide, but rather a guide to help advocates and planners come to terms with the complexities and contradictions of bicycle transportation and to avoid the seductive, yet simplistic, path of the one-eyed prophet.

This paper mostly discusses issues related to bike lanes. But I intend that these issues illustrate a larger topic: the many ways in which bicycle transportation advocates, planners, engineers, and researchers fall prey to one-eyed beliefs. Perhaps because the bicycle seems like a most simple vehicle, perhaps because the act of bicycling is widely regarded as the quintessential example of something that learned once is learned for life, perhaps because of human nature not at all unique to bicycling, for some reason there seems to be a strong tendency among people who get involved in bicycle issues to want to reduce the entire field to a few simple solutions, often to a *single*, simple solution. I intend to show that bicycling's simplicity is an illusion, that integrating bicycles into a environment dominated by fast and powerful motor vehicles is complicated business. My hope is that by seeing how even so-called experts on bicycle transportation limit their perspectives with dogmatic blinders, the reader will more likely approach bicycle issues with a fresh and open mind. In the end, this paper describes the state of our current understanding of bicycle issues. Those who want concrete solutions to specific problems may be disappointed to find that this paper is more about questioning answers than answering questions. I believe that the most important step toward moving beyond one-eyed prophecy is to realize that many bicycle transportation questions are far from closed.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) has compelled transportation planners to give more weight to bicycle issues. This has created new opportunities for planning and funding bicycle facilities. But it has also made squabbles between bicycle advocates more public. At the same time, it has brought more non-bicyclists and more less-experienced bicyclists into the arena. I believe we will need minds that are not fettered by one-eyed dogma if we wish to make the best of the resulting cacophony of ideas. The alternatives are a bicyclist community so fragmented that it carries little clout or spawns projects planned and implemented with tunnel vision.

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Chapter 2
Car-Bike Crashes 1
Those Bothersome Bumps From Behind

The kind of separation between cars and bikes provided by bike lanes and next-to-the-road bike paths helps keep motorists from bumping into bicyclists' back ends. However, these facilities do little to prevent the numerous kinds of collisions caused by the crossing and turning movements of both bicyclists and motorists. Bikeway critics, therefore, question whether overtaking motorists are enough of a threat to justify the effort to separate bikes from cars, considering that there may be side effects, such as hindering bicyclists' movements and making crossing and turning more difficult, or even more frequent. This chapter will put through the ringer what we know about bump-from-behind collisions in hopes of squeezing out a reasoned understanding of these controversial car-bike crashes. (For convenience, I will use "car" to refer to any kind of motor vehicle.)

John Forester (1994) argues that you can get a clear answer to the overtaking-risk question by looking at crash statistics:

> These show that many more car-bike collisions (about 95 percent) are caused by crossing and turning maneuvers from in front of the cyclist than are caused by the car-from-behind-a-lawful-cyclist collisions that worry cyclist-inferiority believers so much. Furthermore, car-bike collisions are only about 12 percent of all accidents to cyclists. This combination makes the car-overtaking-a-lawful-cyclist in urban areas in daylight (which is the type of accident used to justify transportational bikeways) only about 0.3 percent of total accidents to cyclists (pp. 10-11).

Kenneth Cross (1978), whose bicycle crash studies form the foundation for many of Forester's arguments, paints what seems to be a different picture when he describes what he calls "Problem Type 13," in which an overtaking motorist fails to see a bicyclist until it's too late to avoid a collision:

> Although seven other problem types occurred more frequently than Problem Type 13, this problem type must be considered one of the most important because it accounted for nearly one-fourth of all fatal accidents in the sample–three times as many as any other problem type (p. 72).

So we have on the one hand an analysis that says the overtaking risk is negligible, and on the other hand an analysis that characterizes the overtaking collision as the most deadly of all car-bike crashes. A clearer picture emerges when we look more closely at Type 13 crashes and, first, at the study from which these statistics came.

The Cross-Fisher study

Cross and Gary Fisher published the results of their landmark car-bike crash study in 1977. They had gathered police reports describing 166 fatal and 753 non-fatal car-bike crashes from four areas in different parts of the United States: Los Angeles, California; Denver-Boulder, Colorado; Tampa-Orlando, Florida; and Detroit-Flint, Michigan. After undertaking the monumental task of visiting crash sites and interviewing participants, the researchers sorted the crashes into 37 different problem types, grouped into seven general classes (Cross, 1978, p. 25).

Class D consists of five motorist-overtaking-bicyclist crash types. Among these, Type 13 makes up a very high portion of bicyclist fatalities, is arguably the most feared of all accident types, and has therefore been studied very thoroughly. Because of that, and since fear of this motorist-overtaking-unseen-bicyclist crash type is both a strong motivation for advocates of separate bicycle facilities and a major target of those who oppose such facilities, this discussion focuses mainly on Type 13.

Fatal versus non-fatal crash reporting

The difference between fatal and non-fatal crash reporting is an important part of the picture. As we will see, fatalities give us a sense of how destructive different crash types tend to be. Non-fatal crash statistics show us the relative frequencies of different crash types.

Another difference between fatal and non-fatal crashes is that we have a complete record of fatalities, but a great many non-fatal crashes go unreported. Cross estimated that at least two thirds of all car-bike collisions are not reported to police, even though more than half of those unreported crashes inflict injuries "severe enough to require some form of medical treatment" (p. 16).

This raises the question of whether the one third of non-fatal crashes that get reported accurately represent the total crash picture. Bicycles with severe injuries, for example, have more incentive to report crashes than cyclists with slight scratches or no injuries at all. So unreported injuries may be less serious on average than reported injuries. It is possible, then, that crash types that tend to produce more serious injuries would be over represented in the crash reports. There is nothing wrong, though, with being more concerned about crashes that do more damage. For practical purposes, then, we should be well served by the picture of car-bike collisions we get from looking at those that do get reported.

Perspective: 1993 U.S. car-bike crashes

To be more concrete, in 1993 car-bike collisions in the United States killed 814 bicyclists; this we can say with confidence. Also, there were some 65,000 *reported* non-fatal car-bike injuries (National Highway Traffic Safety Administration, 1994, p. 129). Perhaps more than 130,000 car-bike collisions went unreported. So fatalities made up 1.2 percent of reported car-bike collisions and perhaps less than 0.4 percent of all car-bike collisions.

The non-fatal statistics, then, represent about 99 percent of all car-bike collisions and give us the best picture by far of the relative frequencies of different crash types. The fatality percentages, when compared with the non-fatal distribution, give us an idea of the relative destructive capacities of the crash types. We can say, for example, that Type 13 crashes in the Cross-Fisher study are relatively infrequent; they make up a small portion of non-fatal crashes. But when they do happen, they are much more destructive than most; they make up a significantly larger portion of fatalities.

If the Cross-Fisher statistics were accurate for 1993 car-bike collisions, we would expect to see about 200 deaths from Type 13 crashes and about 2,600 non-fatal Type 13's, perhaps 7,800 if you include unreported crashes.

Of *all* 1993 car-bike collisions, fatal and non-fatal combined, Type 13 would make up 4.3

percent of reported crashes and perhaps 4.1 percent of all crashes including those not reported. *Fatal* Type 13 crashes would make up 0.3 percent of all reported car-bike collisions and perhaps 0.1 percent of all crashes, counting those not reported.

It is important (and scary) to realize that nearly one fourth of all bicyclists killed by cars were hit by overtaking motorists who did not see them. But it is also important to keep in mind that those overtaking fatalities account for a fraction of a percent of all car-bike collisions. Although non-fatal injuries, especially those involving brain injury, can be as tragic as fatal injuries—perhaps worse.

Table 1

Estimated share of reported 1993 U.S. motor vehicle-bicycle crashes for Cross-Fisher Problem Type 13: motorist overtaking, bicyclist unseen.

	Non-Fatal	**Fatal**	**Total**
Total reported car-bike crashes, all types	65,000	814	65,814
Estimated Type 13 (4% non-fatal, 24.6% fatal)	2,600	200	2,800
Estimated Type 13 percentage of total reported crashes	3.95%	0.3%	4.3%

Sources: Cross, 1978 ; National Highway Traffic Safety Administration, 1994

Other overtaking crash types

In addition to Type 13, in which the motorist did not see the cyclist, Cross and Fisher named five other types of motorist-overtaking crashes, in which the driver *did* see the bike before the crash. These included Type 14, where the car was out of control; Type 15, where the cyclist swerved left to escape the overtaking car as the motorist swerved in the same direction in an attempt to avoid the bike; Type 16, where the motorist misjudged the space required to pass; Type 17, where the cyclist's path was obstructed, forcing the poor pedaler to either swerve into the path of the overtaking car or collide with the obstruction; and a category with no number labeled “motorist overtaking: type unknown.” Collectively, these make up “Problem Class D–Motorist Overtaking/Overtaking Threat.” Table 2 shows the Cross-Fisher statistics for Class D.

Table 2

Cross-Fisher Class D Car-Bike Crashes

	Fatal (N=166)	**Non-Fatal (N=753)**
Type 13: Bicyclist not observed	24.6%	4.0%
Type 14: Car out of control	4.2%	0.7%
Type 15: Counteractive evasive	2.4%	1.7%
Type 16: Motorist misjudged	1.8%	2.0%
Type 17: Path obstructed	0.6%	2.0%
Type unknown	4.2%	0.1%
Total Class D	37.8%	10.5%

Bike crashes with and without cars

Forester may be close to the mark in saying that cars play a part in only 12 percent of cycling crashes. Studies of emergency room-treated bicycle injuries indicate that motor vehicles are involved in 9.4 or 18 percent of these cases (Clarke & Tracy, 1995, p. 29; Stutts, Williamson, Whitley, & Sheldon, 1990, p. 71).

It does not follow, though, that we should only devote 12 percent of our bike safety concern to car-bike crashes. A Seattle, Washington, study found that half of all *serious* bike injuries involve motor vehicles. What’s more, 82 to 96 percent of bike-related *deaths* involve motor vehicles (Cross, 1978, p. 22; Rogers, 1994, p. 10; Bicycle Institute of

America, 1993, p. 6). On average, then, car-bike collisions tend to inflict worse injuries than bike crashes that don't involve motor vehicles.

Unlucky Type 13

So, car-bike collisions are inordinately dangerous among all types of bike crashes, and Type 13 is inordinately deadly among car-bike collisions. It would appear that to wave off these overtaking accidents because they make up a small part of all bike crashes is like saying never mind the cobra as you walk through the snake pit because most of the serpents in there are garter snakes.

However, Type 13 crashes, like so many bicycle transportation issues, can't be accurately summed up with so simple a statement. A recurring theme throughout this paper is that the more you dig below the surface of bicycle issues, the more the picture changes—usually becoming more complex. Another part of the Type 13 story unfolds when you look at when and where this crash type most often occurs: at night and on rural roads.

Overtaking: a rural and nighttime problem

Cross reported that this motorist-overtaking category was the only crash type in his study where nighttime crashes out-numbered daytime ones. Nighttime crashes made up 71 percent of Type 13 fatalities, but only 30 percent of all fatal collisions. Also, 65 percent of non-fatal Type 13 problems were in darkness. In contrast, only 10 percent of non-fatal collisions of all types fell between dusk and dawn (p. 36). In more than 90 percent of the nighttime Type 13 crashes, the cyclists had no lights (Williams, 1993a).

According to Cross, "about 60 percent of the Type 13 accidents occurred on a narrow, 'rural-type' roadway with two traffic lanes and no ridable shoulder or sidewalk" (p. 72). This problem type made up half of rural car-bike fatalities, as opposed to just 10 percent of urban ones (Williams, 1993a).

To make a more general statement, two key factors in Type 13 crashes are poor visibility and narrow roads. This means, for one thing, that on some roads the risk of getting hit from behind will be higher than the Cross-Fisher average. It also suggests that a blanket statement which says that a particular crash type makes up X percent of crashes is simplistic and may not apply to a given road.

Speed kills

As we have seen, overtaking collisions make up an inordinately large portion of fatalities, even though they make up a relatively small portion of all collisions. This is easy to understand when you consider that such crashes are apt to involve higher speeds.

In the Cross-Fisher study, more than half of all fatalities were on roads with posted speed limits greater than 35 mph, even though less than 20 percent of all collisions occurred in that fast traffic (Cross, 1978, p. 40). A more recent study of fatal accidents in Victoria, Australia, closely matched these findings (Hoque, 1990, p. 4).

The United Kingdom Department of Transport has provided a more dramatic illustration of the difference speed makes. The department determined that when pedestrians are struck by cars traveling at 20 mph, only about five percent are killed and most injuries are slight, with 30 percent of the walkers left virtually unscathed. At 30 mph, though, 45 percent are killed and many seriously injured. Cars zipping along at 40 mph kill 85 percent of the pedestrians they strike (Bicycle Federation of America, 1993b).

Simply put, cars that are overtaking cyclists are more likely to be at full speed than, say, cars crossing and turning at intersections. The higher the speed the harder the impact, and the more damage done.

Where (not whether) overtaking is a problem

In a quote at the beginning of this chapter, Forester creates the impression that what he calls “bicyclist inferiority believers” base their bicycle facilities planning on a distorted and irrational fear of a type of crash that makes up “only about 0.3 percent of the total accidents to cyclists.” But in using this “0.3 percent” figure, Forester himself distorts the bicycle crash picture.

First of all, Forester waters down the statistics by including bike crashes that aren’t relevant to the bikeway discussion. Bicyclists rounding turns too fast, slipping on wet leaves, running into dogs and having other non-motor vehicle crashes have little to do with the wisdom or folly of bikeways.

The one exception is when cyclists mix with pedestrians on trails, an environment which may foster collisions between the two. Yet, Forester uses his “0.3” figure to argue against “bikeways” in general, which he defines as including not only “bicycle sidewalks or side paths,” but also “bike lanes that are part of the roadway,” a type of facility where car-bike collisions (and, perhaps to a much smaller extent, bike-bike collisions) are virtually the only germane types of crashes.

Second, Forester’s “0.3 percent” figure gives no more weight to a crash that’s likely to kill than to a crash that’s likely to cause a few cuts and scratches. Certainly any fall can be fatal, even a slip in the bath tub. Nevertheless, some ways of falling from a bicycle are more likely to cause serious injuries than others. As we have seen, it appears that the motorist-overtaking collision is on average the most destructive of all.

Third, Forester masks the overtaking problem by restricting his count to “urban” roads. To distinguish between roads they called “urban” and those they labeled “rural,” Cross and Fisher looked at the characteristics of the roads, not whether they were within city limits:

> Accidents usually were classified as rural if they occurred in an area where (a) the posted speed limit was 45 mph or more, (b) there were no curbs or sidewalks adjacent to the roadway, (c) street lights were not present at the intersections, and (d) at least 50 percent of the area within one-half mile radius of the accident sites was open. Cases that did not meet all four of these classification criteria were classified as urban.

By restricting the car-bike portion of his crash count to roads classified as “urban,” Forester is excluding many of the kinds of roads on which overtaking crashes are most likely to occur. He is even excluding some roads that are actually within city limits. With such an unusually dangerous crash type, it’s important to understand the dynamics of where it happens and why. Cross describes the setting of Type 13 crashes:

> About three-fifths of the rural accidents and about one-half of the urban accidents occurred on a narrow, two-lane roadway with no ridable shoulder. Thus, about 60 percent of the Type 13 accidents occurred on a narrow, “rural-type” roadway with

two traffic lanes and no ridable shoulder or sidewalk (p. 72).

Fourth, Forester says that "practically all Americans" are "totally misinformed about cycling in traffic" and as a result have phobic fears of the cars from behind (1994, p. 8). Assuming that is true, we would expect practically all Americans to do everything possible to avoid cycling on narrow, fast, hilly, winding busy streets. For the sake of argument, suppose that those streets pose a higher overtaking threat. Then we must ask this: Does the relatively low number of overtaking collisions mean only that there is little threat of that kind of accident in the street system, or do cyclists themselves keep the number of overtaking collisions low by staying away from streets where the threat is strongest? Fifth, to use Forester's own words, "there is no reasonable way to rank car-bike collision types in order of importance, because the order depends upon what kind of cyclist you are and where you are riding..." (1993, p. 268).

The Cross-Fisher statistics are stacked by the preponderance of crashes by children, whose cognitive skills are not as well developed as older cyclists'. The top children's crashes are caused by kids running stop signs and riding out of driveways (Forester, 1993, p. 269).

Moreover, few children in the Cross-Fisher study were involved in Type 13 crashes. The median age of bicyclists in these unlucky crashes was higher than it was for any but one other crash type. "Apparently," Cross wrote, "bicyclists younger than 11 or 12 years of age are not permitted to ride during darkness and in types of areas where Type 13 accidents occur" (p. 73).

The top crash types for adults, though, are not loaded with the kinds of simple, careless errors that children commit. Arguably, adult crashes better represent the inherent hazards of the cycling environment—as opposed to hazards of bad cycling. For adults on roads classified as "urban," Type 13 ranked seventh out of the 37 crash types, followed by Type 16, in which overtaking motorists saw the bicyclists, but misjudged and passed too closely.

On "rural" roads, Type 13 was the number-one crash type for adults, followed again by Type 16 (Forester, p. 269). Granted, in the lion's share of Type 13 crashes, the bicyclists had failed to make themselves visible with lights at night. Type 16, however, is also an overtaking problem, is number two for rural roads, and can't be blamed on anything as simple as lightless night riding.

So, although overtaking motorists are involved in a relatively small portion of bike crashes in general, some stretches of roadway have characteristics that contribute to a higher than average overtaking threat. When it comes to saying yea or nay on plans for bicycle facilities, it seems more effective to address problems of specific places than to adopt blanket policies as if all streets were the same.

A number of factors aggravate the overtaking threat:

High speeds

As we have seen, high speeds mean high impact, which means more severe injuries. In some cases speed might also increase the likelihood of overtaking collisions by decreasing the amount of time motorists have to see, recognize, and maneuver around bicyclists. Although this should not be a factor if motorists are traveling at speeds that suit the conditions, small hills and bends in otherwise straight roads can create blind spots.

Narrow lanes

Cyclists are more likely to be in the path of overtaking motorists when the lanes are narrow. With wide lanes, cyclists are more likely to be to the right of the danger zone.

Sight obstructions

Again, hills and turns limit how far motorists see down the road and decrease the amount of time motorists have to recognize and avoid bicyclists.

Night riding

This may not appear to be a design factor, since you can't control the sun. It may seem like more of a law enforcement problem: getting cyclists to use lights at night. But just a small red light, and in some places just a small red reflector, can satisfy the law without making a bicyclist all that conspicuous on the roadway. Also, bicyclists are not required to have lights on their bikes in the daytime. Few cyclists would want a law that requires them to load their bikes with lighting equipment at all times. But this means that bicyclists who never anticipated riding at night are not likely to have lights when the need for a night ride arises, such as when a meeting unexpectedly runs past dusk.

It would be great if every bicyclist who rode at night looked like a rolling Christmas tree. Certainly, the requirement to have lights at night is one of the most important bike laws that police can enforce for bicyclists' own good. But the advocate or bicycle planner whose town has a lot of nighttime cycling—a university town, for example—may find that facilities such as bike lanes, for example, reduce serious injuries on some roadways more effectively than trying to create a utopian society.

Alcohol/drug use

Alcohol was identified as a factor in a third of Cross and Fisher's rural Type 13 fatalities (Cross, 1978, p. 73). In a 1990s update of the Cross-Fisher study, "alcohol/drug use" was found to be an "over representation" for crashes involving bicyclists in adult age groups (Hunter, Pein, & Stutts, 1994, p. 10). The National Center for Statistics and Analysis (1994) also found that "alcohol involvement—either for the driver or the cyclist—was reported in more than a third of pedalcyclist fatalities in 1993" (p. 3).

Traffic volume?—Not necessarily

Heavy traffic would seem to be an obvious risk factor. It appears reasonable to assume that the more frequently a bicyclist gets passed, the more that bicyclist is exposed to the overtaking threat. But the relationship between traffic volume and crashes is not that straight forward. Wachtel and Lewiston (1994), for example, found no significant relationship between traffic volume and the risk to bicyclists crossing intersections (p. 32). Studies of motor vehicle crashes not involving bikes have even shown that accident rates are sometimes lower with increased traffic (Hall & Pendleton, 1990). This makes sense if you imagine a bicyclist riding urban streets at rush hour when both bicyclists and motorists are extra vigilant and careful because of the heavy traffic. In contrast, picture a cyclist without good lights and reflectors who is pedaling in darkness on a narrow country road. Because of the scarce traffic, a motorist would not anticipate encountering a bicyclist there and could crest a hill and find the cyclist just ahead with no time to react.

Garder, Leden, and Thedeen (1994) point to two more studies that support the notion that the number of “bicycle accidents at an intersection is proportional to the bike volume, but not very dependent on the motor-vehicle volume.” They speculate that “increased vehicle volumes make the cyclists more careful. At least the risk to cyclists would not increase in proportion to the vehicle-volume increase...” (p. 433).

Seat-of-the-pants profile

Putting this all together, we might expect an unusually high overtaking-crash problem on a road with speeds of 45 mph or faster that is narrow, two-lane, hilly, winding, and that connects university student housing with popular night spots in a community that has a depressed economy and therefore high alcoholism.

But “unusually high” is a vague assessment. How bad of a problem would overtaking crashes be on the rare road that fits that profile? How about on roads that fit parts of the profile? There are too many variables and there is too little information to give anything but an intuitive impression.

It is not even possible to clearly define the overtaking risk on “rural” versus “urban” roads. Cross-Fisher tells us that Class D accidents made up 10.5 percent of the total non-fatal sample, but 31 percent of the rural portion of that sample. They made up 37.8 percent of the total fatal sample, but 56 percent of fatalities on roads classified as rural (Cross, 1978, p. 71). This does not, however tell us about risk. Rural-type roads have far fewer intersections per mile than urban roads. So there are fewer opportunities for crossing and turning movements and we would expect these non-overtaking crashes to make up a smaller portion of the picture, even if the risk per mile of getting hit from behind was the same for both urban and rural roads.

Given two randomly-selected car-bike crashes, one rural and one urban, we can say that the chances of the rural one being an overtaking collision is higher than it is for the urban. But to determine the relative risks of riding on different roads, we would have to know how much bicycle traffic there was on the road for each accident in the sample. The data is not there to either confirm or deny differences in overtaking threat from one road to another.

Conclusions

We can say that motorists overtaking bicyclists accounted for 10.5 percent of the non-fatal crashes in the Cross-Fisher study, so that about nine out of 10 car-bike collisions involved crossing and turning movements. We can say that the dangerous Type 13, where the motorist didn't see the cyclist, made up only four percent of the non-fatal crashes. Furthermore, urban *daytime* Type 13's accounted for only one percent of the non-fatals. But how much does that tell us about the problems on a particular stretch of road? And how do we weigh the severity of crashes? How many cuts and scrapes equal a death?

The purpose of this chapter is neither to disparage Forester nor to exaggerate the overtaking threat. Rather it is to chip away at the illusion of certainty that numbers can create. We must use aggregate statistics with caution; they may mislead us when we make decisions about specific local problems.

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Please send comments to jeffrey.hiles@wright.edu.

Hiles, Jeffrey A. *Listening to Bike Lanes*. September 1996.

Chapter 3
Car-Bike Crashes 2
A Broader View

Figure 1

Differences in Cross-Fisher fatal and non-fatal distributions by class.

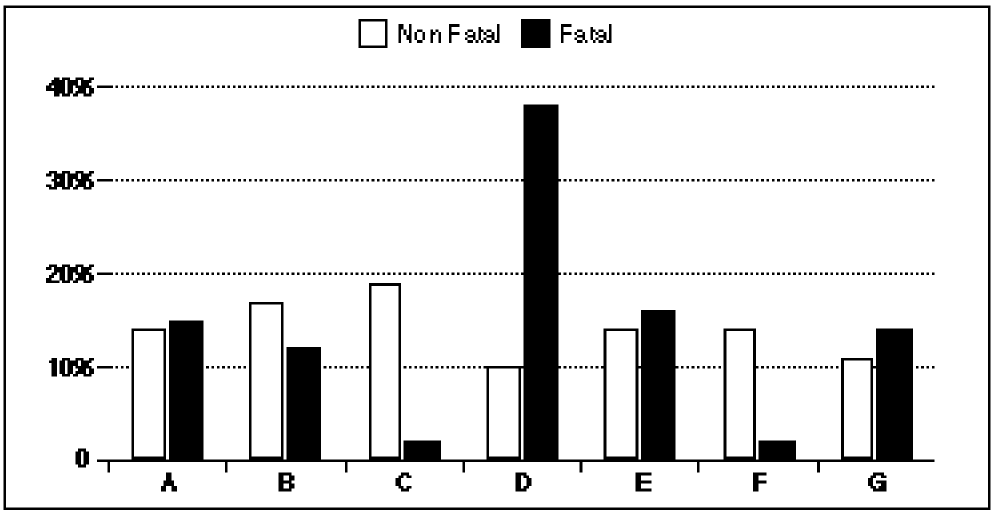
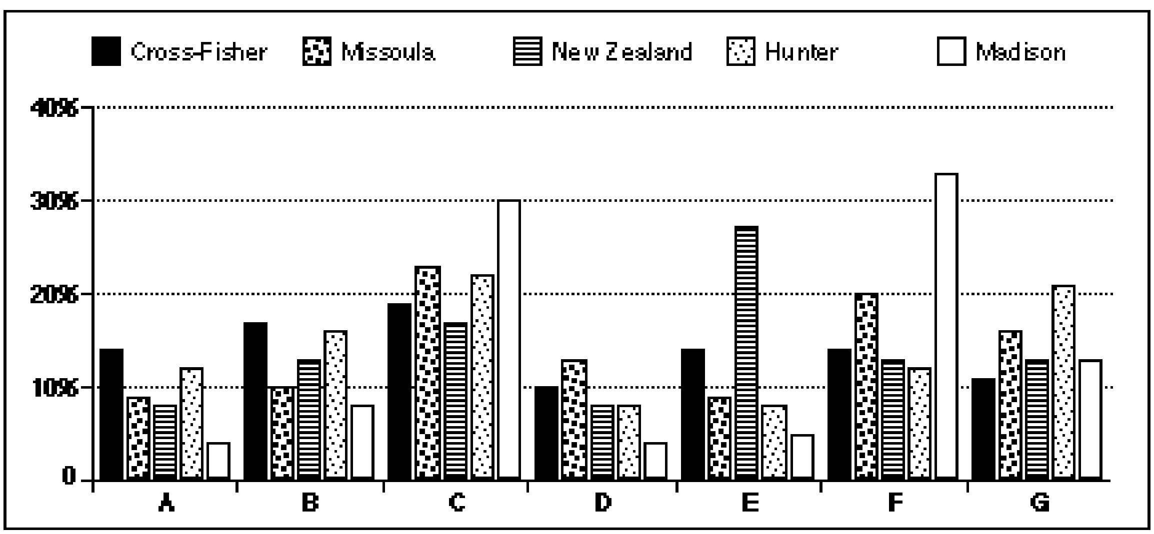


Figure 2

Non-fatal car-bike crash distributions from five studies, grouped by Cross-Fisher class.



Cross-Fisher Problem Class Descriptions

- **Class A:** Bicycle ride-out from driveway, alley, and other mid-block location.
- **Class B:** Bicycle rideout at controlled intersection.
- **Class C:** Motorist turn, merge, drive-through, drive-out.
- **Class D:** Motorist overtaking, overtaking threat.
- **Class E:** Bicyclist unexpected turn, swerve.
- **Class F:** Motorist unexpected turn.
- **Class G:** Other.

Sources: Atkinson & Hurst, 1983; Cross, 1978; Hunter, 1994; Ross, 1992; Williams, 1981.

Cross-Fisher compared with other studies

Cross and Fisher launched their pioneering report nearly two decades ago. Fortunately, over the years other researchers have used the same crash classification system, or customized versions of it, to study local and regional problems. So we can see if the original study findings hold up over time and in different locations.

Figure 2 compares the Cross-Fisher non-fatal crash statistics with those of four other car-bike crash studies. Several of the studies were too small to have a statistically significant sample of fatalities, so I have only compared non-fatal statistics. Of course, the non-fatals give the best overall picture of crash type frequencies, so this is not a serious shortcoming.

There are some other differences between the original study and those done since. For one thing, not many other researchers besides Cross and Fisher were able to visit the crash sites and interview participants. Relying on police reports alone may inject some errors. Also, most of the studies used classification systems that varied in some ways from Cross-Fisher. In an attempt to simplify and increase the accuracy of the comparison, I have used the seven broader categories that Cross and Fisher called “problem classes,” not the 37 more specific “problem types.”

Five other crash studies

Missoula, Montana (Williams, 1981): This study of 91 accidents from a two-and-a-half-year period found that the median age of bicyclists involved was higher in Missoula than in the Cross-Fisher study, reflecting the large number of adult bicyclists in this college town. Otherwise, the distribution pattern follows the Cross-Fisher study rather closely. Only one of the 19 Missoula cyclists involved in nighttime accidents had a light.

New Zealand (Atkinson & Hurst, 1983): Of the 550 non-fatal collisions studied in New Zealand, 8 percent were Class D overtaking crashes, not too far off from Cross-Fisher’s 10.5 percent. New Zealand’s sample of 142 fatal crashes contained 40 percent of type D, which compares to 37.8 percent in the U.S. study. The authors noted other similarities as well:

> It can be seen that the great majority of Type 13 fatalities occur under conditions of bad visibility or at night, often to unlit cyclists. Type 16 accidents (motorist misjudged space required to pass) do not occur at night; the same was true in Cross and Fisher’s study. This suggests that motorists who do see a cyclist at night leave plenty of room.
>
> In nearly all of the Type 13 accidents that occurred in full daylight the motorist’s attention had been diverted by some other activity such as dealing with a fly on the windscreen, picking up a dropped bottle, attending to a misbehaving passenger, or watching something on the other side of the road. The apparently common notion that otherwise-attentive drivers do not see cyclists from behind is not supported by the data. Probably the fact that motorists often fail to see cyclists in other accident situations has been extended in the public imagination to include overtaking accidents.

Class E (bicyclist unexpected turn/swerve) made up an unusually high percentage of crashes in this study. The authors speculate about a number of possible causes, including New Zealand’s narrow, poorly-paved roads; old traffic laws requiring vehicles to wait at the side of the road before turning right (the equivalent of turning left in the U.S., since New Zealanders drive on the left side of the road); and even the growing popularity of

BMX bicycles, which have an "image," the authors say, that could "encourage skylarking and swerving."

Hunter study (Hunter, Pin, & Stutts, 1994). This study classified nearly 3,000 bicyclist-motor vehicle collisions from the recent years of 1990 and 1991. The sample came from California, Florida, Maryland, Minnesota, North Carolina and Utah. A project of the University of North Carolina Highway Safety Research Center, this study found that adults make up a larger portion of the bike crash population now than they did during the Cross-Fisher study. Also, Class E is a little lower and Class G (the "other" category) is a little higher than in the Cross-Fisher study. Otherwise, the crash distribution follows the old classic very closely.

Unlike Cross and Fisher, Hunter and company did not seek out a separate statistically significant sample of fatal crashes. Of all the crashes, just 46 (1.6 percent) were fatal. To compare the relative severity of crash types, the researchers looked at the distribution of fatals combined with the 473 "serious" injury crashes in the sample. Once again, the motorist-overtaking class has the highest percentage of the worst injuries, although the differences between classes are not as dramatic as they are in the Cross-Fisher fatalities.

The two most frequent ways in which bicyclists contributed to causing crashes were "failure to yield" at 20.7 percent and "riding against traffic" at 14.9 percent.

Madison, Wisconsin (Ross, 1992). Madison is a college town with a significant network of bike lanes and bike paths. As one might expect, the Class D overtaking accidents among this sample of 774 bicyclist-motorist crashes is the lowest of any of the five studies—just 4.1 percent of the entire class.

Two other classes were unusually high, though: Class C (motorist turn, merge, drive-through, or drive out) and especially Class F (motorist unexpected turn). An on-coming motorist turning lift into the path of a straight-through cyclist made up a whopping 23.3 percent of Madison's crashes. In the Cross-Fisher study, this type of crash accounted for only 7.6 percent of the sample. In Madison, bicyclists traveling in a contra-flow bike lane on University Avenue made up 36 percent of the victims of this type of crash. A contra-flow lane runs against the direction of traffic. In this case, it runs down the left side of a high-volume, multi-lane, one-way arterial next to the University of Wisconsin. Motorists turning left off University Avenue cross the contra-flow lane. Motorists entering the avenue from side streets turn left across the contra-flow lane; their attention is focused on the motor traffic, which comes from their right, while the bicyclists come at them from the left.

One-eyed folks of either pro-bikeway or anti-bikeway persuasion may be tempted to draw unwarranted conclusions from Madison's unusual distribution of crash types. Pro-bikeway advocates might point to the fact that classes A, D, and E are all quite low (see Figure 2 on page 22), and that all of these kinds of crashes might be reduced by bike lanes and bike paths. Type A (bicyclist ride-out from driveway, alley and other mid-block location) may be reduced because bicyclists would ride onto a bike path or bike lane instead of into a car lane. Type D, of course, would be reduced because bicyclists would be separated from overtaking motorists. Type E crashes (bicyclist unexpected turn, swerve) would be reduced because bikeways make cyclists ride more predictably, or give cyclists room in which to "swerve" free of threat from overtaking traffic. Pro-bikeway advocates might say that classes C and F appear to be large, but that this is because bike facilities have reduced other classes to relatively small portions of the total. Even if C and F did increase, proponents might add, these two classes are the two least destructive–the fatality percentages are much lower than the non-fatal (see Figure 1). An increase in less destructive crashes may be a fair price to pay for a decrease in the more deadly ones.

Anti-bikeway advocates might point to Madison's inordinately large Class C and Class F and charge that these are crashes they would expect to see increase because of the bike paths and lanes. These facilities give motorists and bicyclists a tendency to pay less attention to each other, it might be argued, and "hide" bicyclists from view. Worse yet, they complicate crossing and turning interactions between cyclists and motorists. These critics might argue that bike facilities have made these crashes so inordinately common that other types are dwarfed and therefore make up a smaller than normal percentage of the whole, even though they may not be significantly reduced in number. It is not possible to tell from the Madison study whether the city has an unusually low accident rate for classes A, D, and E, an unusually high accident rate for classes C and F, or some combination of the two.

The one seemingly solid specific problem, the University Avenue contra-flow bike lane, is not so cut and dried either. We might expect bicyclists riding against traffic to have a higher risk of tangling with motorists. Motorists tend to pay most attention to the primary flow of traffic: other motorists. Bicyclists whose movements don't match the patterns of motorists on a roadway risk eluding motorists' awareness. Wachtel and Lewiston (1994) found that bicyclists crossing intersections while riding on the wrong side of the street were twice as likely to collide with cars as right-way cyclists. They also found that wrong-way cyclists riding on sidewalk-like bike paths were about four times more likely to clash with cars while crossing intersections than were those riding with traffic.

A contra-flow lane would seem to be a mistake. University Avenue, though, is a major route to the university. Many bicyclists would have to expend extra time and energy if they took an alternative route. As a result, Madison would probably see a lot of wrong-way bicycling on that road, even without the contra-flow lane. Those bicyclists might be at an even higher risk without the bike lane. Moreover, University Avenue has a high volume of both motor and bicycle traffic, so there are more opportunities for car-bike collisions than on most streets, and we would expect higher numbers of crashes there than on less-traveled roads. Once again, we can't tell from Cross-Fisher-style studies whether bicyclists have higher or lower risks per mile in different locations.

The one thing we can say with confidence is that crash types in Madison appear to differ from the typical American city's. Without more information, we cannot say for sure why there is a difference. It could be from bike facilities (for better or worse), from the city's unusually large number of adult cyclists, from peculiarities in the street patterns of the city, or from any combination of these or other factors. We can't even say if the difference we see is for better or for worse. If we saw Madison-like distributions in other towns with similar networks of bike lanes and paths, we might conclude that the facilities were a factor, but even this would not tell us if they were a good factor or bad, only that they had made a change in the relative distribution of crash types.

Table 3

Five crash studies compared

	A	**B**	**C**	**D**	**E**	**F**	**G**
Cross-Fisher	13.9	17.0	18.7	**10.5**	14.2	14.5	11.2
Missoula	8.9	10.0	23.3	**13.3**	8.9	20.0	15.6

New Zealand	8.0	13.0	17.0	**8.0**	27.0	13.0	13.0
Hunter	11.8	16.0	22.3	**8.5**	8.4	12.1	20.9
Madison	3.8	8.3	29.8	**4.1**	5.1	33.4	23.3
Average	*9.3*	*12.9*	*22.2*	***8.9***	*12.7*	*18.6*	*16.8*

Sources: Atkinson & Hurst, 1983; Cross, 1987; Hunter, 1994; Ross, 1992; Williams, 1981.

The overall pattern

The slight differences in the results of these five studies provide material for some interesting speculation. But it's the similarities that are most significant. All of the studies reveal the same general crash patterns. Most notably, overtaking crashes are relatively infrequent. One possible explanation is that the motorists who come from behind you when you're bicycling usually have plenty of time to see you long before they reach you, so they have plenty of time to avoid you. What's more, an overtaking motorist is following a path parallel to yours, several feet to the left in most cases—and parallel lines don't meet.

Most often, the danger lies where the bicyclist's and motorist's paths cross suddenly, catching both parties by surprise, and leaving too little time for either party to avoid impact.

Another possible explanation for the low number of overtaking collisions is that, as noted earlier, bicyclists fear and avoid roads where the overtaking threat seems greatest. Given that overtaking crashes are the most destructive types, this fear would not seem totally unfounded. If this is a factor, it may mean that bicyclists are not making full use of the road system. To put it another way, it may mean that the road system is not fully accessible to bicyclists.

Yet another factor that could contribute to the relatively low percentage of overtaking collisions is that the overall statistics are child-heavy. That is, two thirds of the Cross-Fisher non-fatal crashes involved cyclists 15 years old and younger (Cross, 1978, p. 28).

In general, children make more mistakes than adult bicyclists. Youngsters are especially prone to ride out of driveways or run stop signs without looking, crash types that stack the deck against overtaking types. Children also tend to stay more within residential areas where traffic is slower, so the overtaking risk is smaller. These neighborhood streets may also have frequent intersections, which may raise the likelihood of crossing and turning crashes. In contrast, for adults on rural roads, Type 13 overtaking crashes are the number one crash type, and Type 13 is number six among urban adult crashes. It should be said again, though, that this does not mean that adults on rural roads are more prone to overtaking crashes than kids on city streets. There are just fewer intersections in the country, so fewer intersection-type crashes. Also, keep in mind that most overtaking crashes, regardless of location, happen at night.

In any case, the crash report patterns show that it’s the motorists in front of cyclists, primarily at intersections, who are most likely to be involved in car-bike collisions—except, of course, when the bicyclists are riding without good lighting on narrow, high-speed roads at night. However, we cannot unequivocally conclude from this that overtaking crashes are inconsequential.

Table 4 shows the ten most frequent crash types in the Cross-Fisher study. The top seven, which together make up 52.9 percent of the crashes, are all crossing and turning types. But number eight out of the 37 crash types is unlucky Type 13, the leading cause of car-bike fatalities. So although the statistics tell us that overtaking crashes make up a relatively small part of all crashes, we can hardly tell planners and engineers to just disregard these bumps from behind.

Table 4

Top 10 Cross-Fisher crash types, all age groups

Class/Type	**Description**	**percent**	**cummulative percent**
B5	Bicyclist ride-out: intersection controlled by stop sign or yield sign	10.2	10.2
C9	Motorist failure to yield at stop sign or yield sign	10.2	20.4

E18	Bicyclist unexpected left turn, parallel paths, same direction	8.4	28.8
F23	Motorist unexpected left turn, parallel paths, same direction	7.6	36.4
A1	Bicyclist ride-out from residential driveway or alley	5.6	42.0
F24	Motorist unexpected right turn, parallel paths, same direction	5.6	47.6
C8	Motorist drive-out from commercial driveway	5.3	52.9
D13	Motorist overtaking, bicyclist unseen	4.0	56.9
A2	Bicyclist ride-out from commercial driveway	3.2	60.1
E19	Bicyclist unexpected left turn, parallel paths, opposite direction	3.3	63.3

Source: Cross, 1978.

Education and engineering: different needs, different outlooks

The bottom line is that a cycling instructor teaching a group of bike club members how to ride in city traffic can confidently say that by far the most frequent collisions are crossing and turning types and that urban cyclists have a relatively slim chance of getting rear ended as long as they don't ride at night without lights. On the other hand, planners and engineers can point with equal confidence to overtaking crashes as one of their main concerns. Overtaking crashes are the number one cause of bike-related fatalities—and fatalities make the news, spur people to action, and bring demands onto city officials far more than non-fatal crashes. Moreover, we must keep in mind that when traffic planners and engineers are pressured to take action to help prevent bike crashes, of all their engineering choices none are as visible to the public as bike lanes and paths, and these facilities are capable of reducing both overtaking collisions, which are the most deadly types, and bicyclist ride-out collisions, the most common type of car-bike crash for younger children (Wilkinson, et el., 1994b, pp. 24-25). In a later chapter we will see more clearly that crash statistics alone do not give us a complete picture of why planners, engineers, and bicycle advocates have reason to shape environmental design with the overtaking threat in mind.

Table 5

Cross-Fisher Type 13 crashes summarized

- 4.0% of non-fatal crashes
- 24.6% of fatal crashes
- 10% of urban fatal crashes
- 50% of rural fatal crashes
- Two thirds happened at night, 90% to cyclists without lights
- Nearly one third involved a drinking driver
- Half of urban Type 13's and three fifths of rural Type 13's were on narrow, two-lane roadway with no ridable shoulder.
- Number six adult urban crash type, out of 37 types.
- Number one adult rural crash type

Sources: Cross, 1978, pp. 71-72; Forester 1993, p. 269; Williams, 1993a.

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Please send comments to jeffrey.hiles@wright.edu.

Hiles, Jeffrey A. *Listening to Bike Lanes*. September 1996.

Chapter 4
Bicyclist Behavior 1
The Ideal: Vehicular Cycling

For the most part, motor traffic flows like a well-choreographed dance. Stop lights set a kind of rhythm. Each driver knows the steps and when to take them. Add bicyclists to the mix and some join the dance, flow with the motor traffic; others dart about like mice on a dance floor. This chapter and the next will explore different riding styles, with the aim of helping to explain why different bicyclists have such different feelings toward bicycle facilities.

Three things keep motorists in a reasonably orderly flow. First, each driver knows the dance and is compelled to stick to it or risk losing driving privileges. Second, there are lots of visual cues (signs, signals, and pavement markings) to help motorists along. And third, it is physically impossible for motorists to flout the rules of the road very much without crashing. So motorists know it's in their own best interest to follow the rules, at least generally.

For bicyclists, though, things aren't so clear. Unlike motorists, few cyclists have taken a drivers' training course designed specifically to help them use their vehicle. Since bicyclists are not required to pass tests before climbing onto their saddles, and since law officers in most U.S. cities pay little attention to bicyclist behavior, cyclists have less compulsion to follow formal rules of the road and obey the signs, signals, and pavement markings. Even if a cyclist does make an effort to comply with those visible cues, it is not so clear what they mean for bicyclists. A cyclist in a given traffic lane, for example, may have more options than a motorist. The car driver is either in the lane or not: the bicyclist takes up much less of the width of the road and may choose to ride on the right side, in the center, on the left side of the lane, or even down the wrong side of the road.

Generally, cyclists can squeeze through places where automobiles would never fit. So a cyclist has the choice–it's an unwise choice, an illegal choice, but a choice nevertheless–of riding on the wrong side of the street, for example, an act that would very soon bring a motorist to a halt. Add the task of making these choices to the difficulties of maneuvering through traffic that moves faster than you, throw in the physical demands of moving under your own power and keeping the bicycle balanced–bicycling in traffic can be more demanding than driving a car.

Drivers' training for cyclists

To help its members deal with the demands of the road, and to raise the status and safety of bicycling in general, the League of American Bicyclists has established an Effective Cycling certification program, sort of a bicyclists' equivalent of getting a driver's license. The program's text began 20 years ago when John Forester, a British-born industrial engineer living in California, copied notes for his adult cycling classes on a mimeograph machine he had used for cycling newsletters. The book *Effective Cycling*, which Forester has polished and updated over the years, is now in its sixth edition and is published by the MIT Press. The Effective Cycling program is taught by certified instructors across the country.

The Effective Cycling credo is that "cyclists fare best when they act and are treated as drivers of vehicles" (Forester, 1994, p.1). This guiding idea, which Forester calls the "vehicular-cycling principle," means that bicyclists should follow the five "basic principles of traffic cycling" outlined below.

Forester's "basic principles of traffic cycling"

- Drive on the right side of the roadway, never on the left and never on the sidewalk.
- When you reach a more important or larger road than the one you are on, yield to crossing traffic. Here, yielding means looking to each side and waiting until no traffic is coming.
- When you intend to change lanes or move laterally on the roadway, yield to traffic in the new lane or line of travel. Here, yielding means looking forward and backward until you see that no traffic is coming.
- When approaching an intersection, position yourself with respect to your destination direction–on the right near the curb if you want to turn right, on the left near the center line if you want to turn left, and between those positions if you want to go

straight.

- Between intersections, position yourself according to your speed relative to other traffic; slower traffic is nearer the curb and faster traffic is nearer the centerline (Forester, 1993, p. 246).

As you can see, these are not just principles for cyclists, they are the basis for the rules of the road that apply to all vehicles. This does not mean, though, that bicyclists should drive exactly like motorists. Both cars and bikes are subclasses of the broader category "vehicle" and, because they are different in speed and width, cars and bikes often use different parts of the roadway. In doing so, both modes are still adhering to the basic traffic principles. Vehicular cycling, then, is mostly a matter of joining the dance:

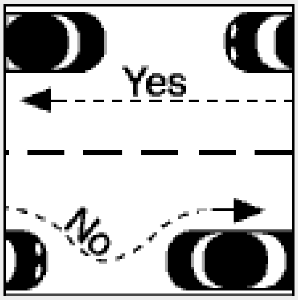
> There is much more to the vehicular-cycling principle than only obeying the traffic laws for drivers. The vehicular-style cyclist not only acts outwardly like a driver, he knows inwardly that he is one. Instead of feeling like a trespasser on roads owned by cars he feels like just another driver with a slightly different vehicle, one who is participating and cooperation in the organized mutual effort to get to desired destinations with the least trouble (Forester, 1994, p. 3).

With the aim of reaching that level of comfort, Effective Cycling students learn about accident statistics, so they have an accurate mental picture of traffic threats. Also, they're given detailed instruction in how and where to ride on the road, and they go through on-road training that gradually works up to more difficult riding conditions.

Figure 3 shows some basic steps to the vehicular cycling dance. (The illustration is not part of the official Effective Cycling literature, however.) This riding style emphasizes good communication between bicyclists and motorists. As an Effective Cyclist, you minimize conflicts by using signals, body language and road position—and, of course, by following standard rules of the road. You make sure other road users know where you are and where you are going.

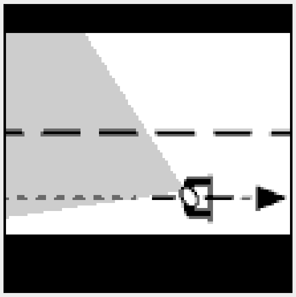
Figure 3

A vehicular cycling sampler



Ride a straight course.

Don't swerve between parked cars or you'll disappear behind a car, then surprise a motorist when you pop out into traffic again.



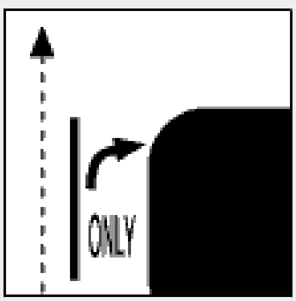
Look behind you.

Learn to quickly scan the traffic behind you without swerving.

Practice in an empty parking lot until it's easy.

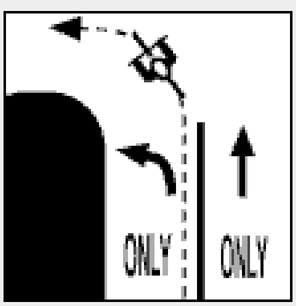
"Vehicular" left turn.

Signal and look behind you. When there's an opening, merge left and turn from near the center line. Important: Start moving over early, don't dart left at the last moment.



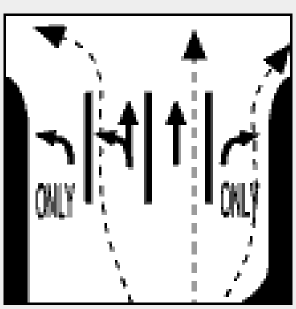
Right-turn-only lanes.

Use right-turn-only lanes only when you want to turn right. Cross an intersection from the through lane, not from a right-turn-only lane.



Left-turn-only lanes.

Turn left from the right side of a left-turn-only lane, if you have one. Or use the middle of the lane if it's narrow.



Multiple lanes.

Choose the right-most lane that will get you to your destination. If you're turning left, and the right-most left-turn lane is also a through lane, turn from the left side of that lane.

Although vehicular cycling is fairly simple in principle, it can get confusing and frightening for novices faced with complicated intersections or with having to make left turns in heavy traffic. It would be a bit much to expect a beginning cyclist to just read the traffic cycling principles then go out and apply them on the spot at a busy intersection. So Forester designed an eleven-week program that includes two hours each week of riding. Effective Cycling students put their new knowledge into practice first on easy, low-traffic roads, then in progressively more difficult places. By the sixth or seventh week, according to Forester (1993), students are competent and confident enough to ride in heavy city traffic (p. 584). (Note: the League recently shortened the program.)

Road position: how cyclists “talk” to motorists

This chapter is not meant to be a complete course in Effective Cycling. However, some aspects of the program warrant more in-depth explanation because they are key to understanding the Effective Cycling viewpoint on bicycle facilities. As the “traffic cycling principles” suggest, vehicular cyclists choose a road position according to the circumstances. Their choices serve several purposes: to make themselves more likely to be seen by motorists, to let motorists know where the cyclists are about to go, and to put themselves where their movements will not conflict with motorists’.

For example, suppose you’re riding on a two-lane road (one lane each direction) and want to turn left at the next intersection. If you are a certified Effective Cyclist, you will probably move away from the right side of the road and approach the intersection riding near the center line. This way, you cross the traffic from behind you first, then you only have to pay attention to the oncoming traffic when you get to the intersection. You don’t have to deal with traffic both in front of you and behind you at the same time. This maneuver reduces your chances of turning left in front of an overtaking car. This road position also makes it clear to motorists from all directions that you intend to turn left. As an extra benefit, through traffic in your lane can pass you on your right as you wait for a gap in the oncoming flow. So you actually delay the traffic behind you less than would a left-turning car, unless the road is wide, in which case the motorist would also stay left while others passed on the right. Again, the vehicular cycling philosophy emphasizes following established traffic patterns.

Life can get more complicated, though, for cyclists faced with right-turn-only lanes, left-turn-only lanes and mixtures of through-only lanes and lanes that serve both through and turning traffic. Forester (1993) offers these "cyclist's turning-lane rules" to help cyclists choose a path through an intersection on a multi-lane road:

- Choose the rightmost lane that serves your destination (left, straight, or right).
- If one lane serves two destinations, such as left and straight, ride on the side nearer your destination (p. 318).

Negotiating with traffic

Choosing the best road position takes more than a little know-how at some intersections. It takes practice to be able to choose quickly on the fly. Choosing is the easy part, though. Getting yourself there in heavy traffic, moving away from the side of the road and across the lane(s), takes skill and courage. First, without swerving, you have to turn your head and look behind you. This not only allows you to look for an opportunity to move over, it communicates to motorists—it gets the point across more effectively than a hand signal, Forester says—that you want to move over. When a motorist slows to let you in, then you have successfully "negotiated" a lane change:

> As a competent cyclist, you persuade motorists by negotiation; you ask, and you watch for the answer, be it yes or no. Generally it is yes, because motorists often find themselves in exactly your position, wanting to change lanes through crowded traffic. they agree because they know that if nobody allowed anyone else to change lanes, traffic would stop and nobody would get home (Forester, 1993, p. 309).

In heavy traffic, you must negotiate repeatedly as you work your way across the lanes. My condensed and incomplete description of Effective Cycling technique is, again, not meant to teach anyone how to ride. It is only here to give the reader a sense of how Effective Cyclists, and many other experienced riders, move through the streets.

The importance of downplaying the overtaking threat

Effective Cyclists do not hug the curb, for another example. They ride a few feet to the right of the motor vehicle track. On a wide boulevard, this may put the cyclist well away from the edge of the road. This road position puts the rider closer to where motorists entering from side streets are looking for traffic, which makes the cyclist more visible. It also lessens the danger that a motorist will creep out from the curb into the cyclist's path. Where lane width is tight, Effective Cyclists assertively "take the lane":

> ...cyclists must think for and control the overtaking driver to some extent, even though this is not in the rules of the road. Motorists overtaking cyclists on narrow roads too often assume that there is sufficient width for overtaking, even though there is opposing traffic or a curve around which it might come. Or else they assume that the cyclist is traveling more slowly than his actual speed, slowly enough to stay clear when they move right again to avoid the oncoming traffic. The cyclist will be riding beside a motorist who dodges right to avoid oncoming cars. The answer is to stay enough out in the roadway to inform the following driver that the left lane must be used for passing. That motorist will then be cautious enough to do it properly, because of the fear of approaching cars (Forester, 1993, p. 253).

To ride in this style, a cyclist must have faith that overtaking motorists are not a major threat. John Forester is the Arthur Murray of cycling technique. Just as dance lessons can help you cut a rug with freedom, confidence, grace, and a minimum of stepped-on toes, Forester's teachings help cyclists learn to get around more confidently and competently:

> Most people start by believing that cycling in traffic is dangerous and threatening and that they don't belong there. Heavy traffic is not one of the joys of life, but once you learn how to ride in traffic you will realize that you are a partner in a well-ordered dance, with drivers doing their part to achieve a safe trip home. Then traffic ceases to be a mysterious threat and becomes instead just one of the conditions you can handle with reasonable safety (Forester, 1993, p. xxiii).

Some misconceptions

The 85-page section of *Effective Cycling* that describes riding technique is arguably one of the most lucid and thorough guides to cycling in traffic in print. However, Forester's obsessive opposition to bicycle facilities and his cantankerous criticisms of those with whom he has differences have alienated many bicyclists that would otherwise be his allies.

For example, in a publication written by Bicycle Federation of America staff for the Federal Highway Administration, Clarke and Tracy (1995) describe *Effective Cycling* as a book which "holds that bicyclists fare best when they behave like motor vehicles and that bicyclists should not venture onto the roads until they can ride this way" (p. 67). This twist on Forester's words does his work a disservice.

First of all, the Forester philosophy says that "cyclists fare best when they act and are treated as *drivers of vehicles*." It does not say "like motor vehicles." If cyclists could behave like motor vehicles, then there would be no need for the Effective Cycling program; what works in a high school drivers' education class would work for bicyclists, too. The cycling techniques described above, though, clearly contain concerns and actions foreign to motoring. The meaning of the phrase that was misquoted is not that bicyclists should literally drive just like motorists. That would be impossible because of the speed difference. Effective Cycling seeks to create harmony between cyclists and motorists by teaching cyclists to understand traffic patterns and to move with the patterns, not against them. It is like teaching a canoeist to read the river and work with the current, rather than against it. The theory is that when cyclists try to circumvent the flow of traffic they are most likely to put themselves at odds with it. And it's a theory that's supported by the patterns of car-bike crash statistics.

Forester invites charges of elitism, though, when he writes that "the choice is between effective cycling and none at all; the cyclist must either ride properly or shouldn't ride at all..." (1993, p. 510). I do not wish to defend arrogance, but his statement does make more sense when put into context. At the core of his argument he is responding to those who claim that cycling on many streets is not safe for beginning riders and that we therefore need networks of bike paths or bike lanes. Forester believes that paths and lanes do not make cycling safer, but have the opposite effect. From that premise Forester argues that if there are cyclists who shouldn't ride on streets because the streets are "unsafe," then they shouldn't ride at all because paths and lanes wouldn't make their rides safer. (This is *my* interpretation of the point Forester tried to make.)

We will return to the bikeway safety question in a later chapter. For now, the point is that Effective Cycling enthusiasts sometimes appear arrogant and intolerant of other cyclists' riding styles. (Well, sometimes they are; Forester's glorification of vehicular cyclists and denigration of nearly everyone else is bound to breed some haughtiness among his admirers.) Often, though, "hubris" would be a more appropriate word for it, as those who discover vehicular cycling sincerely want other bicyclists to enjoy the sense of safety and freedom of movement that comes from knowing how to ride skillfully and confidently in traffic.

Effective limits to Effective Cycling

Some people have "two left feet" on the dance floor while others glide gracefully through complex steps almost by instinct. With all the similarities between Effective Cycling and dance, it seems likely that some cyclists would have an easier time than others executing the techniques. As Forester insists that the single best way to improve cyclists' safety is to teach them to "ride properly," detractors complain that Effective Cycling is only for strong, swift riders on expensive bikes:

> Forester's system relied upon a high level of skill and (especially) strength. So much so, in fact, that he used average sustainable speed as the indicator of a cyclist's skill level. In Forester's judgment, a competent cyclist was one able to maintain a speed of 18 mph for a lengthy period of time, despite the fact that only two to three percent of the population can sustain the requisite 120 watts of energy output for more than a few moments (Epperson, 1994, P. 6).

Epperson goes on to say that, while in the general population women have a lower bike accident rate than men, in a study of cyclists who belonged to the League of American Wheelmen–they would presumably adhere to vehicular cycling principles more closely than the general population–men had the lower rate. Epperson offers this as evidence that "women have a lower ability to generate the high level of strength needed to translate the Effective Cycling program from theory to safe application" (p. 6). His comment, of course, is not meant to be sexist. It is offered in support of his claim that the slower the rider, the less useful the vehicular-cycling dance.

Forester's own cycling instructions would seem to confirm that notion, at least for some of the techniques, most notably the lane changing described above. Yet he seems to see skill and attitude as the only relevant factors. "Changing lanes," Forester says, "really shows up the difference in morale and technique between expert cyclists and those who feel inferior to cars..." (1993, p. 307).

> The basic premise of the cyclist inferiority complex is the motoring viewpoint: according to which the cyclist survives and is allowed to use the road only through the generosity of the motorists. This frightened philosophy turns the cyclist who must change lanes in traffic into a road sneak, pretending he or she isn't there while

> dodging through whatever gaps exist between cars.
>
> The vehicle code's philosophy is exactly the reverse: The cyclist rides as one among equals, able to persuade other drivers to leave room to change lanes safely (1993, pp. 308-309).

That ability to "persuade other drivers," however, clearly depends on the cyclist's speed. The less difference there is between the speeds of the cyclist and a car, the more time there is for the motorist to recognize and respond to the cyclist's nonverbal request. "When the traffic is moving more than 15 mph faster than you," Forester writes, "negotiation is impossible.... You have to play the road sneak and move left only if there is a gap in traffic long enough that you won't affect any vehicles" (1993, p. 311). If that is true, then for a cyclist riding less than 10 mph on a street with a 25 mph speed limit, negotiation would not be an option. Where motorists tend to travel slightly faster than the limit, a cyclist may have to ride as fast as 15 mph or else "play the road sneak." That's a respectable cruising speed for a seasoned touring enthusiast. Children, the elderly, people who ride heavy old one-speed bikes because they can't afford a car, and many others may ride at speeds closer to eight mph.

That faster cyclists have an easier time negotiating with traffic is no big revelation. It is the speed difference between bicycles and cars that makes cycling in traffic a challenge to begin with; the bigger the difference the more the challenge. All that this really means is that negotiation works best for faster cyclists on slower roads, and that slower cyclists on slower roads face the same challenge and must use the same techniques as faster cyclists on faster roads. This hardly negates the entire Effective Cycling program. It's an unfortunate insult to slower riders, though, that Forester would deem a speed-dependent technique the measure of "expert cyclists." It's especially unfortunate if slower riders, or those who claim to be advocates for slower riders, discount vehicular cycling because of faster riders' arrogance.

Do Effective Cyclists ride more safely?

Although some Effective Cycling techniques may be subject to various interpretations, the program for the most part teaches straight-forward techniques that avid cyclists have tried and found true through many years and miles of experience. By "true" I mean they help cyclists get to their destinations quickly and efficiently while at the same time minimizing conflicts with motor traffic. There are plenty of stories told in cycling circles of cyclists who become more confident and comfortable in traffic, who ride more often to places they would not have dared go before, and who have fewer conflicts with motorists—all because they learned vehicular cycling techniques. There is no hard data, however, directly linking Effective Cycling instruction with reduced accident rates.

Forester (1994) addresses the issue tangentially. In short, his arguments for the benefits of Effective Cycling instruction start with evidence that accident rates are lowest for bicyclists who ride more miles per year and for bicyclists who belong to bicycling clubs. So, he concludes, bicyclists can reduce their accident rates by learning from experience and from other bicyclists. Effective Cycling is designed to quickly teach bicyclists what they would learn through experience and from other bicyclists. Therefore, Forester argues, bicyclists who take an Effective Cycling course will reduce their accident rates in a relatively short time (pp. 41-44). Table 6 shows an example of the supporting numbers that Forester constructed from data from four unrelated surveys.

Table 6

Forester's General Accident Rates

Type of cyclist	**Miles per year**	**Accidents per million miles**
Elementary school	580	720
College-associated adult	600	500
League of American Wheelmen	2,400	113
Cyclists' Touring Club	2,000	66

Source: Forester, 1994, p. 41.

These numbers, Forester contends, not only demonstrate the need for cycling instruction, but support the value of the kind of bold riding style Effective Cycling teaches:

> ...cyclists who habitually rode in mountains, rain, and darkness averaged a lower

> accident rate than those who rode on the flat in fair weather only.
>
> These surveys disprove the notion that for cyclists in general deliberate risk-taking is a significant cause of accidents. Of the students over age 16, those most likely to take deliberate risks had the lowest accident rates, while those least likely to take deliberate risks had the highest accident rates.
>
> These data confirm my earlier hypothesis that most cyclists are too cautious to be safe on the road. Being cautious of the dangers that are least likely to produce an accident causes the cyclist to expose himself to the dangers that are most likely to produce one. These data also confirm my other hypothesis that cyclist training is the means of accelerating the experience effect. One learns almost any skill much more quickly when taught than by trial and error, and in the case of cycling an error may cut one's cycling career short (pp. 41-42).

Forester even provides a chart to show how much more quickly cyclists learn through Effective Cycling courses:

Table 7

Forester's estimate of "distance and time required to learn traffic-safe cycling."

Type of learning	**Miles**	**Years**
Self-teaching	50,000	10-20
Club cycling	5,000	2
Learning from books	2,500	1
Effective Cycling instruction	800	one fourth

Source: Forester, 1993, p. 271.

Unfortunately, Forester's books do not explain how he arrives at figures such as the ones above. He tends to reinterpret data from other people's surveys and to combine data from unrelated surveys, often without providing even good citations, let alone his calculations.

Not that it matters, though. However impeccable his calculations may be, his view of human nature is suspect because it's so mechanistic.

It does seem reasonable that club cyclists, such as members of the League of American Bicyclists (formerly the League of American Wheelmen) and the British Cyclists' Touring Club, do ride more skillfully and therefore have fewer accidents per mile than the general population. But will what works for LAB members work for the rest of the cycling population? A person who joins a cycling club, and especially someone who springs for the dues of a national cycling organization, has a higher interest in and enthusiasm for bicycling than the average Joe. Would the non-club cyclist have as much motivation to learn the finer points of vehicular cycling? Looking at it from another angle, would someone who does not have a natural alacrity for cycling enjoy the sport enough to join a club, even though bicycling may serve him well for everyday transportation? Conversely, perhaps the average club cyclist has an above-average natural aptitude for handling a bike and judging and tolerating traffic.

As if all bicyclists rolled off the same assembly line, industrial engineer Forester stretches his statistics even farther to estimate that Effective Cycling training has the potential to save 500 lives and prevent 100,000 injuries annually. To get some sense of what an enormous claim this is, note that in 1993 bicyclists suffered 824 fatal and 65,000 reported non-fatal car-bike collisions (National Traffic Safety Administration, 1994, p. 129).

In another of his undocumented tables, Forester compares the "annual casualty reduction" of eight "bicycle-safety programs." Not surprisingly, Effective Cycling training leads the pack by a healthy margin, followed by helmet wearing, intersection improvements, headlamps and rear reflectors, roadway widening, dog leash laws and bicycle mechanical repair. In last place, of course, is "bikeways." He does not say if he means bike paths, bike lanes, bike boulevards, or what. But in his estimation the "improbable favorable results" of a bikeways program are eclipsed by the "probable unfavorable results" of "hundreds more deaths" and "ten thousands more injuries" (1994, p. 69).

Forester says nothing about how many bicyclists would, in reality, be interested in going through 11 weeks of Effective Cycling training and nothing about what percentage of those cyclists would practice the techniques faithfully and well. His "casualty reduction" estimates appear to be based on a dream world in which everyone who rides a bike practices vehicular cycling with skill and zeal. As we will see in the next chapter, that dream ignores the very heart and soul of bicycling.

North Carolina study: A direct approach

Stutts and Hunter (1990) took a more direct approach to the bicycle-safety-instruction question when they evaluated "The Basics of Bicycling," a safety education curriculum for elementary school-age children. Developed by the North Carolina Department of Transportation Bicycle Program and the Bicycle Federation of America, the curriculum consisted of two classroom lessons and five on-bike sessions. As part of the evaluation, the researchers compared the summer 1990 crash record of 300 Mebane, North Carolina, children who had taken the lessons with the crash record of a control group from the similar city of Graham, North Carolina.

They found that the children who had taken the lessons rode more often and appear to have had fewer falls and injuries than the control group. However, the follow-up survey had only 195 respondents from the experimental schools and just 117 from the comparison schools, too few to draw definite conclusions. The report's authors explain the difficulty of trying to pin down the difference education makes: "One recent estimate cited in an unpublished National Institute of Child Health and Human Development document was that 12,000 children would need to be followed for a period of five years to collect prospective information on 100 children with injuries severe enough to result in hospitalization" (p. 43).

Table 8

Bike injuries among North Carolina school children: Students who took "The Basics of Bicycling"compared with control group.

Frequency of riding			
Survey Questions	**Experimental Schools (Mebane)**	**Comparison Schools (Graham)**	**Total**
Every day or almost	57.4%	38.5%	50.3%
3 or 4 times/week	11.8	12.0	11.9
1 or 2 times/week	11.3	7.7	9.9

Several times/month	6.7	11.1	8.3
Never, or hardly ever	12.8	30.8	19.6

Falls or injuries over summer			
Survey Questions	**Experimental Schools (Mebane)**	**Comparison Schools (Graham)**	**Total**
No falls or injuries	71.7	60.3	67.4
One or more falls, no injuries	14.1	25.0	18.2
Injuries treatable at home	12.6	11.2	12.1
Injuries requiring a doctor	1.6	1.7	1.6
Injuries with hospital stay	0.0	1.7	0.7

Source: Stutts & Hunter, 1990, p. 34.

Evaluating the effectiveness of bicyclist education is even more difficult with adult students than with children. A school program like the one in the North Carolina study provides a diverse population. Adult cyclists who complete Effective Cycling training are mostly bike club members and others with a stronger than average desire to learn a prescribed riding style. They can't be considered a representative sample of cyclists. Studies of motorcyclists have found that although training programs appeared to reduce accidents and injuries, when researchers controlled for confounding factors, such as participant self-selection, the programs' benefits disappeared (Cooper & Rothe, 1988, p. 78). In a study of nighttime bike light use, Ronkin (1995) found that bicyclists who used lights at night correlated with those who wore helmets and rode responsibly. Of course, those without lights were more likely to be bare-headed and to ride against traffic or on the sidewalk (p. 7). It seems likely that bicyclists who signed up for Effective Cycling classes would fall in the "responsible" cyclist category at the outset. Likewise, those cyclists most likely to ride recklessly would be least inclined to take bicycling courses. So by simply comparing the crash statistics of Effective Cycling graduates (or those of club cyclists) with those of the general population of cyclists, we cannot predict how much crash reduction we could achieve if we could somehow implement cyclist training on a mass scale. It's impossible to tell how much of whatever difference we would find could be attributed to the training and how much would reflect differences in bicyclists' temperaments and interests.

The only sure way to find out if vehicular cycling is significantly safer than other riding styles would be to give diaries to a very large population of cyclists and have them log their miles and crashes over the course of several years. We would also need a test to distinguish vehicular cyclists from others, a distinction that is not so clear cut, as we will see in the next chapter. Of course, another way to get at the question is after the fact. That is, we could ask cyclists how many miles they rode and how many crashes they had during a certain period of time in the past. This might yield accurate data from those club cyclist who meticulously keep track of their miles with bike computers. For most cyclists, though, all you would get would be wild guesses. It's hard to say whether any one group of cyclists' guesses would be more wild than another's or whether all the individuals' errors would even out in the end and provide an accurate basis for comparison.

In a study for the U. S. Consumer Product Safety Commission, Rogers (1994) attempted a bicyclist risk assessment based on surveys. If the information gathered was accurate, we would have to conclude that bicyclists travel at an average speed of two mph. Both the data and the conclusions the report draws from the data have been dissected, ridiculed, and dismissed by the bicycling community (Allen, J., 1995; Forester, J., 1994, pp. 325-332; & Jones, S., 1994).

Forester (1994) also draws on after-the-fact surveys to try to show that bicyclists' riding styles make significant differences in their accident rates. For example, he presents a table showing that "college cyclists" had a car-bike accident rate of 80 per million bike miles ridden while "adult club cyclists" had a rate of only 20 (p. 44). Forester's argument seems to be that because of their many miles of cycling experience, and because of what they learn from each other, club cyclists are much more likely to practice vehicular cycling techniques than other cyclists and that it is this riding style that accounts for the club cyclists' lower accident rates:

> These techniques, identified and described in my book *Effective Cycling* and taught through the League of American Wheelmen Effective Cycling Program from the *Effective Cycling Instructors Manual,* produce a measurable change in the behavior of the participants equivalent to many years of cycling experience. This strongly suggests that the...accident rates...will be reduced significantly as this technique spreads (Forester, 1994, p. 44).

Forester compares club cyclists with college cyclists, he says, to show that the reason experienced cyclists show a lower accident rate in his charts is "not due to simply the development of sufficient maturity to drive a car, nor to motor-vehicle training" (p. 44). That's fine, but in motor vehicle crashes of all types, not just those involving bikes, college-age drivers, especially males, have accident rates that soar above other age groups (National Highway Traffic Safety Administration, 1994, p. 89). This cannot be blamed on a lack of training, a shortage of role models, or ignorance of vehicular driving techniques. So even if we assume that club cyclists' crash records are indeed significantly better than college cyclists', we cannot tell how much of that difference is due to club cyclists' wisdom and how much to college cyclists' wild oats.

There is another important difference between these two groups of cyclists. College cyclists ride for transportation; many don't have cars. They bike to class, they bike to the post office, they bike for pizza. It's urban cycling with frequent intersections. Forester says that club cyclists "tend to cycle in heavier motor traffic than college students." Although Forester offers no support for that statement, we will grant that club cyclists may be more bold. But in my experience with club cyclists, many of them also put in a great many of their miles on club rides. That often means driving to meeting places on the edge or outside of town and riding around in circles on routes with light traffic and few intersections. Comparing college students' miles with club cyclists' miles may be like comparing city driving with highway driving.

What's more the two groups probably differ in how accurately they provide data. To determine crash rates, we need an account of both crashes and number of miles ridden. Crashes are unpleasant and unusual events that we would expect to be just as easily remembered by either group. Mileage is another story. Club cyclists take pride in how far they ride and are notorious mile counters. College students' trips, though, are more likely to be short, informal, unmeasured, unrecorded, and easily-forgotten jaunts. So the college crowd may be more prone to underestimate its miles. If so, accurate crash counts combined with underreported mileage would exaggerate the collegian crash rate. If Forester's (1993) claim that "American college-associated adult cyclists fall off their bicycles about once every 100 miles" (p. 261) is correct, you've got to wonder why these poor souls don't give it up. His statistics, by the way, predate the mountain bike craze, so they don't include that kind of risky off-road hot dogging.

When comparing avid cyclists with other groups of cyclists, we must recognize that there are many differences that can muck up our efforts to assess one particular rider attribute, such as accident rate. These differences include why people ride, where they ride, ability to accurately recall the number of miles they have ridden, and attitudes toward safety in general, to name a few. This is not to say that club cyclists do not ride more safely than most bicyclists. We would expect ski club members to be more knowledgeable and skillful on the slopes than skiers who just spend half a day at a resort once every few years. We would expect yacht club members to be safer sailors than those who rent a little boat for an afternoon. And we have every reason to expect enthusiastic club cyclists to be more knowledgeable and more skillful and, yes, safer riders than the average bloke. But just how much safer is hard to say. More importantly, to estimate the "potential" of bicycle education by envisioning a world in which all bicyclists ride like club cyclists is as useless as hoping for all skiers to one day be ski club members, or counting on everyone who sails a boat to be as knowledgeable and dedicated to the sport as a yacht club member. Such utopian visions have little practical relationship to reality.

This is not to say that vehicular cycling education in general, or Effective Cycling in particular have no value. On the contrary, by all indications these seem to represent good ways for cyclists to deal with traffic most of the time. As we will see, though, not even experienced cyclists agree on just what constitutes proper vehicular cycling technique, once you get beyond obvious things like riding on the right side of the road and using lights at night.

Until someone has the motivation and massive resources to track a large number of cyclists over a long period of time, we will not have anything like a clear idea of how significantly an education program or a "spreading" of knowledge could reduce bicyclists' accident rates.

Beyond crashes: A sense of competence

My description of Effective Cycling would be neither complete nor accurate if I left the impression that crash reduction was its sole benefit. In fact, traffic cycling techniques make up a small part of the text, which covers bicycle selection and fitting, maintenance and repair, nutrition and physiology, night riding , riding in the rain, cold weather riding, commuting, touring, racing, mountain riding, teaching children to ride, and more. It even includes mate-finding tips for the single cyclist. When he signed my copy of *Effective Cycling*, John Forester wrote, "Effective Cycling is better, faster, and more fun!"

The Effective Cycling program was designed to empower students, to give them the knowledge and skill to cope with any situation that might come up. "Once you can ride comfortably and efficiently, without worrying about traffic, on a machine that you trust, you are ready to experience the full joys of cycling" (Forester, 1993, p. xxiii). Because it works, vehicular cycling is becoming more wide spread. Check the older books on bicycling in any public library and you're likely to find that their advice on traffic cycling is quite bad, if it exists at all. Most recently-written books address the issue more intelligently. There is a classic mountaineering text called *Freedom of the Hills*. *Effective Cycling* might as well have been named *Freedom of the Roads*. For those who take courses, learn from club members, study books, and read magazine articles to bolster their cycling competence, there is freedom that comes with that sense of competence. It is freedom from fear and freedom to go wherever they want to go by bicycle.

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Chapter 5
Bicyclist Behavior 2
The Real: How Bicyclists Actually Behave (and how hard that is for some of us to accept)

Effective Cycling program graduates are rare, even among serious cyclists. Less than 3,000 bicyclists have passed the Effective Cycling course (Clarke & Tracy, 1995, p. 67). Jerry Hopfengardner, chairman of the League of American Bicyclists' Education Committee estimates that "only three thousandths of one percent of the cyclists in this country have received the training that the Effective Cycling program provides for safe and efficient bicycling" (McClun, 1995). But certified Effective Cyclists are not the only riders who are aware of, or who seriously adhere to, vehicular cycling principles. Repeatedly in his writings, Forester emphasizes that expert cyclists throughout the world have practiced the techniques he espouses since long before he put them in print. Cyclists have numerous sources of information on riding techniques besides Forester and the League of American Bicyclists. It's hard to tell how widely vehicular style cycling is practiced, or how closely those who do practice it adhere to the official Effective Cycling methods.

Peter Lagerwey, bicycle coordinator for Seattle, Washington, estimates that 80 percent of the bicycle miles traveled in the U.S. are covered by "a hard core of experienced and frequent cyclists." The remaining 20 percent, he says, "are ridden by the 80 percent of cyclists who consider themselves infrequent or less confident riders." Seattle has a larger than average adult bicyclist population, so Lagerwey's estimate of "experienced" cyclists' portion of mile traveled may run high. The 1990 Nationwide Personal Transportation Survey found that the average bicycle trip length was 1.99 miles, and more than half the trips were "social and recreational" (Federal Highway Administration, 1994, sec. 3, pp. 17 & 21). Given that "experienced" cyclists frequently travel 15 to well over 100 miles on recreational trips, it seems that the bicycle miles are overwhelmingly made up of shorter trips more characteristic of less hard-core riders.

This chapter will leave behind the sophisticated—some would say esoteric—realm of Effective Cycling and examine how ordinary people behave when they travel by bicycle. Most studies of bicyclist behavior start with some criteria for "proper" behavior and count the number of cyclists who either conform with or deviate from the criteria. For this section, though, I ask the reader to, at least temporarily, suspend the temptation to view certain cycling behaviors as deviant or problem behaviors. I ask the reader to assume that cyclists have rational reasons for what they do. The task here is to explore and learn from the day-to-day habits of common bicyclists.

Riding with traffic or facing traffic

Studies of bicyclists' behavior point to one overriding rule: The more options cyclists have, the more options they take. This is true whether or not those options are officially sanctioned.

The side of the street on which bicyclists ride, for example, is influenced by the kind of space they have in which to ride. Thom and Clayton (1992a) observed bicyclists riding at mostly busy intersections with standard 12-foot lanes and speed limits mostly either 50 or 60 kph (31 or 37 mph). A full 97.6 percent of the cyclists rode on the side of the street with the flow of traffic (p. 97). On most of the streets at the seven intersections studied, bicyclists would have had to ride close to on-coming traffic if they had chosen the other side of the street.

The picture changes where bicyclists have more room. A study of bicyclists on nine streets with striped bike lanes (Cycecki, Perry, & Frangos, 1993) found that 22 percent of the cyclists who rode on the streets chose to ride facing the motor traffic on their side of the street. On one street the bike lane was marked with four arrows per mile "to show clearly that bicyclists must ride with traffic." Apparently the arrows did not deter wrong-way riding as much as the extra space encouraged it; 23 percent still rode facing traffic. On another bike-laned street, 39 percent cycled against the flow (pp. 29, 31).

Cyclists also choose sides more freely on sidewalks. In a comparison of sidewalk riding with street riding, Wachtel and Lewiston (1994) found that of the cyclists riding on the road at the studied intersections, 95 percent were riding with traffic. Among cyclists riding on sidewalks along the same roads, though, 32 percent faced the traffic on their side (p. 33). Thom and Clayton (1992a) found a half-and-half split between sidewalk cyclists riding with traffic and those facing it (p. 93). In fact, of all wrong-way bicyclists they observed, 70 percent were riding on sidewalks (p. 98).

Bicyclist behavior varies somewhat from place to place, though. It's influenced by factors beyond roadway design, such as local bicyclist education and public relations programs, having large numbers of experienced adult cyclists to set examples, the degree to which police enforce bicycle laws, and local motorists' attitudes toward and treatment of bicyclists on the road. So, statistics such as those in the last two paragraphs illustrate a general principle, that cyclists take advantage of the available options, but the numbers are site specific. They do not reflect how cyclists behave on all bike lanes, for example. In fact, a recent bicyclist behavior analysis in Oregon (Moule & Ronkin, 1996) found less wrong-way riding on streets with bike lanes than on those without, and the lanes seemed to lure cyclists off the sidewalk (see Table 9).

Stop signs and red lights

So, the space in which cyclists ride influences the freedom with which they choose a side of the street on which to ride. Likewise, the amount of traffic at intersections influences how bicyclists respond to stop lights and stop signs. Most of the bicyclists in the Thom and Clayton study had little choice when they were required to stop. "At the observation sites," the authors say, "most cyclists were forced to comply with stop signs and red lights because of high traffic volumes." As a result, 97 percent stopped (p. 97). "Cyclists were, however, more likely to disobey red lights and stop signs when traffic was light" (p. 93).

Cynecki, Perry, and Frangos found that although 80 percent of their subjects stopped for red lights, only 17 percent stopped for stop signs, "even though the observer was instructed to give the bicyclists the benefit of the doubt when they came to a near stop" (p. 31). In addition to conveying a stronger message than stop signs, red lights are most likely to be installed at intersections with heavy traffic which, again, forces bicyclists to stop.

Table 9

Wrong-way and sidewalk riding in Oregon bicycle counts

Bicyclists riding against traffic	
Riders on street (at sites w/ sidewalks)	4%
Riders on sidewalks	42%
Sites with bike lanes	16%
Sites without bike lanes	28%
Sites with bike lanes and sidewalks	14%
Sites without bike lanes or sidewalks	33%
Sites with 2 or 3 lanes	9%
Sites with 4, 5, or 6 lanes	24%
Bicyclists on sidewalks	
Total	40%
Adults	37%
Youth	53%
Sites with bike lanes	24%
Sites without bike lanes	65%
Sites with 2 or 3 lanes	21%
Sites with 4, 5, or 6 lanes	48%

Source: Moule & Ronkin, 1996.

Members of the New York City advocacy group Transportation Alternatives defend running red lights. It is a way, according to Herman (1993), for bicyclists to get ahead of the platoon of motor vehicles and away from the exhaust and the “pressure from impatient drivers” (pp. 26-27). (For the record, I am not trying to advocate, condone or defend the practice of running red lights. I’m just trying to describe how normal, rational people behave on bicycles, and why.)

Scofflaw, or just plain human?

Non-cyclists and “expert” cyclists often view bicyclists who ride against traffic and who run stop signs and red lights as reckless scofflaws or, at best, sorely misguided. Yet, the statistics above demonstrate that these behaviors are not totally arbitrary, that cyclists use some discretion when choosing where to ride or whether to stop at a stop sign. No doubt there are reckless and misguided cyclists on the streets, but there are also plenty of rational reasons for cyclists to choose non-vehicular-style actions.

A bicyclist whose destination is the wrong way up a one-way street, for example, might choose to ride against traffic if the alternative is a considerably longer route. A cyclist turning left on a busy street with four lanes may decide that it makes sense to ride the left bike lane to a destination half a block up the road on the left; otherwise, the cyclist would have to cross four lanes, ride a short distance, then cross back again, exposing himself to greater risk.

Even John by-the-rules-of-the-road Forester advocates that bicyclists treat stop signs as if they were yield signs:

> You don’t have to stop to yield, and you are best able to get moving again if you are still riding, with your feet on the pedals. Therefore, it is to your advantage to keep going, riding as slowly as you can between the visibility point and the edge of the actual traffic line, because that gives you the maximum time to see and choose a gap in traffic that is long enough for you to cross the intersection. If you get close to the actual traffic line and no gap comes along, you must stop to wait” (1993, p. 314).

Where traffic is light and it’s easy to see down the road, bicyclists may appear to ignore stop signs entirely while, in fact, they may be entering intersections with as much care as those who stop. On a bicycle, the energy to get up to speed after a stop comes out of the rider’s endurance, not a gas tank, so there is a strong, practical incentive to keep rolling. As one very experienced bicyclist put it, “it’s not human” to stop at every stop sign.

Bicyclists are not the only practitioners of this sort of situational decision making. For example, motorists may flout speed limits where a road seems to be able to handle faster traffic. One study found that “drivers paid little attention to posted speed limits and chose a speed that they considered appropriate for the prevailing conditions” (Garber & Gadiraju, 1989, p. 65). Some scofflaw behavior is just what a particular combination of environmental cues seems to ask of a cyclist—it's just human.

Affordance cycling

To most people who bicycle for transportation, cycling is an informal activity. It's common, ordinary, everyday. It could be argued that motorists manage to adhere to well-defined behavior patterns a lot better than bicyclists, even though driving a car is also an everyday activity. There are some important differences between motor vehicles and bicycles, however, that account for bicyclists' less structured behavior. I have touched on these differences before, but they take on new meaning in this context.

First, bicycles are narrow. On the whole, this is a great asset. It allows bicyclists to share lanes with faster-moving traffic. Being narrow makes it possible for the bicycle to be a slow-moving vehicle that can move about city streets and rarely hold up traffic. This sets the bicycle apart from most other slow-moving vehicles, too. If one fourth of a city's workers biked to work, that would be just fine. If, instead, they drove tractors, harvesters, and threshing machines, you would see major tie ups. However, this narrowness also affords other behaviors that would be difficult or impossible with wider vehicles. Along with the ability to share a lane comes the ability to ride on the wrong side of the road without colliding with on-coming traffic. A bicyclist can ride in the space between lines of cars and the curb. A bicycle fits on a sidewalk and through other narrow spaces where motorists in cars wouldn't normally think of going. Being narrow also makes it possible for a bicyclist who wants to turn left to wait on the right side of the road for traffic from behind to pass, a commonly-used technique, even though it is frowned upon by vehicular cycling advocates.

In addition to being narrower, bicycles generally move more slowly than cars, of course. This creates some opportunities and precludes others. For example, while approaching a stop sign, a bicyclist may have plenty of time and a clear view by which to judge whether it is safe to cross the intersection. So bicyclists can often blow stop signs safely, even if illegally, where motorists would have to stop to assess the situation. The speed difference also makes it impossible, though, for a bicyclist to take a place in the traffic flow in the same way that a motorist would. That constraint forces bicyclists to create alternatives, for better or worse.

Finally, bicyclists pose much less of a threat to other road users than do car drivers. The dangers inherent in the speed, size, and weight of a car demand a high level of care and responsibility from drivers. Consequently, there are severe legal incentives for motorists to follow prescribed rules of the road. In most cities bicyclists are not held to the same standards because they are not seen as such threats.

In short, compared with motorists, bicyclists have a different set of constraints and, more importantly, affordances. Norman (1988) defines “affordances” as the “perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used” (p. 9). Bicyclists have more diverse physical and social/legal affordances than motorists, so bicyclists exhibit a more diverse range of behaviors than motorists. If we label one style of riding “vehicular cycling,” we can dub the broader range of cyclists’ behavior as “affordance cycling,” meaning that the bicyclist’s actions are governed less by preplanned and analyzed patterns and more by what seems to make sense from among all the possible actions the bicyclist perceives in the moment. The “affordance cycling” concept may become more meaningful once we begin to explore how bike lanes influence bicyclists’ perceptions. For now, the point is that bicyclists have such varied behavior because they have so many options.

Cyclists who understand the rules of the road well know when those rules can be safely and usefully broken. Roadside researchers who make ledgers of vehicular-style behaviors versus non-vehicular-style behaviors give us data that is interesting, but that does not tell us the extent to which the supposed transgressions pose real dangers.

Bicycling: the “folk transportation”

While Effective Cycling is presumably guided by extensive planning and analysis, bicycling in general is much more free form, which should not be confused with chaotic, even though it may sometimes look that way. Part of the appeal of bicycling for some people is that it offers the freedom to go places and do things that a car driver couldn’t without being a threat to health and property. Bicyclists enjoy more spontaneity than motorists.

Cincinnati traffic engineer Jim Coppock, who is also a folk musician, folk dancer, avid bicyclist, and bicycle advocate, describes bicycling as “folk transportation,” an apt description of this informal method of moving about. One of bicycling’s greatest assets, arguably its single most socially significant attribute, is the mobility it offers people from a wide range of ages, abilities, and economic means. There is no test to pass or driver's license fee to pay. "Expert" cyclists may sigh and shake their heads as they watch other bicyclists improvise their way through traffic, but the behavior they are seeing goes hand in hand with a vehicle that's as available to five your olds and people with Down's syndrome as it is to three-time Tour de France winner Greg LeMond.

Cycling sanctimony

As a group, bicyclists behave in richly diverse ways. Individually, though, bicyclists often harbor strong feelings about what's true and proper cycling technique. Those of us who invest a lot of time in studying bicycle issues and practicing advanced cycling techniques run the risk of developing what C. M. Deasy (1974), writing about problems in environmental design, calls "naive realism." It's a sort of professional tunnel vision:

> ...the action schemes in the designer's mind are very special ones; they are formed by training and by the values of his professional group and thus may need to be "accommodated" to the viewpoint of the rest of the world.... The alternative possibility, that human nature will adapt itself to the designer's values, is so utterly unrealistic as to be absurd, yet it is a concept that is implicit in much of the literature of architecture and planning (p. 39).

Two Canadians provide a good example of naive realism at work. Robert Thom is a research engineer with the University of Manitoba Road Safety Research Unit. He has reportedly "carried out extensive research in the area of cycling safety." He is also an "avid cyclist who rides through all four seasons and averages 16,00 kilometers (9,900 miles) per year." Alan Clayton is an engineering professor at the University of Manitoba. (Thom and Clayton, 1992b, p. 378 .)

Based on observations of 900 cyclists in the Canadian cities of Winnipeg and Vancouver, Thom and Clayton (1992a) concluded that "it is apparent that many cyclists do not ride according to the established rules and principles of traffic flow: only half of the cyclists were observed to be riding correctly" (p. 93). As we will see, this statement is based on an unrealistically rigid definition of what "riding correctly" means.

In addition to "wrong way" riding and disobeying stop signs and red lights, the criteria the researchers used to judge "correct riding style" included the following:

Sidewalk or crosswalk riding

The researchers do not say whether sidewalk riding was illegal in the study cities. In some cities it is, in others it's not. As recently as 1994, three cities in the Dayton, Ohio, area had laws that *required* bicyclists to ride on sidewalks. Clearly, experience has shown that sidewalks can be dangerous places to ride (Williams & McLaughlin, 1992; Wachtel & Lewiston, 1994). From an affordance cycling perspective, though, we would have to know where the rider was going, the alternative ways of getting there, the conditions of the various routes, the cyclist's speed, the care the cyclist took in crossing intersections. Without knowing such circumstances, we cannot carte-blanche condemn sidewalk riding.

I have seen an "expert" cyclist—he was a certified Effective Cycling Instructor and president of a bike club with more than 1,000 members—lead a group of cyclists comprised of the board of directors of that club down city sidewalks for two blocks to access a bike path. Considering the surrounding streets and traffic patterns, no one could argue that it would have been safer or wiser to use the road. In some cases, the choice between riding the road or the sidewalk is more a matter of style than substance.

Improper left turn

As described in the last chapter, vehicular cycling has definite, sometimes complex, rules about choosing a lane position. Many cyclists put in the majority of their miles where the traffic is light enough that left-turn technique is not a major concern. The researchers stacked the deck, though. All but one of the seven study sites were on streets with four or more lanes. Three of the sites were extremely complex intersections with pork chop islands and center dividers. These sites are good examples of places where, as Forester (1993) put it, "being a good cyclist requires more skill and forethought than driving a car" (p. 296). Undeniably, vehicular cycling techniques enable a bicyclist to glide through such intersections with the greatest ease and least risk of conflict with traffic. But to expect the average cyclist to be more skillful and more thoughtful than the average motorist flies in the face of bicycling's nature as folk transportation. Finally, a turn from the "wrong" position poses no hazard at all if done at the right time, when there's no possibility of conflict with traffic. Faced with the complexity of choosing a "proper" position and the difficulty of changing lanes to reach that position, many bicyclists, especially slower ones, may find a way to muddle through that's not technically correct, but that works well enough for them.

Overtaking between traffic and curb

This is another maneuver that even Forester does not universally condemn. The danger is that a motorist will turn right and slam the bicyclist riding in the motorist's blind spot. The official Effective Cycling text says it's all right to pass on the right "when motorists are stopped, or are barely moving with no place to turn into" (p. 313). In a vehicular cycling manual distributed by *Bicycling* magazine, Allen (1988) gives several paragraphs of instructions for riding through stopped motor traffic, then advises cyclists to "wait behind the first car at the traffic light."

In the end, it is hard to pin down one "proper" way of cycling. There is not even a clear consensus about what should properly be called "vehicular cycling." Not even the carefully thought-out Effective Cycling program provides a cut-and-dried standard. I have known Effective Cycling graduates who either did not fully understand, were unable to carry out, or had forgotten, Forester's detailed instructions. I have known certified Effective Cycling Instructors who outright disagreed with some of the Effective Cycling lessons. Even if you follow Forester to the hilt, affordances sometimes offer several choices: at stop signs and when passing on the right, for example. Thom and Clayton chose to chronicle actions that they believed were improper, implying that these actions would put bicyclists at risk. What we have seen is that in specific instances these actions may be harmless, or even safer than the supposedly proper actions. Those of us who are involved with bicycle advocacy and planning face one very real risk if we cling too tenaciously to our vehicular cycling principles: We risk denying ourselves the ability to fully understand the depth and breadth of bicycling as it is practiced on the streets of our cities every day.

There's a man, about 45, who rides the sidewalk down Main Street in my home town—against the flow of traffic on his side of the street, by the way. "Joe" is large, though not tall. The low seat on his old ten speed makes his knees stick out as he pedals. He does not push himself breathless, but rolls slowly, draws a hit off his cigarette, and sends smoke swirling beneath the brim of his cowboy hat. When he reaches Central Avenue in the middle of town, he stops and waits for the pedestrian signal, then slowly rides the crosswalk to the other side. At the video store, he pries down his kickstand with his stable stomper, finishes his smoke, and leaves his unlocked bike by the door as he saunters inside.

Is Joe a problem bicyclist? Should we put a helmet on him, boot him off the sidewalk, put him on the right side of the street, and teach him to ride properly? I'd wager he's as much of an expert at pedestrian cycling as many club cyclists are at vehicular cycling. He has figured out how to get where he wants to go, and he gets there in a way that's comfortable for him. At the speed he rides and with the care he takes, Joe may be no more at risk than a vehicular cyclist. If we judge his behavior by vehicular cycling principles, his actions are quite improper. But it's hard to argue that Joe is a hazard to himself or anyone else on the sparsely-peopled sidewalks of downtown Fairborn, Ohio. The beauty of the bicycle is that it can accommodate both a Joe and a John Forester. And it would be just as absurd to try to make Joe into John as to try to get Forester on the sidewalk. This is not to say that Joe couldn't practice vehicular cycling if he wanted. But what would make him want that?

The curse—or the challenge—of bicycle planning is that John and Joe experience bicycling so differently. For Joe, motor traffic goes by him. Period. He moves around its periphery and through its gaps. John, on the other hand, is part of the traffic. He rides in its midst and participates in its flow. What makes bicycling even more complicated—or interesting—is that there is no pure John experience or pure Joe experience. As long as traffic moves faster than a cyclist, that cyclist cannot be 100 percent in the flow. And as long as there are streets without sidewalks you can't ride 100 percent on the periphery. Even where there are sidewalks, for most bicyclists it would take great constraint to poke along for any distance with the amount of caution it would take to cross every driveway and intersection safely. Sidewalks do not isolate bicyclists from traffic.

How realistic is it to hope that Americans will some day embrace vehicular cycling on a large scale? It's hard to say. Culture has a lot to do with it, I suspect, since cultural attitudes will determine how motorists and bicyclists act toward and respond to each other. For example, Drake (1996) describes how he watched as a "nun in full habit rode her three-speed sedately" into the midst of a busy French roundabout:

> Immediately, she was afforded what I could only assume was the leeway exclusively

> reserved for people of the cloth. Then I tried it myself, and discovered her secret had nothing to with social strata, but with assertiveness. Easy.

Drakes allows that not all European motorists are so courteous: "Cycling in Milan, for instance, calls for a downhiller's body armor. Ditto for Barcelona. I would no sooner ride in these cities than I would go jogging in Sarajevo."

How bad are bicyclists, really?

A common way in which bicycle safety pundits link behavior with consequences is to compare the share of car-bike crashes caused by bicyclists with the share caused by motorists. If there is a 50/50 split, then we assume, for what it's worth, that bicyclists aren't doing any worse than motorists. That is, if bicyclists' contribution to car-bike crashes is equal to motorists', then bicyclists aren't any worse drivers than motorists. This may be a crude measure of bicyclists' skill, but many people take this kind of comparison seriously, often using it to put cyclists in a bad light. So it is worth examining.

Thom and Clayton estimated that cyclists were at fault in 65 percent of reported crashes they analyzed from Winnipeg, Canada, and cyclists were partly at fault in 5 percent more (p. 96). Other studies have credited cyclists' errors with causing from 21 percent to 65 percent of car-bike crashes (Clarke & Tracy, 1995, p. 31). A. F. Williams came up with a nearly identical range overall, and found that cyclists aged 25 and older weighed in at just 35 percent (Drury, 1978, p.).The Cross-Fisher study revealed a similar tendency for child cyclists to be at fault, and adult cyclists not to be (Table 10). It appears as if adult cycling habits are not so hazardous; motorists are more often to blame. In general, children do not pilot their bikes as safely. Celestine Trainor of the Human Factors division of the U. S. Consumer Product Safety Commission attributes this to children's limited cognitive abilities, self absorption, and fondness for testing their skills (Rogers, G., et al., 1994, pp. 87-88).

There is cause to be cautious about interpreting this information, though. That motorists appear to be more often at fault in crashes with adult cyclists may reflect factors other than just the adult riders' street smarts. If adult cyclists tend to ride faster than children, motorists may have less time to detect and react to the presence of an adult cyclist on the road. Also, motorists might drive more cautiously around children. In any case, many crashes that are technically caused by motorists' errors could be avoided by skilled cyclists; bicyclists who practice vehicular cycling have techniques that not only minimize cyclist errors, they reduce the likelihood of crashes caused by motorists' errors as well. Finally, the top rural adult crash type appears to be carelessly caused by overtaking motorists, but is often the result of bicyclists riding at night without the gear to make themselves visible.

Vehicular cycling principles guide the actions of an experienced, well-informed, "hard core" of cyclists. The reason they choose this riding style is simple: the principles help bicyclists get where they want to go most safely and efficiently. There is room for fudging, true, but even there a bicyclist who understands traffic and how to avoid crashes can more clearly see her options and more wisely choose among her affordances. Those of us who enjoy the benefits of a vehicular riding style naturally wish the same freedom and sense of safety for other bicyclists.

But bicycling is not by nature so tidy, and shouldn't be. There are many who sing, but few expert singers. There are many who dance, but few expert dancers. There are many who bicycle, but as along as bicycling remains folk transportation, as long as bicyclists don't need a skills-based license to mount up, as long as bicycling serves the young, the poor, and the mentally handicapped, "expert" cycling is likely to remain the realm of the hard-core few.

Table 10

Most frequent car-bike collisions by age

Child-urban

1. Cyclist running stop sign
2. Cyclist exiting residential driveway
3. Cyclist riding on sidewalk turning to exit driveway
4. Cyclist riding on sidewalk hit by motorist exiting commercial driveway
5. Cyclist running stop sign

Child-rural

1. Cyclist exiting residential driveway
2. Cyclist swerving about on road
3. Cyclist swerving left
4. Cyclist entering road from sidewalk or shoulder
5. Cyclist running stop sign

Adult-urban

1. Motorist turning left
2. Traffic light changed too quickly
3. Motorist turning right
4. Motorist restarting from stop sign
5. Motorist exiting commercial driveway

Adult-rural

1. Motorist overtaking unseen cyclist
2. Motorist overtaking too closely
3. Motorist turning left
4. Motorist restarting from stop sign
5. Cyclist swerving around obstruction

Source: Forester, 1993, p. 269.

If bicycling is a dance, no one should have to be an Arthur Murray graduate to jump in. At the same time, we don't want people bumping into the furniture and we don't want to make it hard for accomplished dancers to cut a mean rug. If we must build a dance floor–some kind of bicycle facility, that is–we must take care of two things. First, we must try to find a design that neither encourages unsafe behavior nor perpetuates inaccurate ideas about car-bike interactions; misinformed bicyclists cannot accurately predict the consequences of their improvisations. Second, the design must not prevent, inhibit, or contradict vehicular cycling: to do so is to squelch the safest and most efficient form of bicycling transportation.

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Chapter 6
Design Concepts

Before moving on to bike lane issues, we'll explore some design concepts that will help us in the following chapters make sense of how and why bike lanes affect cyclists. These concepts come primarily from the works of cognitive psychologist Donald Norman (1988) and environmental-behavior studies professor Amos Rapoport (1982).

Rack your bike, not your brain

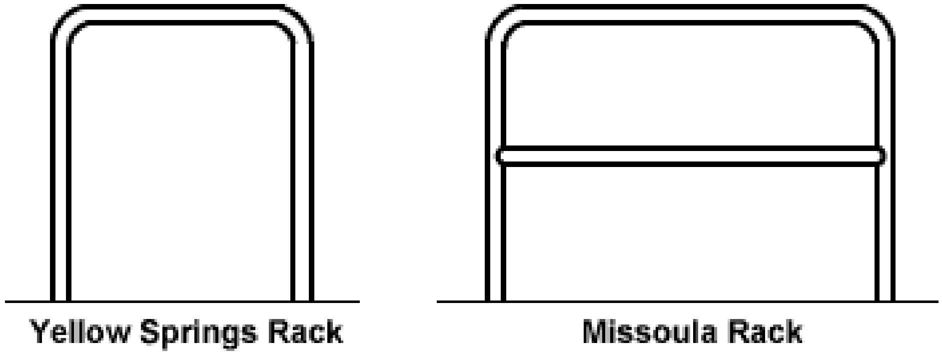
Until a few years ago, the only bike racks in downtown Yellow Springs, Ohio, were a couple of wheel benders. By "wheel benders" I mean they were the kind of rack famous for the bicycle domino effect. You stick your front wheel between vertical rods, you start to walk away, the wheel slips, you hear a clatter as each bike falls against the next, and, thanks to those vertical rods, some of the bikes' wheels aren't as well aligned as they were before.

When the village decided to add bike racks to its downtown sidewalks recently, it installed a different kind of rack. It was what I call a rail rack. That is, you park your bike by leaning it against a horizontal rail, like leaning your bike against a railing or hitching rail. Unfortunately, many bicyclists had a hard time figuring out how to use the new racks. They parked their bikes perpendicular to the rail, leaned them against the supporting posts.

Rail-type racks have worked wonderfully, however, in many communities. They are the best bike rack design I've seen for downtown sidewalks. Because both the racks and the bikes run parallel to the street, they take up a minimum of sidewalk width. Also, rail racks give two- or three-point support to bikes' frames, virtually eliminating the falls, scratches, and bends associated with many bike racks. Finally, this sturdy and hard-to-vandalize type of rack will accommodate nearly any frame design and locking device conceivable.

Figure 4

Yellow Springs rack versus Missoula rack



So, why did people in Yellow Springs lock their bikes to the racks the wrong way, a way that gave less support to the bikes and that took up more sidewalk width? I believe there were two forces at work: an inaccurate *mental model* in cahoots with a misleading *system image* (Norman, 1988).

In this case, the model that many bicyclists had in mind for how a bike rack works was the wheel bender. Like a rail rack, most wheel benders also have a horizontal bar on top. But with the wheel bender, you park your bike perpendicular to the bar, not parallel to it. This is the bike parking method most Ohio bicyclists grew up with. Confronted with the new type of rack and no instructions on how to use it, many bicyclists simply tried—and still try—to use the racks according to their old mental models of how racks should be used. They parked their bikes perpendicular to the horizontal bars.

It would be unfair, though, to blame the bicyclists for assuming that their old mental models of bike rack parking applied to the new racks. The larger problem was that the design of the new racks gave no clue to the contrary. In fact, the new racks had *affordances* that not only did nothing to discourage inappropriate parking, they may have even encouraged it. As you may recall, Norman defines affordances as "the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used" (p.9). One of these properties was that the racks were taller than they were long. If you want an object to be used as a rail, you have to make it look like a rail. That is, it needs to be a horizontal shape, longer than it is tall. Another problem was that the racks were open beneath the rail, which "afforded" the possibility of sticking bikes into the rack the wrong way.

Figure 4 compares the rail rack design used in Yellow Springs with one used in Missoula, Montana. Notice first that the Missoula rack is horizontal, it looks like a rail, not like a pair of posts. Also, there is a second horizontal bar beneath the top bar. The lower rail has a number of functions. It helps keep the bicycle's wheel from turning when the handlebars are leaned against the top rail. It also affords more options for locking a bike. For this discussion, though, the key function of the lower bar is that it acts as a *constraint* that prevents you from putting your bike into the rack the wrong way (Norman, p. 84). Like any good physical constraint, this one is easy to see and interpret you don't even think about putting the bike in the wrong way.

So the *system image*—what you see when you look at an object or an environment—of the Missoula rack gives you much better clues as to how the rack is to be used. You don't need lessons or an instruction book. The design itself "tells" you how to use it. Norman calls this "natural design," using "signals that are mentally interpreted without any need to be conscious of them" (p. 4). These signals consist of the visible affordances and constraints.

The right to signal a right with the right

Is it right for a bicyclist to signal a right turn with his right hand, or should that be left to the left hand? In many states bicyclists have no choice, not legally anyway. In Ohio, for example, the only legal right-turn hand signal (at this writing) is the kind a motorist with broken blinkers must make: you stick your left arm out the window and bend it upward at the elbow. This makes sense in a car; unless you have a nine-foot arm, you can't signal by pointing your right arm out the right window. On a bike, though, it's a different story. Cyclists in a number of states have gotten the right-handed, right-turn signal legalized for bicycling because they have found that it works better.

Why does the right hand work better when the left-handed signal is the standard with which, presumably, everyone is familiar? Consider the difference from a design perspective. Pointing to the right to signal a right turn, just like pointing to the left to signal a left turn, communicates intuitively. There is a direct relationship between the form of the signal and the action that it signifies. Norman calls this *natural mapping*. It leads to immediate understanding.

In contrast, there is very little relationship between bending your left arm and making a right turn. Even though it is the standard hand signal, few motorists have used it since the invention of blinkers. So they have to search the corridors of their memories for what they learned in drivers' education class. Not only can this make motorists slow to catch on, it's easy for them to turn down the wrong mental corridor on the way to retrieving that information. Some bicyclists have seen motorists smile and wave back. In a test of motorists' ability to quickly read bicyclists' hand signals, Drury (1979) found that motorists correctly read left-handed right-turn signals less than two thirds of the time, but right-handed signals had an 80 percent success rate (p. 1045).

Knowledge in the head and knowledge in the world

Both the Missoula rail rack and the right-handed, right-turn signal convey information through their forms. Norman calls this kind of information *knowledge in the world*. Our everyday activities are guided, for better or worse, by an interplay of knowledge in the world and *knowledge in the head*.

A bicyclist who moved to Yellow Springs from a city such as Missoula, for example, would probably know immediately how to park a bike on the new rail racks despite the lack of visual clues. Also, many motorists correctly read bicyclists' left-handed, right turn signals with no problem. Knowledge in the head can fill in where design leaves off. To strike a good balance between information that a design conveys and information that a user must have in her head, a designer must understand the characteristics of these two kinds of knowledge. Norman explains:

> Knowledge in the world acts as its own reminder. It can help us recover structures that we otherwise would forget. Knowledge in the head is efficient: No search and interpretation of the environment is required. In order to use knowledge in the head we have to get it there, which might require considerable amounts of learning. Knowledge in the world is easier to learn, but often more difficult to use. And it relies heavily upon the continued physical presence of the information; change the environment and the information is changed. Performance relies upon the physical presence of the task environment.
>
> ...gaining the advantages of knowledge in the world means losing the advantages of knowledge in the head (p. 80).

Environmental design as nonverbal communication

Another way of looking at knowledge in the environment is that it consists of those attributes of the design that communicate, nonverbally, with the user. Unfortunately, the meaning of that communication may vary considerably from user to user.

Rapoport (1982) describes three kinds of elements that make up the built environment (pp. 87-101). *Fixed feature elements* "change rarely and slowly." The asphalt or concrete surface of the street and its curbs and gutters are fixed-feature elements of the bicycling environment. *Semi-fixed feature elements* "can, and do, change fairly quickly and easily." Rapoport offers examples such as furniture and how it is arranged, advertising signs, lawn decorations and many other things. Pavement markings will be our main concern among the semi-fixed feature elements in the bicycling environment. However, speed humps, channelizing islands, and all manner of traffic signs would also count as semi-fixed feature elements. Semi-fixed feature elements, Rapoport says, "become particularly important in environmental meaning...where they tend to communicate more than fixed-feature elements" (p. 89). *Nonfixed-feature elements* are people and their nonverbal behaviors (p. 96). Of course, our nonfixed-feature concerns will be mostly with bicyclists and motorists, and with the ways in which they behave.

We can uncover the meanings of built environments by observing who does what in those settings. As Rapoport puts it, we can "move from the nonfixed-feature realm to the semifixed and fixed-feature elements" (pp. 96-97).

You see, we create and adapt our built environments for specific purposes. For worship we build churches, for entertainment, dance halls. To carry out the serious business of our judicial system, we build court houses. For relief from serious business, we build taverns. For speedy travel we build freeways. For the comings and goings of communities we build residential streets. The elements that distinguish one type of environment from another, the features by which we know taverns when we see them, for instance, then act as cues that remind us of the behaviors expected of us in those settings. As Winston Churchill put it, "We shape our buildings and afterwards our buildings shape us" (Deasy, 1974, p. 5).

This "mnemonic function" of built environments sounds very tidy, but nonverbal communication is not always clear. We can think of settings as "cognitive domains made visible," Rapoport points out:

> This conceptualization has two consequences: First, there are important, continuing relationships to culture and to psychological processes, such as the use of cognitive schemata and taxonomies, that tend to be neglected in the sociological literature. Second, conflicts can easily arise in pluralistic contexts when settings may elicit different meanings and behaviors—or where particular groups may reject meanings that they in fact fully understand (p. 64).

So, as motorists and bicyclists move down a roadway, there are many features of that roadway that remind the travelers of what kind of behavior is expected of them in that setting. Fixed-feature elements include the width of the street, whether or not there is a curb, the kinds of buildings that line the street, perhaps the type and quality of the pavement. Semifixed-feature elements include pavement markings, roadside signs, street furniture, trees, lawn ornaments. Nonfixed-feature elements include the volume of traffic and the mix of cars, trucks, busses, bikes, and pedestrians. From these clues, motorists get a sense of what speed is most appropriate and of what kinds of hazards to watch for. The clues affect bicyclists' sense of comfort and safety in ways that vary considerably from bicyclist to bicyclist. In the next chapter, we will explore "psychological processes" related to that nonverbal communication called bike lanes. We will see why these settings elicit different meanings and behaviors and how these differences, combined with the inherent tension between knowledge in the head and knowledge in the world, create the conflict we see among bicyclists today.

Asking the right questions

The Intermodal Surface Transportation Efficiency Act of 1991 raised hopes that transportation planners would become more responsive to public input. Federal guidance on public involvement paints a picture of grass-roots planning:

> A good indicator of an effective public involvement process is a well informed public which feels it has opportunities to contribute input into transportation decision-making processes through a broad array of involvement opportunities at all stages of decision-making. In contrast, an ineffective process is one that relies excessively on one or two public meetings or hearings to obtain input immediately prior to decision-making on developed draft plans and programs (FHWA/FTA, 1995, p. 6).

Put another way, transportation planning is moving away from a process by which a few technocrats plan *for* the community and toward a process where the experts' role is to create plans by working *with* the community. This helps prevent unfortunate products of that designers' mind set Deasy called "naive realism," as discussed in the last chapter, where designers' training and experience so shapes their viewpoint, that they can't see or appreciate the problems other system users face. But there is a trap within this noble trend.

One Ohio city, for example, recently conducted a "Bikepath Opinion Survey" to assess "the value bike paths play in our community." In essence, the six-question survey asked residents if they wanted more bike paths. There are several problems with this. One problem is that it's a backward approach to planning. As Williams (1993d) puts it:

> One way to come up with trivial results is to start with a solution in hand and look for a problem it can solve. The idea is to only look at the problem closely enough to justify our preconceptions and determine its usefulness in furthering our agenda. A closer view may present a more complicated problem to solve. And a more complicated problem may require a different solution.

The transportation planner or engineer who believes his primary obligation to bicycling is to build paths (or lanes) is like a physician who believes his primary task is to administer penicillin. It's prescription without examination or diagnosis.

The Ohio city's survey used the terms "bikeways" and "bike paths" interchangeably and made no mention of the differences between paths, lanes, routes, traffic calming, or any other approach to accommodating bicycling. Even if the survey had offered more options, though, few residents have much experience with or understanding of those options; so their choices would have little meaning. And it would still be starting with a solution before identifying a problem.

If the planner's role is to work *with* the people, but asking people what kind of facilities they want is fruitless, what then? According to Constance Perin, the environmental designer needs to ask not what people *want*, but what people want to *do:*

> ...the emphasis on behavioral expectations is intentionally a departure from

> "preferences," in that behavior that is satisfying is likely to be preferred, and people are more likely to have ideas about alternative ways of achieving satisfactory behavior whereas they may be lacking in preferences for what they have never experienced. By raising questions of detailed preferences for environmental ensembles instead of questions about the behaviors people find necessary for attaining their ends, the designer is hemmed in with limitations to his imaginative abilities, right from the start (Perin, 1970, pp. 72-73).

The first step in planning for bicycling is to find out what people want to do on their bikes, the ways in which they are successful in carrying out those behaviors, and the ways in which they find it difficult to do what they want to do. Only then does it make sense to talk about what changes a bicycle program should advocate. The last step in planning for bicycling, the measure of a bicycle program's success, is not the number of miles of facilities a city has built. It is the ease with which bicyclists can do what they want to do:

> The concept environmental design might organize its data around, as it measures and estimates the consequences of what it does and proposes to do, is that of the *sense of competence* people have in carrying out their everyday behavior...(Perin, 1970, p. 45).

The next two chapters will look at bicycle facilities as environmental design. This should make it easier to see the ways facilities such as bike lanes contribute or detract from bicyclists' sense of competence. The last chapter, of conclusions and recommendations, will include suggestions for assessing bicyclists' sense of competence.

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Chapter 7
Facilities of Fashion: From Bike Paths to Bike Lanes

> How charming to control a complicated and ornery society by bestowing upon it rather simple physical goodies. In real life, cause and effect are not so simple (Jane Jacobs, 1961, p. 113).

This paper focuses on bike lanes for several reasons. One is that lanes have become the preferred facility for many bicycle advocates and advocacy organizations of late. Also, because of that popularity, a lot has been written lately in attempts either to justify or disparage bike lanes, and much of this literature provides excellent evidence that many contemporary bicycle program professionals remain "one-eyed" and pseudoscientific despite claims on both sides of the controversy that we now have the information and understanding we need to make wise decisions about these and other facilities. Finally, bike lanes are like ink blots. As we will see, their actual functions and meanings are fairly innocuous and ambiguous. People with strong feelings about bicycling tend to project their feelings into bike lane issues. And if we look beyond traditional clashes and cold statistics, if we dig for the roots of the feelings that run so strong, then we can put a more human face on our approach to bicycle facility design, planning, and research.

A holistic trend

In the 1960s and early 1970s, bike paths were all the rage. A 1973 bikeway plan for the Dayton, Ohio, area describes bike paths as "perhaps the most ideal type of bike facility" (Miami Valley Regional Planning Commission, 1973, p. 94). At the time, literature on bicycle facility design commonly put on an air of technical sophistication by labeling different types of bicycle facilities–bike paths, bike lanes, bike routes–with stodgy jargon: Class I, Class II, and Class III bikeways. This esoteric system may have given bikeway techies a rush, but otherwise hindered communication because the labels it used were, by themselves, meaningless. That is, unlike the descriptive term "bike lane," the term "Class II" tells you nothing about the facility unless you study the manual. In another sense, though, the labels were not meaningless at all. They implied that bike paths (Class I) were first class facilities and everything else was second or third rate.

Fortunately, most modern literature has left the class system behind. (One exception is the California state design guidelines.) We now recognize more types of bicycle facilities than will fit into that simplistic scheme. Also, descriptive labels enable us to communicate more clearly than the old class system. Most importantly, we now realize that no one type of facility is "most ideal." Each has places where it is most fitting and places where it is most ill-suited.

Although this chapter will focus on bike lanes, it is hard to understand bike lane issues without understanding the major alternatives: bike paths and wide curb lanes. So we will start with descriptions of these alternatives before we launch into bike lane issues.

Paths

Bike Path: A bikeway physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right of way or within an independent right of way (American Association of State Highway and Transportation Officials [AASHTO], 1991, p. 3).

The question of fit is most important with bike paths. In some places, these facilities provide wonderful transportation and recreation for bicyclists of widely diverse abilities. In the wrong places, though, paths are dangerous impediments to bicycle travel. To make this more clear, we'll look at two distinctly differently kinds of bike paths: side paths and rail trails.

Side paths

Also known as sidewalk bike paths, these facilities run along the sides of roads like sidewalks. Often they *are* sidewalks transformed into bike paths with "Bike Route" signs. As bicycle transportation facilities, side paths seldom allow bicyclists as much freedom of movement as the roadway. Frequently, side paths create more safety problems than they solve. Studies both in the U.S. and abroad have revealed high bicycle-motor vehicle accident rates on sidewalk bike paths, some as much as three times higher than the accident rates for on-street facilities, such as bike lanes (Clarke & Tracy, 1995, p. 85; Williams & McLaughlin, 1992, p. 7). A study in Palo Alto, California, found that, although streets with side paths carried only 15 percent of the city's bicycle travel, those same streets hosted "70 percent of the reported bicycle/motor vehicle accidents on the bikeway system" (Zehnpfenning, Cromer, & Maclennan, 1993, p. 32). The *State of Oregon Bicycle Master Plan* summarizes some of the problems:

Sidewalks are generally unsafe because they put the cyclist in conflict with motorists using driveways and with pedestrians, utility poles and sign posts. Also, the cyclist is generally not visible or noticed by the motorist so that the cyclist suddenly emerges at intersections, surprising the motorist and creating a hazardous condition. Every attempt should be made to allow bicyclists to function as vehicle drivers, rather than as pedestrians (Oregon Department of Transportation, 1988, p. 24).

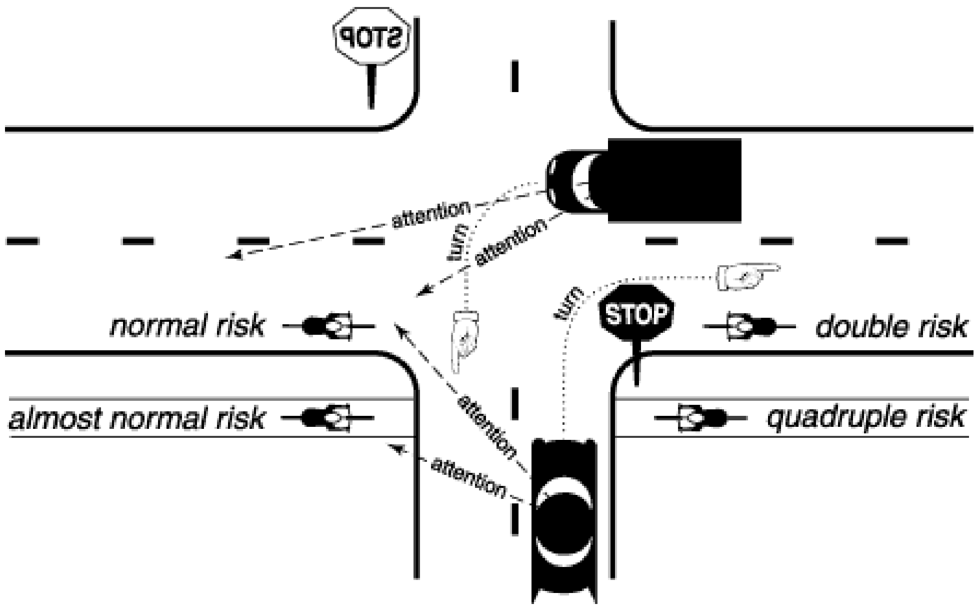
The American Association of State Highway and Transportation Officials' *Guide for the Development of Bicycle Facilities* (1991), lists eight problems with side paths. Among them are encouraging wrong-way riding, increased conflicts at intersections, motorists blocking the paths while exiting side streets and driveways, bicyclists having to stop at every side street, and motorists harassing bicyclists who use the adjacent street (pp. 22-23).

Intersection complications

Wachtel and Lewiston (1994) carried out a very selective analysis of side paths in Palo Alto, California. The researchers' goal was to compare the car-bike collision risks for cyclists on sidewalk bike paths with that of cyclists riding on streets adjacent to those paths. To accomplish this, the researchers did traffic counts of the bicyclists at three arterial intersections to determine the relative percentages of bicyclists on the sidewalk and on the street. Then the researchers compared those percentages with actual car-bike crash data for those intersections. If there was a match, if the percentage of observed bicyclists who were on the sidewalk matched the percentage of collisions that involved sidewalk cyclists, for example, then that would indicate no difference in risk between street and sidewalk. They found that bicyclists crossing intersections from sidewalk bike paths were 1.8 times more likely to collide with cars than were bicyclists crossing intersections while riding in the street.

Figure 5

Side path intersection hazards and risk factors from Wachtel and Lewiston 1995 study.



On closer examination, though, Wachtel's and Lewiston's most dramatic finding was not the difference between road and sidewalk, it was the difference between riding with traffic and against it. In fact, they found very little difference in risk between road and sidewalk for cyclists riding with traffic. But when riding against the flow, road riders had twice the risk and sidewalk riders had four times the risk of those riding the same direction as the motor traffic on their side of the street. Figure 5 illustrates two kinds of motorist maneuvers that are particularly dangerous to wrong-way cyclists, primarily because motorists focus their attention on traffic coming from the other direction.

The overall higher risk for sidewalk riders, then, was due to the high percentage of wrong-way riding on the sidewalk and to the high risk for those wrong-way riders. It would seem that as long as sidewalk cyclists ride with the traffic, they run no greater risk of an intersection collision than do road cyclists. If that is true, then right-way sidewalk cyclists, who are removed from the threat of mid-block overtaking collisions, appear to be better off than road riders. Once again, though, it's not that simple.
For one thing, the study only dealt with roadway intersections. Sidewalk riders, even right-way sidewalk riders, probably run a higher risk at driveways; and they have to cross every driveway, including busy entrances to commercial parking lots, whereas road cyclists travel a track that's beyond the point where motorists have to stop before entering the roadway.

In addition to the safety problem, sidewalk riding tends to be slow and confining. Riders move slowly and cautiously because of driveways, pedestrians, and stops at every intersection. In the rare cases where side paths cross few intersections or driveways, bicyclists may still have to deal with being struck on a facility that is not well connected with the streets that will take them where they want to go. Even to reach a destination on the opposite side of the street from a bike path, a cyclist may have to dismount, walk through wet grass, wait by the curb for a break in the traffic, then dash across the road. For a street-savvy cyclist, that's a demeaning maneuver compared with a simple vehicular turn. In addition, any cyclist who approaches the street from the non-path side is apt to have an awkward time getting onto the path. A cyclist who both approaches and wants to exit from the non-path side is likely to forgo the path in favor of a more simple option.

Anyway, one particularly valuable aspect of Wachtel and Lewiston's study is that the researchers compared statistics for bicyclists crossing the same locations during the same period of time. Bike-path safety evaluations that compare all crashes at a location before and after a facility is built can be misleading. Garder, Leden, and Thedeen (1994), whose own study of intersections with stop lights led them to conclude that bike paths increased accidents by 40 percent, remarked that before-and-after studies have yielded conflicting results, perhaps because of factors that inspired the paths to begin with:

> Furthermore, countermeasures are usually installed where a large number of accidents have been recorded. That the number is large might be caused by the fact that the intersection actually is dangerous or by the fact that an abnormally high number of accidents occurred by chance. A consequence of this is that a number of countermeasures have seemed to be effective, even though they really have not had a positive true mean effect; rather, they may even have been counter productive. The explana-tion for this is usually called the regression-to-mean effect; i.e. that a randomly caused high accident number is probably followed by a lower number, even though nothing has changed. This has led to misinterpretation of several–and most older–nonexperimental evaluation studies.
>
> ...*before-and-after studies,* without control for the regression-to-mean effect, usually have a tendency to *overestimate the accident-reducing effect* (pp. 430, 435).

The emphasis is theirs. We will see examples of this problem when we look at crash comparisons done on bike lanes.

So, state-of-the-art wisdom says that "bike paths are not a convenient way of simply 'getting cyclists out of the way of motor vehicles,' and should never be developed with that intention in mind" (Wilkinson, et al., 1994b, p. 63). Yet, once a side path is in place and city officials proudly point to it as an expensive gift to bicyclists, any suggestion that cyclists' needs have not yet been met will likely fall on deaf ears and the road itself, which could afford cyclists the greatest freedom and flexibility, and often the most safety, will remain ill suited to bicycling.

Trails

Of course, if there are no intersections or driveways to cross, a cyclist on a bike path has no risk of colliding with a car. So paths that run through the country along abandoned railroad beds or that run along river banks beneath city bridges are not at all the same as most side paths. (For convenience, I'll us the term "trail" for any path that is not primarily a side path.) Simply put, car-bike conflicts are few where intersections are few, particularly if what intersections do exist are simple, perpendicular road crossings without the complicating influence of motorists entering and exiting a road adjacent and parallel to the path.

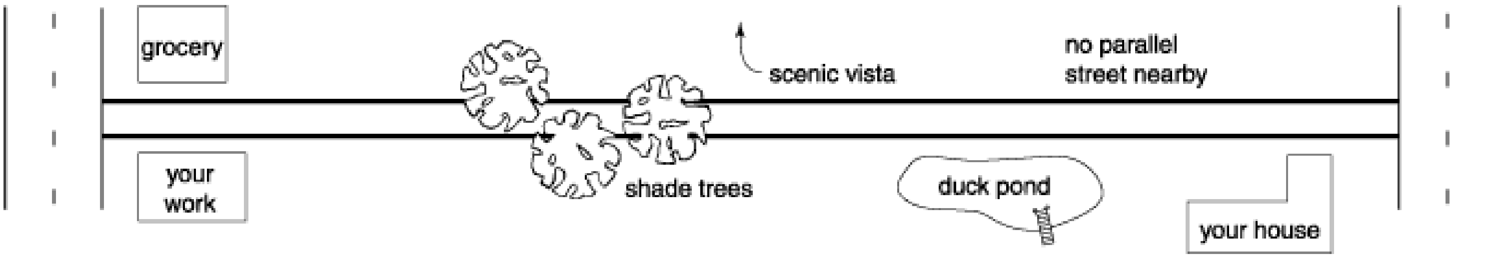
Trails are the most grand and inspiring of bicycle facilities. They can run for many miles through scenic greenways. They can be used to preserve abandoned railroad corridors, along with historical tunnels and bridges. Hikers, joggers, skaters, people in wheelchairs, and bicyclists can commune with nature away from the noise and fumes of motor traffic.

From an urban transportation point of view, though, even these facilities are far from being "most ideal." The League of American Bicyclists' advocacy director, Noel Weyrich (1995), writes that trails "can poison the minds of planners, politicians, and other citizens in strange and dangerous ways." He adds that "...many counties have put together their "comprehensive bike plans" by merely compiling lists of planned trail rights-of-way, ignoring potential on-road accommodations entirely."

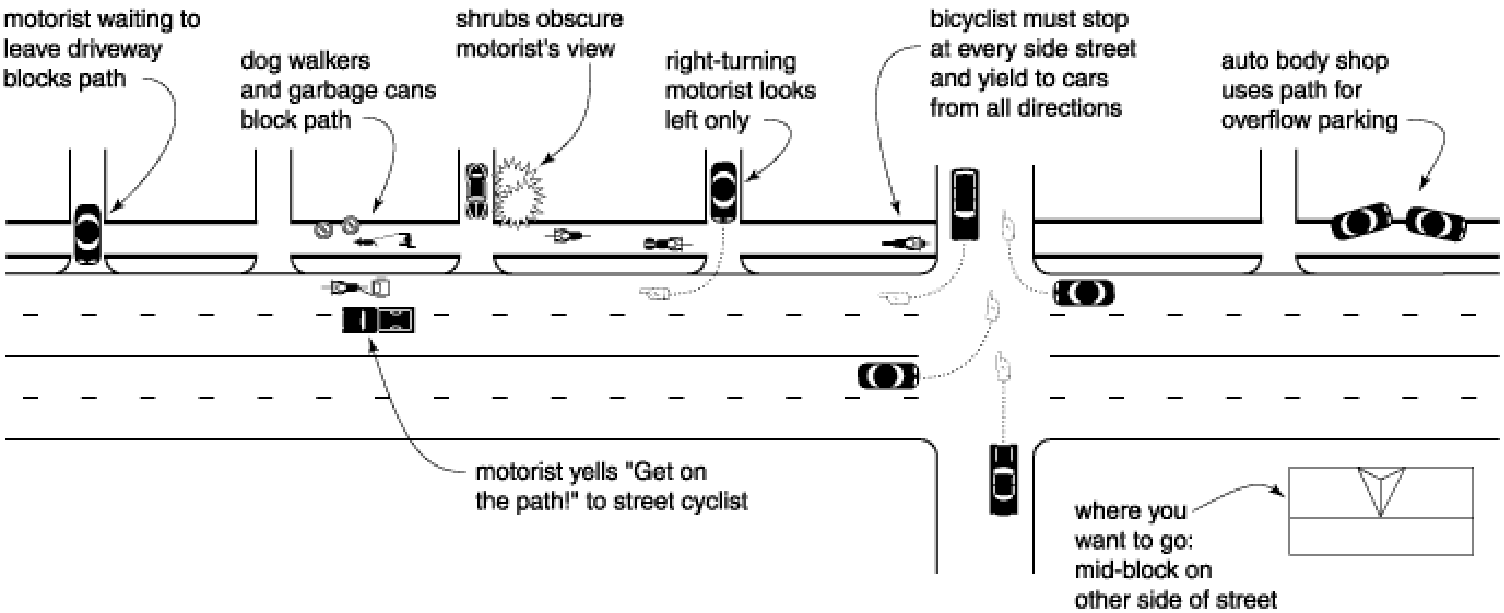
Clarke and Tracy (1995) have listed a set of "ground rules for accepting the legitimacy and value of separate facilities such as these." The rules include dropping the term "bike paths" in favor of "multi-use trails," which better describes the nature of these facilities that attract dog walkers, baby joggers, skaters, and wheelchairs. They also stress the need to avoid building trails where there are frequent conflicts with cross traffic at intersections and driveways. Authorities must not mandate trail use and must realize, Clarke and Tracy say, that trails may serve novice riders and children, but have "limited utility" for faster cyclists. Also, trails are "an addition to the highway system, not a substitute for it." That is, the presence of a trail should not preclude making streets better for bicycling. "Indeed, bicycle use on roads adjacent to trails will frequently increase," the authors add (p. 87).

Figure 6

A safe, isolated trail and a hazardous side path.



The best of paths (above), the worst of paths (below).



In practice, there are three kinds of bike paths: the best kind, the worst kind, and the kind you're likely to meet in real life. Almost any trail has some intersections, for example. The corridor it follows may occasionally run next to a road. When such a trail runs through a city, the advantages of maintaining the continuity of the trail may outweigh the disadvantages of some clumsy side-path stretches. There is no absolute formula for making that call (Wilkinson, et al., 1994b, p. 64).

Forester (1993), on the other hand, says "by far the most dangerous facility is the bike path, with an accident rate 2.6 times that of the average roadway" (p. 262). That sounds very exact and scientific, pegged with a decimal point. But the number comes from a twenty-year-old study of cyclists who had to deal with some of the worst kinds of paths. Design guidelines have come a long way in two decades. If Forester's assessment of bike paths in general seems unreasonably harsh, his slant on side paths looks downright phobic. "By actual measurement, during commuting traffic hours," he says, "side path bikeways with most of their intersections protected by stop signs produced 1,000 times more serious car-bike conflicts than normal cycling on the same roadways at the same time of day." Forester's "actual measurement" consisted of a single ride he took on a four-mile stretch of side path and the "serious car-bike conflicts" were what he judged to be near misses, not actual collisions (Forester, 1994, pp. 100-101).

Williams (1993b) describes three factors that affect bike path safety. One is the "built environment": the path's width, nearby obstructions, curve radii, number and nature of intersections, etc. Another factor is "the bicyclists." Paths attract less experienced riders, who crash more. That can skew crash data. Then there are "other users." "In general, the more 'mixed use' there is, the more stressful for all users and, potentially, the more dangerous the path is for any given user type." Williams points out that bike path crashes seldom get reported so we don't have the data we would need to devise rules for how safe or dangerous a bike path might be, given a design and location. So, "we must rely on more intuitive and, possibly, less reliable measures." "Generalized statements," Williams says, "(such as 'bike paths are X times safer–or more dangerous–than riding on the road') do little to further understanding."

Wide curb lanes

> *Wide Curb Lane:* On highway sections without bicycle lanes, a right lane wider than 12 feet...(AASHTO, 1991, p. 14).

From a vehicular cycling point of view, wide curb lanes would be the "most ideal" way to accommodate bicyclists, at least in the city. Rather than attempt to separate bikes from motor traffic, just make sure there's plenty of room on the road for motorists to comfortably pass cyclists. With wide lanes, bicyclists riding down thoroughfares don't have to cross driveways and they have the right of way over drivers approaching from side streets. The cyclists are free to make vehicular left turns from a wide curb lane, even in the middle of a block, and aren't forced to make awkward pedestrian-style turns at intersections. In heavy traffic, bicyclists can "negotiate" with motorists before changing road position.

Technically, anything wider than the standard 12 feet is a wide curb lane, although most guidelines recommend at least 14 feet of "usable width" (AASHTO, 1991, pp. 14-15) to qualify as a wide curb lane. Some design guides recommend lanes as wide as 17 feet (Clarke & Tracy, 1995, p. 77). If a lane is too wide, motorists reportedly double up in heavy traffic as if it were two lanes. Accounts vary as to the width at which this begins to happen, ranging from 15 to 17.6 feet (Wilkinson, et al., 1994b, p. 14). In any case, this effect limits how wide a shared lane can be and still function as a single lane.

Unlike bike lanes (described below), wide curb lanes are invisible. That is, there are no markings to set aside space for bikes or to affirm that bikes have a legitimate place on the road. Most significantly, wide curb lanes do not give bicyclists the sense of separation and protection from traffic that bike lanes or side paths appear to offer, however illusory that appearance may be. The feeling among many bike advocates these days is that where traffic is heavy, wide curb lanes do not adequately serve any but the boldest of bicyclists, and that something more is needed to make the more timid cyclists comfortable on city streets.

Bike lanes

> *Bike lane:* A portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists (AASHTO, 1991, p. 3).

If bike paths were the darlings of the 1970s and wide curb lanes a fad for the '80s, then bike lanes are a trendy choice for the '90s. Realizing that bike paths work well only in a very limited number of places, and that wide curb lanes don't give average bicyclists the sense of protection they desire, many bicycle advocacy groups and government bicycle programs have embraced bike lanes lately with wide-eyed optimism. "One-eyed optimism" may be a better term, though, to describe the alleged benefits being claimed for these facilities.

The Florida Department of Transportation's *Bicycle Facilities Planning and Design Manual* (1995), for example, has two nearly identical photos on its cover. One shows a car passing a bicyclist in a wide curb lane and is captioned "1982–Wide Curb Lanes." Next to it is the same picture with a bike lane stripe drawn between the car and bicyclist. Its caption reads "1992–Bike Lanes." "Wide curb lanes," the manual says, "are to be used in Florida only as a last resort" (p. 10). It also says that bike lanes "are to be used on future urban roadway sections, whenever right of way and existing curb/drainage sections permit" (p. 13).

The manual says that bike lanes:

- Establish the correct riding position for bicyclists.
- Establish the correct riding direction for bicyclists.
- Reduce motorist and bicyclist sudden swerves (lane changing).
- Reduce serious bicycle crashes by up to 80 percent within some corridors.
- Guide bicyclists through intersections in the safest, most predictable course.
- Permit bicyclists to pass motorists stopped at a signal.
- Permit motorists to pass bicyclists on 2-lane roadways.
- Send a message to motorists that bicyclists have a right to the roadway.

Most of these "benefits" are questionable. As we saw in the chapter on how bicyclists behave, bike lanes have their share of wrong-way riding; in some studies they had more than their share. In fact, the lanes create a more comfortable space in which to ride the wrong way, and some bicyclists take advantage of this affordance.

According to vehicular cycling principles, the "correct riding position for bicyclists" is highly variable, especially at intersections, so fixed marks on the pavement have only limited use as guides. Also, we might ask how safe it is to encourage bicyclists to pass motorists stopped at signals, and could question whether the message to motorists might just as well be that bicyclists must stick to one small part of the roadway.

Of all the claims, the one that looks most impressive is that bike lanes "reduce serious bicycle crashes by up to 80 percent within some corridors." This 80 percent reduction seems possible, with an emphasis on "serious" crashes within "some corridors." We would expect bike lanes to reduce or eliminate overtaking crashes. In some corridors, namely on rural roads, Type 13 alone makes half of all car-bike fatalities (Williams, 1993); and fatalities are about as serious as crashes get. Furthermore, this 50 percent is just an average, so some kinds of corridors no doubt have above average frequencies of Type 13 crashes. if we add the four other types of overtaking crashes and perhaps some bicyclist ride-out crashes, it may be that in some corridors bike lanes could create an 80 percent reduction in serious crashes–just maybe. Unfortunately, the study from which the authors of the Florida manual got their 80-percent figure does not very well support the claim.

According to Mary Ann Koos (personal communication, June 23, 1995), the 80 percent figure comes from a study of car-bike crash reports in Gainesville, Florida, that Koos did while she was bike coordinator for that city. During the first year of the study period, the city had five fatal crashes. That's a high number for a city that size, even considering Gainesville's large bicycling population. During the following four years, Koos said, there were "one or two" fatal car-bike crashes each year.

The city first began painting bike lanes on major streets in the late 1970s, according to Koos, and continued to put bike lanes on more streets throughout the five-year study period. So the study, which began in 1984, was not a clean before-and-after assessment of the effects of bike lanes. Certainly, the mere fact that the city recorded five fatalities during the study's first year and only one fatality in a succeeding year falls far short of demonstrating that bike lanes brought about an 80 percent reduction in serious crashes.

Acknowledging that the number of car-bike fatalities in a city naturally varies considerably from year to year, Koos spoke more proudly of the fact that non-fatal motorist-bicyclist crashes in Gainesville declined 16 percent during the study period. It is not possible to say how much these crash reductions are due to bike lanes, how much the city's bicycle safety public information campaign contributed, or how much is normal variation unrelated to anything the city did.

Figure 7

Ohio car-bike collisions, 1980 through 1993.

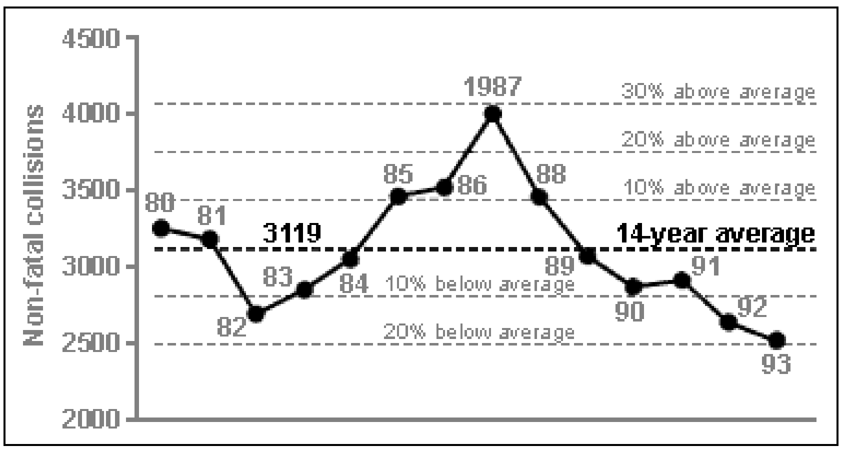


Figure 7 offers some perspective. In 1987, there were 4,018 motorist-bicyclist crashes reported in the state of Ohio. After that year, the statistic dropped steadily to 2,541 in 1993 (Ohio Department of Public Safety, 1994). What's more, fatalities fell from 42 in 1987 to just 15 in 1993. Why? Perhaps bike riding reached an all-time high in 1987. Maybe Greg LeMond inspired a surge. Maybe the weather had something to do with it. Certainly, there was no massive proliferation of bicycle facilities to account for the statewide drop in crashes. An increase in helmet wearing would decrease fatalities, but not the non-fatal count. And too few Ohio cyclists wear helmets to decrease fatalities that much.

In any case, it's a documented fact that from 1987 to 1993 Ohio cut its reported car-bike crashes by 36.8 percent and its fatal crashes by 64.3 percent. The state's Bicycle and Pedestrian Administration missed an opportunity in 1987 to launch a bicycle safety campaign. The program would have appeared to be wildly successful, even if it did nothing at all.

More claims for bike lanes

If the Florida Department of Transportation's manual was an isolated case of reaching into the fringe to justify bike lanes, there would be no need to waste space here questioning the claims. But these days the ranks of bicycle program professionals seem riddled with one-eyed prophets extolling the virtues of painting thick white lines on pavement. This would not be so bad if they got their claims right. Bike lanes do have virtues. But there is as much myth as meat in a lot of what bike lane boosters are saying.

For example, the Bicycle Federation of America (1993a) reports that bike lanes in a San Diego community reduced car-bike crashes (p. 8). Forester (1994) disputes this, saying that the accident reduction came not from the bike lanes but from “the prohibition of parking motor homes and boats on the street” (p. 33). When cities install bike lanes, it is rarely just a matter of laying down stripes. They remove parking, widen streets, remove sight obstructions, and launch public awareness and safety campaigns. In some cases, an anomalous spike in bike crashes may be what prompts a city to lay down stripes. So even if crash reports do drop significantly after a city installs bike lanes, it may just be “regression to the mean.” It’s hard to know how much credit to give to a white strip and how much to these other factors. When Ronkin (1993), for example, says that there were 40 bicycle accidents reported in Corvallis, Oregon, the year before that city installed 13 miles of bike lanes, and only 16 the year after, the reasons for that drop are not as obvious as they at first appear.

Smith and Walsh (1988) conducted one of the rare before-and-after bike lane safety studies that takes into account a number of threats to validity. Madison, Wisconsin, had tracked its bicycle crash reports and had done regular bike traffic counts starting several years before the city installed bike lanes on Johnson and Gorham streets. Using this data, the researchers were able to control for fluctuations in ridership and to compare any changes in crash reports on the bike-laned streets with trends throughout the city during the study period of four years before and four years after the lanes were installed.

Essentially, Smith and Walsh failed to find a significant change in the crash rates on those two streets. There was a slight increase in crashes on Johnson, but only during the first year. The bike lane was installed on the left side of that one-way street to avoid conflicts with frequent right-turning traffic. Apparently, motorists who had grown used to having cyclists on their right on Johnson Street needed time to adjust to the new arrangement.

There are two conclusions we can confidently draw from bike lane safety studies: Bike lanes don’t always decrease car-bike crashes, and bike lanes don’t always increase crashes. Seattle, Washington, bike coordinator Peter Lagerwey calls the bike lane safety issue “a wash,” and *Bicycle Forum* editor John Williams says, “All in all, I don’t think you can either sell bike lanes or oppose bike lanes on the basis of data showing their effects on bike crash problems” (Williams, 1993c, p. 12).

Encouragement

Another benefit that proponents claim for bike lanes is that these stripes on the pavement encourage people to ride bikes. No doubt there is some merit to this claim. Nevertheless, a couple of studies that are frequently cited in support of this claim deserve a closer look.

One is a Harris poll commissioned by *Bicycling* magazine that, among other things, asked survey subjects if they thought they “would sometimes commute to work if there were safe bike lanes on roads and highways” (Pena, 1991, p. 44). A full 20 percent of all U.S. adults would answer “yes” to that question, according to the poll takers. There are two problems with this. First, what people think sounds like a good idea and what people will actually do are two different things. A more important flaw, though, is in the wording of the question. It asks about *safe* bike lanes. This makes it hard to tell if the subjects responded to the general concept of safety or if they specifically liked bike lanes. I would predict similar results from a question that just said "safe routes." Surely, the response would have been far less enthusiastic if subjects were asked about "bike lanes, which may not affect your safety one way or another."

Case Study Number 1 of the National Bicycling and Walking Study is another source of bike lane enthusiasm. Goldsmith (1993) studied twenty U.S. cities to find out what factors correlated with high levels of bicycling. He found that cities with "higher levels of bicycle commuting" have on average "six times more bike lanes per arterial mile." The "presence of on-road facilities looms large," he wrote (p. 1), and has often been quoted for it.

In their rush to justify their ideology, though, bike lane advocates invariably overlook Goldsmith's caveat concerning his plot of bike lanes versus commuting:

> Still one must be cautious in making inferences because of the numerous peaks and troughs evident in this chart. Moreover, innumerable other factors such as street layout, land use, and traffic patterns–not to mention the dubious quality of bike commuting estimates–may be confounding the picture. Lastly, it should not be discounted that in some instances the presence of bike lanes may be a product of an organized, vocal, bicycle community. Under these circumstances, highly visible bicycling facilities may be a result, rather than a cause, of high levels of bicycle commuting (pp. 41-42).

Channelization

Researchers have also done a number of studies on how bike lanes influence the tendency of motorists to veer left while passing bicyclists (McHenry & Wallace, 1985; Wilkinson, et al., 1994b, pp. 23-26, 69-77). The results of these studies are often used in defense of bike lanes. As with so much in bicycling, though, not all the implications of these studies are as obvious as they at first appear. Wilkinson, et al., (1994b) list the following conclusions from a study of the "lateral placement" of motor vehicles passing bicyclists:

1. Motorists tend to slow down and move over when passing bikes on bike lanes and shared use lanes.
2. There is less slowing down and less moving over at locations with marked bike lanes than there is at locations with shared use lanes.
3. These behaviors are not correlated with bike lane width, shared use lane width, or parking lane width (p. 77).

In short, the researchers conclude that "a marked bike lane tends to direct vehicular traffic in a manner that produces less perturbance when a car passes a bike." This, they go on to say, is of particular benefit to cyclists who are not bold, Effective Cycling types. "Less confident riders need to feel that traffic is not going to be driving in the same lane with them and will not be moving about from side to side–with the potential for misjudgment–as they pass. Bike lanes make traffic behavior more predictable and reliable" for less experienced riders (p. 23).

Surely, no one would dispute the fact that many bicyclists feel more comfortable knowing that motorists have been cordoned off to the side. But the research does not show that bike lanes create *more* separation on average between bikes and cars. It's just that the amount of separation varies less from car to car with bike lanes than with shared lanes. What's more, this difference between stripe and no stripe is "most pronounced on low speed streets (25 mph), less so on medium speed roads (40 mph), and nonexistent on 55 mph roadways" (p. 24).

Let me put this another way. Suppose you are riding down a street with 17-foot curb lanes. As cars pass you, some pass more closely than others. The difference between the distance from you to the cars that pass closest to you and the distance from you to the cars that give you the widest berth is the "variation in lateral location." If you divide that 17-foot lane into a 12-foot car lane and a 5-foot bike lane, the average distance from you to the passing cars will probably be about the same as if you had no bike lane, but the "variation" will be less; the cars will drive a more uniform track. But this is most true at slow speeds. That is, motorists passing you in a shared lane differ more in how close they come to you when speeds are low than when they are high. In fact, at 55 mph the variation in a shared lane is not significantly more than the variation with a bike lane.

Now, something is strange here. Bike lanes, it is said, are desirable because they make the motorists' behavior seem more predictable, thereby reducing some bicyclists' fears of being rear ended. So far, so good. Bike lanes accomplish this fete by reducing the variation in lateral location. This, too, sounds fine. But bike lanes reduce variation most at low speeds and have virtually no effect on it at high speeds. If bicyclists fear variation so much, and enjoy bike lanes because they reduce variation, then it would seem that the slower the speed, the more bicyclists would want bike lanes in order to feel that motorists' behavior was predictable. To put it another way, if variation is what bicyclists fear, then bicyclists in shared lanes should fear slow-speed (high variation) traffic more than high-speed (low variation) traffic. This is strange.

It's not strange to assert that some bicyclists, and motorists, feel more comfortable with the delineated space that bike lanes provide. It is strange to think that these measures of variation describe some benefit that bicyclists receive from bike lanes. Yet Wilkinson, Clarke, Epperson, and Knoblauch are so confident of their premise as to conclude from the results of their study that bike lanes work best on streets "with a posted speed of 40 mph or less" (p. 31). The next chapter will put a different spin on variation studies.

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Chapter 8
Listening to Bike Lanes

So far in this paper I have diligently tried to cast doubts on assumptions that shape both sides of the bike lane debate. One of my goals has been to take a crow bar to the hard shells of dogma with which we bicycle advocates shield ourselves from bicycling's complexities and contradictions. I have also tried to paint an accurate picture of bicycle transportation, warts and all.

Still, I have stayed on the surface, have examined the more common subjects of discussion and points of contention. In this chapter, I part company with most of what has been written about bicycling and explore some different approaches to understanding bike lane issues.

Variation: threat or asset?

In the previous chapter, we saw that studies measuring the consistency, or inconsistency, of how closely cars pass bicyclists make questionable arguments for bike lanes. Nevertheless, these studies can help us describe motorists' movements if we view the data from a different perspective. First, we have to understand the concept of "shy distance." When you pass an object or another vehicle on the road, whether you are in a car or on a bike, there is a certain minimum distance at which you feel comfortable passing; any closer just feels too close because it requires too much accuracy and vigilance to avoid a collision. This distance that you shy away from things is called the "shy distance." As a bicyclist, you might be able to ride four inches from the curb, but it would be unnerving; one small mistake and you're lying on the sidewalk. Most cyclists ride at least a couple of feet from the road's edge, often farther, so they can give their attention to everything else that's going on around them.

Shy distance is related to speed. The faster you go, the more distance you want between you and something you pass. At higher speeds you have less time to identify and respond to the obstacles in your path. The results of your responses are magnified by your speed, so you have to be more accurate. If you need to drive through a space that is only slightly wider than your vehicle, you will proceed slowly so you can thread that needle without scraping the sides. If you have lots of room, you can sail through. Conversely, in a given space you have more room to maneuver at slow speeds than at high speeds. That is, if you are driving a car at 25 mph past a bicyclist in a 15-foot lane, your shy distance on either side of you is smaller and takes up less of the lane than if you were doing 55. So you have more leeway at slower speeds; you can comfortably pass more closely by the bicyclist if you want, or move out nearer the on-coming traffic—again, it's because at slower speeds you have more time to correct your errors or respond to changes in what's happening around you, and you can maneuver more accurately when you do respond. At high speeds, your shy distance increases, taking up more of the available space and narrowing your choice of trajectories—again, it's because at higher speeds you have less time to correct your errors or respond to changes in what's happening around you, and you cannot maneuver as accurately when you do respond.

In short, the variation in lateral position the researchers observed can be interpreted as a measure of the motorists' ability to respond. That response ability is not a bad thing. It partly explains why, in the real world, bicyclists feel more comfortable riding among slower motor vehicles than they do in faster traffic. Furthermore, if you drop the premise that bike lanes should reduce variations in lateral position and substitute the assumption that their channelization is most needed where motorists have the least ability to respond and correct for misjudgements, then you come to the more reasonable conclusion that it's the higher-speed roads where the lanes "work best"—remember also that high speeds are a major component of those Type 13 fatalities, a kind of crash that bike lanes could help prevent. In addition to speed, hills and turns would also reduce response ability by reducing sight distances.

Response ability and vehicular cycling

To the vehicular cyclist, the more response ability motorists have, the easier it is to establish communication. Motorists' response ability makes it possible for a cyclist to "negotiate" a lane change, for example. When experienced cyclists vary their road positions to signal their intended tracks through intersections or to keep from getting squeezed into hazards up the road, they depend on motorists' ability to notice and respond to these nonverbal signals. Remember, Forester says that bicyclists must resort to being “road sneaks” when the motor traffic is moving more than 15 mph faster. Forty-mile-per-hour motorists have less ability to respond to cyclists’ body language than 25-mph motorists.

So, variation is a measure of response ability and bike lanes decrease variation. Of course, it doesn’t necessarily follow that by decreasing variation bike lanes decrease motorists’ ability to respond to cyclists. Even so, some bicyclists charge that bike lanes decrease motorists’ *inclination* to respond. They say they feel trapped, that motorists won’t let them out of the lane to get into position for a left turn. In a typical response, Oregon bike lane advocate Michael Ronkin acknowledges that left turns are often difficult when bicycling in traffic, but says:

> This has nothing to do with bike lanes versus shared roadways either way, a bicyclist is going to have to be prudent and look over their shoulder repeatedly before merging to the left. A bike lane does not trap a bicyclist: they may cross over the white line to turn left, pass other cyclists or avoid road hazards (Ronkin, 1993).

Ronkin’s statement is probably true for many bicyclists who never try to negotiate with motorists. Cyclists who always think of themselves as road sneaks, who don’t make a point of establishing communication with motorists, would feel no more trapped with bike lanes than without them. But Ronkin’s reply doesn’t address the heart of the complaint against bike lanes. Effective Cyclists do not passively “look over their shoulders repeatedly” and simply wait until it is “prudent” to merge left, they actively use body language to create an opening into which they may move. Some cyclists feel that the thick, solid bike-lane stripe creates a psychological barrier that makes it harder to “ask permission” to move over.

This may seem like a small point, not something likely to create great chasms within the bicycling community. But if we examine these views from the perspective of contemporary stress theory, we can better understand just how deep the division runs.

Cognitive stress theory, system image, and perceptions

According to the cognitive theory of stress and coping developed by Lazarus and colleagues, the amount of stress a person feels in a situation depends on what that situation means to the person. That meaning arises through two kinds of appraisal. In "primary appraisal," the person judges the degree of threat he faces. In "secondary appraisal," the person takes inventory of his resources and options for dealing with the threat (Folkman, 1984, p. 840). In other words, the more a situation appears to threaten your well being, the more stress you feel. But you can mitigate this effect if you believe you have ways of dealing with the threat, if you believe you have some control. (Although the theory just stated will serve our purposes, secondary appraisal has actually proven to be more complicated. Sometimes, for example, it's not clear how much control you have, in which case you might read into that ambiguity either that you do or you don't have control; your choice reflects your personality. Also, sometimes taking control requires us to break our usual ways of thinking or doing things, which can be more stressful than not having control.)

Using this stress theory as an analytical framework, I will now describe two bicyclists. Call these bicyclists hypothetical, stereotypical, archetypal; each is a composite of many bicyclists I have interviewed. Stress theory can help us understand bicycle facility issues on a level that is closer to the heart of what bicyclists think and feel, closer than we could ever get by looking at crash statistics alone.

Gus the ordinary guy

Gus's primary and secondary appraisals make him feel pretty uncomfortable in the presence of overtaking motorists. Getting hit by a speeding car is a threat to a bicyclist's health (primary appraisal); no one would dispute that. While Gus is riding in heavy traffic, he notices that it's the overtaking vehicles that pass him most closely, most often, and at the highest speeds. So he naturally worries most about the cars that come from behind. What's more, once in a while a motorist inflames Gus's fear of being rear ended by passing too closely, blasting the horn, shouting, or tossing a pop can out the window. Plus, it's almost always overtaking motorists who do these things. It's only while overtaking that motorists have time to think up such abusive deeds. In any other situation, motorists' interactions with Gus are much too fleeting. Although the vast majority of motorists pass Gus carefully and politely, the rare transgressions make an impression:

> If there were a thousand similar events, we would tend to remember them as one composite prototype. If there were just one discrepant event, we would remember it, too, for by being discrepant it didn't get smudged up with the rest. But the

> resulting memory is almost as if there had been only two events: the common one and the discrepant one. The common one is a thousand times more likely, but not to the memory; in memory there are two things, and the discrepant event hardly seems less likely than the everyday one.
>
> So it is with human memory. We mush together details of things that are similar, and give undue weight to the discrepant. We relish discrepant and unusual memories. We remember them, talk about them and bias behavior toward them in wholly inappropriate ways" (Norman, 1988, p. 118).

So what Gus sees around him when he's riding—the system image of the cycling environment—makes him wary of overtaking motorists. To him, they pose an in-your-face threat. Crossing and turning collisions, on the other hand, are out of sight and out of mind. He spends most of his cycling time between intersections, so his crossing and turning interactions with motorists are few and far between compared with being overtaken. When he does turn, he tries to wait until he is nowhere near a speeding vehicle. If it's the motorist who is turning, the vehicle is usually moving slowly when it crosses Gus's path, and that car rarely comes anywhere near as close to Gus as do overtaking motorists. So Gus's primary appraisal is that crossing and turning is not a big threat. (Of course, crossing and turning collisions are so common precisely because they take both bicyclists and motorists by surprise.)

So far, we have only looked at Gus's primary appraisal. He also believes he has little control over overtaking collisions. This secondary appraisal arises from two things. First, Gus has no rear-view mirror and rarely looks behind him while he's riding for fear he will swerve if he turns his head to glance over his shoulder. As a result, overtaking motorists approach unseen, giving Gus the impression that if he is struck from behind, it will be without warning and so without any possibility for evasive action. Second, Gus does not know of any action he could take to help prevent an overtaking collision; he believes he is totally at the mercy of motorists, including some who are careless or even hostile. In contrast, crossing and turning interactions happen in plain view in front of him or from the side. It appears to Gus to be much easier to see these threats coming and so easier to avoid them.

If, as Forester asserts, many bicyclists fear overtaking collisions more than they should, we can now understand why this might be. For Gus, the key is right there in the system image. The real-life experiences of riding in traffic, the messages carried in the sights and sounds, conspire to convince him that he has plenty to fear from the rear. What's more, this same dynamic shapes motorists' perceptions. Their most frequent and stressful interactions with bicyclists involve trying to squeeze by in shared lanes. So motorists, too, are apt to see overtaking as their primary threat to cyclists.

The implications are profound. Whether or not we as bicycle advocates believe that overtaking motorists are a major threat to cycling, whether or not we think that protecting cyclists from these passing cars should be our highest priority, whether or not we believe that facilities such as bike lanes offer any real protection, we have to understand that the fears people feel are real and that those fears are fostered and perpetuated by the cycling environment, by the system image.

True, there are "bicycle safety" efforts that inappropriately reinforce the fear. But those efforts would have little power or credibility if life on the street did not seem to confirm the message. Gus does not suffer from, as Forester would put it, a "phobia" perpetrated by anti-bicycling interests. Gus's concept of the dangers he faces while cycling may not match actual crash statistics, but he has nevertheless reached his conclusions through a rational interpretation of his observations.

Betsy the Effective Cyclist

Having taken an Effective Cycling course, Betsy feels comfortable riding in traffic. She's much more comfortable than Gus with overtaking traffic. The program shaped both Betsy's primary appraisal of the overtaking threat and secondary appraisal of her skills and options for dealing with that threat.

First, Effective Cycling taught her that motorist-overtaking collisions make up a tiny portion of all the ways in which bicyclists crash. So rear-end collisions are virtually insignificant, the story goes. Like a hypnotist, Forester repeats this message over and over in the course text. In addition to reducing Betsy's primary appraisal of the threat, Effective Cycling taught her to communicate with overtaking motorists, to affect motorists' behavior through her body language and road position. Betsy gets a sense of security not from staying out of the way of motor vehicles, but from actively establishing communication with drivers. Unlike Gus, she does not feel helpless. Her secondary appraisal is that she can join the flow and influence the traffic around her. Betsy has “knowledge in the head” that informs her experience of riding in traffic. Her experience is different from Gus’s because she interprets the system image differently. Also, she has a sense of competence while riding in traffic. To her, the cycling environment aids her in getting where she wants to go. For the most part, she sees traffic not as something she has to struggle through, but as something she rides cooperatively with.

Bike lanes: Knowledge in the environment

Gus loves bike lanes. That six-inch white stripe assures him that motorists will stay to the left when passing. It relieves him of uncertainty; he knows where the overtaking car will be. With the stripe he no longer feels helpless, it seems to afford him a simple technique for staying out of harm’s way: Stay on the right side of that line. Bike lanes also give him road space to call his own. Motorists can’t challenge him for being on the road. The pavement markings leave no question about his right to ride there.

Betsy, however, is frustrated and annoyed by bike lanes. The very premise behind bike lanes conflicts with her belief that overtaking traffic is not a significant threat. To her, the stripe is not only unnecessary, it creates a psychological wall that separates her from motorists and undermines the sense of security she would otherwise get from feeling that she is part of the traffic flow. It “says” that motorists and bicyclists both shall stay in their places. The area to the left of the bike lane is often referred to as the “car lane,” a term which implies that it’s for cars only, just as the bike lane is for bikes only. Being accustomed to using the entire roadway, Betsy does not share Gus’s feeling of having gained legitimacy on the road with bike lanes. Instead, she feels like she has lost ground, has been confined to one small part of the street. When moving out of the bike lane to set up for a left turn, she feels as if she is encroaching on motorists’ territory. Also, she finds that it’s harder to get motorists’ attention when she wants to negotiate her way across the roadway, and drivers seem less inclined to let her in when she does catch their eyes. It’s as though motorists pay less attention to cyclists, perhaps because they assume that cyclists will stay in their place. The motorists do not understand why bicyclists would want to ride anywhere but within what appears to be a safe zone.

Bicycle facility design guidelines, both at the state and national level, commonly recommend that bike lane stripes be dropped 50 feet before intersections to make it easier for bicyclists to get into the best position for a turn. But Betsy wants to begin getting into position 300 feet before the turn. Moreover, she sometimes needs to turn mid-block into driveways, not just at intersections.

Also weighing on Betsy's mind as she pedals down a bike-laned street is Forester's (1993) analysis that "all practical bikeway designs increase the number and difficulty of collision situations that produce some 30 percent of car-bike collisions while reducing the difficulty of only 2 percent" (p. 547). Forester, the man to whom Betsy feels an allegiance because his writings have helped her to ride comfortably and safely anywhere she wants to go, makes bike lanes sound downright diabolical:

> So far as cyclists are concerned, the assumption is that bike lanes don't impede competent cyclists while making incompetent cyclists believe they are kept safe. So far as motorists are concerned, they believe that bike lanes keep cyclists out of their way. These assumptions contain three errors. One error is physical: we don't have, and probably will never be able to develop, bike lane designs that properly designate where cyclists should ride at the more difficult locations. The second error is political: such a system tells the world that cyclists should ride, for their own safety and because they are incompetent, in bike lanes and not on streets without bike lanes. Such messages justify the political opposition to competent cyclists and lower their social acceptability. The third error is moral: because bike lanes do nothing to reduce accidents to cyclists (and probably increase them), using bike lanes to attract people to cycling on the premise that they will be protected even if they are incompetent is immoral because it is deadly. It is deadly initially when incompetent cyclists use the roads; it continues to be deadly because it persuades people that becoming competent isn't necessary for safety (Forester, 1994, p. 124).

Forester (1994) claims to have produced a study with statistical confidence levels of 95 to 99 percent, that "compared the behavior of cyclists in cities with bike-lane systems against the behavior of cyclists in cities without bike lanes" (pp. 119, 136-141). Because he saw bicyclists in the bike-laned cities of Davis and Palo Alto deviate from his list of acceptable cycling techniques more often than the cyclists he observed in the non-bike-laned city of Berkeley, he concluded that he had shown the detrimental effects of bike lanes. Unfortunately, all we can conclude from the study is that the cyclists he observed riding in Berkeley scored better on his proficiency test than those he observed in Davis and Palo Alto. To draw a general conclusion about bike-laned cities as opposed to non-bike-laned cities he would need a study sample of more than just three cities. It seems reasonable to expect some bicyclist behavior changes when you change the system image, when you change the apparent affordances and constraints. Forester's results are consistent with that conclusion, but they don't lead to it. It may be true that bike lanes encourage unsafe cycling and discourage competent cycling, but as one Transportation Research Board referee put it, the conclusions Forester drew in this case "are far beyond what is warranted by the meager and biased data" (Forester, 1994, p. 137).

Forester's charts and tables make his arguments *appear* authoritative and logical. His words carry extra weight in Betsy's mind because the League of American Bicyclists appears to endorse his expertise by promoting the education program Forester initiated.

Gus rides his bike unencumbered by such knowledge. His gut responds intuitively to what he sees going on around him. His neighbor Betsy has talked to him about Effective Cycling techniques. But to Gus, Betsy's habit of fearlessly charging through heavy traffic seems a little nuts. He feels satisfied to let his common sense be his guide in what appears to be a very simple and easy-to-understand activity.

The ABC's of the "design cyclist"

Wilkinson, Clarke, Epperson, and Knoblauch would call Betsy an "A" bicyclist and Gus a "B" bicyclist (1994a, pp. 1-3; 1994b, pp. 4-6). They define these classifications as follows:

Group A–Advanced Bicyclists

These are experienced riders who can operate under most traffic conditions. They comprise the majority of the current users of collector and arterial streets and are best served by the following:

- Direct access to destinations usually via the existing street and highway system.
- The opportunity to operate at maximum speed with minimum delays.
- Sufficient operating space on the roadway or shoulder to reduce the need for either the bicyclist or the motor vehicle operator to change position when passing.

Group B–Basic Bicyclists

These are casual or new adult and teenage riders who are less confident of their ability to operate in traffic without special provisions for bicycles. Some will develop greater skills and progress to the advanced level, but there will always be many millions of basic bicyclists. They prefer:

- Comfortable access to destinations, preferably by a direct route, using either low-speed, low traffic-volume streets or designated bicycle facilities.
- Well-defined separation of bicycles and motor vehicles on arterial and collector streets (bike lanes or shoulders) or separate bike paths (1994a, pp. 1-2).

This classification system is akin to Forester's dichotomy. Instead of "A" cyclists, Forester talks about "club cyclists" or "vehicular cyclists." Then there are his victims of "cyclist inferiority phobia." Calling this group "B cyclists" is less insulting, but no less simplistic. (Wilkinson, et al., also recognize "C"cyclists, or children, but consider their needs to be essentially the same as "B" cyclists.) Both classification systems are based on cyclists' experience and assume that with experience comes a change in the kind of environment cyclists prefer.

Forester maintains that we should only accommodate vehicular cyclists' preferences because everyone else's preferences are misguided and unsafe. Wilkinson, et al., (1994b) consider "A" cyclists' preferences—wide curb lanes, mostly—to be the least, not the best, accommodation a city should make for bicyclists:

> The Bicycle Federation of America estimates that less than five percent (of U.S. bicyclists) would qualify as experienced or highly skilled bicyclists. Therefore, as the goal is to increase bicycle use and as new users will be predominantly novice riders, any plans must meet the needs of both experienced and less experienced riders (p. 4).

They call Forester's emphasis on education a "sales approach," where advocates have a product, a training program, that they have tried to sell, and that the public hasn't shown much interest in buying. These authors recommend what they call a "marketing approach," where "the needs of the intended users are determined and a product or service offered that they will find attractive and use" (1994b, p. 4). For "B/C" cyclists on urban streets with posted speed limits of 30 mph or greater, or with average daily traffic over 10,000 vehicles, the product they propose is bike lanes (1994a, pp. 19-20; 1994b, pp. 103-104). (Incidentally, these recommendations by Wilkinson, et al., that bike lanes be used on higher-speed roads contradict the conclusion they drew from their own "variation" studies, that bike lanes work best at slower speeds. The recommendations are, however, in accord with a "response ability" analysis.)

Limitations of dichotomous paradigms

Are all cyclists either "A" or "B"? More importantly, do cyclists progress, as the description implies, from a preference for "well-defined separation" to a preference for shared lanes? This is one of those firm convictions that "mark our limitations and our bounds." Perhaps if we question those convictions we can expand the bounds of our understanding of bicycle transportation.

One reason to question the experience/preference assumption is that there are plenty of experienced cyclists among the proponents of separate facilities. *Bicycling* magazine, for example, gave a nod to bike lanes after it commissioned a poll to find out what would encourage more people to bike to work: "The results make it clear: Much of mainstream America is ready for bicycle commuting. The only thing holding it back is a lack of bike lanes, showers at work, and other basic amenities" (Pena, 1991, p. 44). Bicycle advocacy organizations, such as the Santa Cruz-based People Power, New York City's Transportation Alternatives, and the national Bicycle Federation of America, frequently publish articles in favor of bike lanes.

Since its inception nearly 30 years ago, the Miami Valley Regional Bicycle Council has been a successful advocate for bike paths in the Dayton, Ohio, area. Yet Jerry Hopfengardner, who was MVRBC chair for many years, was not only an Effective Cyclist but a trainer of Effective Cycling instructors. He also served as chairman of the League of American Bicyclists' Education Committee. "I've bought into John Forester's philosophy of riding—that the safest riding style is to assume your fair share of the road and ride predictably," Hopfengardner has been quoted as saying. "It has helped to make me more confident and with lane positioning and city riding." Apparently, though, he has not bought into the anti-bikeway venom that comes through Forester's writings, for Hopfengardner believes that "there is a place for both bikeways and surface streets that accommodate bicyclists" (MVRBC, 1995, p. 10).

Then there is Palo Alto, California, city council member Ellen Fletcher, who is well known for her bike facilities advocacy in that city, which now has bike lanes and bicycle boulevards. Writer Janet Else Basu (1990) describes cycling around Palo Alto with Fletcher as her guide:

> "Stay in the middle of the lane at a stop light," Fletcher coaches as we pause at an intersection waiting to turn onto busy El Camino Real. "Don't hug the curb, and at a signal assert yourself so a driver doesn't occupy the lane and then turn into you without noticing." Be brave, be bold. "Whatever you do, don't be timid," Fletcher adds. "Drivers need to see you and understand your intentions" (p. 72).

Fletcher does not sound like a victim of "cyclist inferiority syndrome." Experience and training may give cyclists a greater sense of security riding in traffic, but that doesn't mean that experience erases all desire for some sort of separation from motor vehicles.

Replace "experience" with "traffic tolerance" or "preference"

Clearly, Gus and Betsy do not represent the full spectrum of bicyclists' personalities. I have met young and novice cyclists who ride boldly on major thoroughfares. I have talked to experienced cyclists who have told me they can't remember ever having much fear of traffic. I also know some long-time bicyclists who routinely take longer routes to avoid major roads.

One way to get beyond the misleading dichotomy of "skilled" or "experienced" cyclists versus "novice" riders is to replace those terms with levels of "traffic tolerance." That is, some cyclists have high traffic tolerance, feel comfortable riding in heavy traffic; some have low traffic tolerance, stick to less-traveled routes; and there are many levels of traffic tolerance between. Traffic tolerance, then, would refer to the relative level of stress a bicyclist feels while riding amidst motor traffic. The lower the stress, the higher the traffic tolerance. Betsy has high traffic tolerance. Gus may have low to medium traffic tolerance.

Stress is a complex psychobiological phenomenon. We have already discussed cognitive theory relating stress to primary and secondary appraisal. Studies have also shown relationships between stress and many other factors. For example, the amount of stress experienced by motorists commuting to work is influenced by the degree to which they feel they had a choice in selecting where they live and by whether they tend to perceive events as consequences of their own behavior and therefore under their control or whether they tend to perceive the things that happen around them as independent of them and out of their control (Novaco, et al., 1979, p. 365). A correlation has also been found between commuter stress and “Type A” (no relation to “A” cyclists) “coronary-prone behavior” (Stokols, et al., 1978). The degree to which people react to stressors has been linked to such personality characteristics as introversion and extroversion (Stelmack, 1990). DeLeeuwe, et al., (1992) identified “stress-resistant” and “nonstress-resistant” personalities. Moreland (1993) describes different styles of dealing with stress that correspond to the personality types identified by the Myers-Briggs Type Indicator. Even air pollution has been shown to contribute to stress (Bullinger, 1990)—the motor vehicles with which bicyclists share the road are the world’s single largest source of air pollution (Lowe, 1990, p. 9)—and some people are clearly more sensitive than others to airborne chemicals (Lawson, 1993).

Also, a cyclist’s ability to create mental images could affect his traffic tolerance. Dean and Morris (1991) show relationships between skill on spatial tasks and some aspects of imagery ability. Riding in traffic is a complex spatial task. It’s more complex for cyclists than for motorists because, as discussed before, cyclists have more choices, have fewer environmental clues to guide those choices, and must try to fit in among faster-moving vehicles. A cyclist must create a mental image that keeps track of the surrounding motion and that helps him anticipate where motorists will be in the next moment, even while those motorists are beyond the cyclist’s angle of view. Cyclists with less acute imagery may have more difficulty making the minute-by-minute decisions that traffic cycling requires and would therefore find the experience more stressful and intimidating.

Finally, Carpi (1996) reports that a trauma or series of stressful experiences can “sensitize” a person to stress. That is, the brain gets “rewired” to react more strongly to stress. He quotes Jean King of the University of Massachusetts Medical School: “We must remember that there are physical reactions in our bodies when we are under stress and the extent to which we endure these reactions may be dictated by our past. Telling someone to ‘just take it easy’ is of no help” (p. 70). Likewise, telling someone to “just learn to ride in traffic” may be of little help.

Considering all the possible ways that cyclists might differ in their responses to stressors, it is not sufficient to describe traffic tolerance as simply a function of skill and experience. To do so slights bicyclist who have lower traffic tolerance. Their problem, it implies, is that they are unskilled and inexperienced, a derogatory characterization that does not really get to the heart of the matter. It also puts those with high traffic tolerance on a pedestal. It makes it appear as though, through experience, they have achieved something to which others should aspire. In at least some cases their boldness may be due less to wisdom than to a reckless disregard for their own safety.

Worst of all, defining traffic tolerance as a function of experience encourages bike lane opponents to dismiss bike lane advocates as simply inexperienced and therefore unenlightened. When "vehicular" or "club" cyclists become smug and condescending, they lose their ability to understand and appreciate those cyclists who have no use for the latest clipless pedals. Who is the more experienced cyclist, anyway, the upstart gearhead who does interval training on a thousand-dollar composite frame or the senior who has rambled to the coffee shop and drug store each week for half a century on a rusty-but-trusty mount? Whose devotion to bicycling is more sincere?

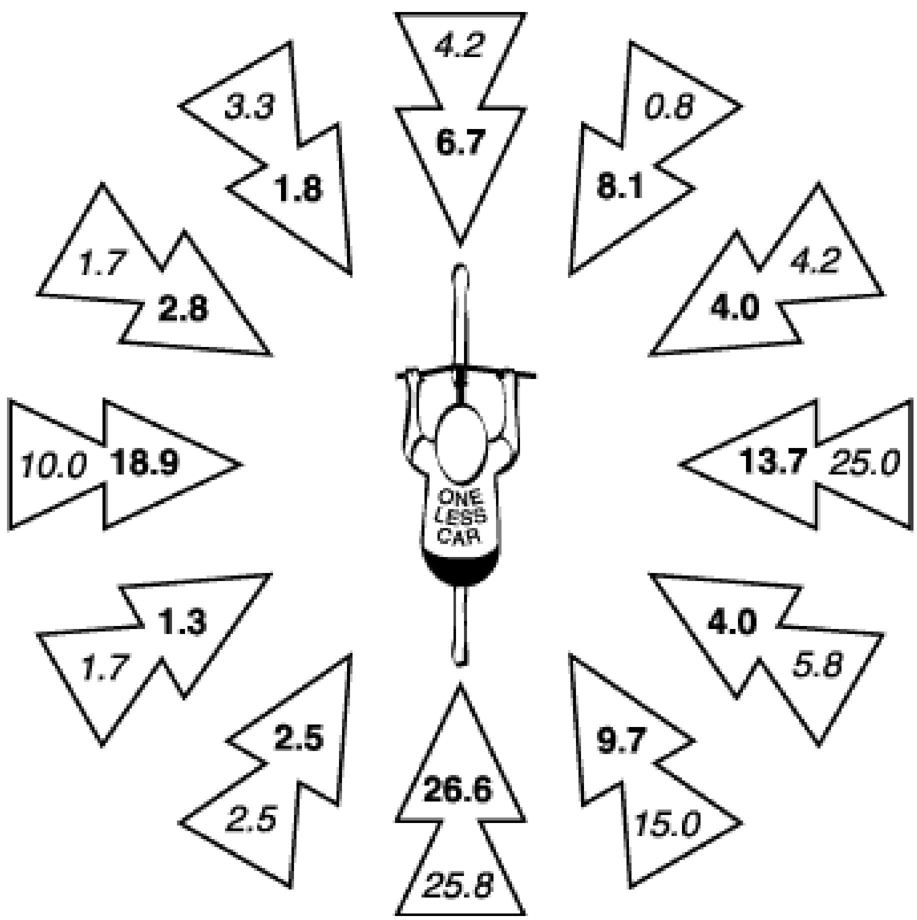
Yes, we can expect cyclists to increase their cycling confidence through training and experience. This is true of almost any activity. Ultimately, though, the level of bicyclists' traffic tolerance will be determined by many other things as well. Moreover, we might expect that cyclists with inherently high traffic tolerance would be more likely to become avid cyclists than would cyclists with low traffic tolerance. So, is high traffic tolerance an effect or a cause of more cycling experience? It could be both. We can avoid the whole chicken-or-egg problem by accepting that cyclists have differing levels of traffic tolerance, and that this is because they are human.

We could take this concept even further and use the term "traffic preference." That is, even some bicyclists who have high traffic tolerance prefer a distinct separation between bicyclists and motorists. There is no need to psychoanalyze their reasons. In practice, it doesn't matter if bicyclists can't tolerate traffic or just prefer separation; either way their decision to ride a bike or take a car can hinge on the system image of the cycling environment.

Hoque (1990) compared actual bicyclist fatality figures from Australia with the results of a study by the Bicycle Institute of Victoria, which asked bicyclists to report their perceptions of the relative danger of a car-bike collision from different directions (see Figure 8). The bicyclists' perceptions mirrored the fatality figures rather closely. So these perceptions differ from the actual likelihood of being hit as measured by *non-fatal* collisions, but they do seem sensitive to the danger of serious injury as measured by fatalities. At least in this case, what might be considered a distorted perception of risk may not be as off-base as it appears, providing another example of why it's best to respect bicyclists' varying perceptions.

Figure 8

Daytime crashes (outer circle of numbers) compared to bicyclists' perceptions (inner circle of numbers) of risk of colliding with vehicles from various directions in percent of total collisions. Source: Hoque, 1990.



Linking stress and design

There is nothing new about looking at user stress to evaluate environmental design (Perin, 1970, p. 76). Bicycle-related research, though, has tended to focus on crash statistics and bicyclist behavior. Debates over bicycle facility issues frequently hone in on what's safe, or what's not. This is beginning to change, however. One reason is that bicyclists, and bicycle transportation planners and engineers, are becoming increasingly aware that separate facilities have limited potential for improving bicyclist safety. Side paths can be awkward or even downright dangerous, rail trails require select locations, and bike lanes haven't been proven effective for reducing crashes either. So facilities advocates have begun to shift their arguments away from safety and to talk more about encouraging people to use bicycles. This shift has been bolstered by a movement throughout our society to put less emphasis on catering to cars and more on fostering a diversity of transportation options, a philosophy codified in the Intermodal Surface Transportation Efficiency Act of 1991.

One consequence of this shift is that the concept of stress has finally made its way into bicycle-related research, most notably in the work of Sorton and Walsh (1994), who have devised a rating system by which to assess the "bicycling stress levels" of different kinds of streets. Their system is still in the developmental stages and, unfortunately, uses experience-based categories for bicyclists. I won't describe it in detail here. However, while explaining the stress level concept, Sorton and Walsh make a significant point:

> It is well known that bicyclists choose routes that will cost them the least amount of effort. They save energy by following the flattest route, one that will enable them to avoid stopping and slowing as much as possible. However, conserving physical effort is only part of the story.
>
> Bicyclists also seek to avoid conflict with motor vehicles, harassment from heavy traffic and the strain of having to concentrate for long periods on riding along narrow, high-speed, high-volume roads. In other words, they want to reduce not only physical effort but mental stress as well (p. 3).

This concisely describes two key factors that bicyclists weigh when choosing routes, and when choosing whether to travel by bicycle or by motor vehicle. It is also a respectful description because it makes no judgment about whether the "mental stress" is justified or overblown. Finally, it is a departure from much of the research of the past. That is, it frames the bicycling problem in terms of the bicyclists' subjective experience. Past research has had an almost obsessive preoccupation with crash statistics.

Certainly, bicycle transportation planners need to understand the car-bike dynamics that cause collisions. But their efforts to reduce those collisions will have limited effect if planners do not also understand bicyclists' desire to keep both the physical and the mental stress to a minimum. If, in the name of safety, you plan elaborate networks of circuitous bike routes that wind through quiet residential streets and you build bike paths in vacant and remote corridors, you are likely to find, as many communities have, that bicyclists largely ignore your efforts and take the more direct routes anyway. In surveys, people often say that fear of traffic is the number one reason they choose not to bicycle. But other factors play strong roles, too. In a survey of downtown workers in Missoula, Montana, for example, Bickell (1992) found that "time/distance constraints" was the top deterrent to bicycle commuting, followed by a closely-related problem: the need to run personal or work-related errands. "Safety concerns," which included darkness in addition to traffic fears, was next; it garnered barely more than a third of the points that time/distance got (p. 4).

On the other hand, there are those who oppose virtually any kind of separate facility in the belief that it is far more important to accommodate bicyclists to the streets than to make the streets accommodate bicyclists. You may come to this conclusion by analyzing crash statistics. But it's a cold analysis that lacks appreciation for the depth and breadth of human perception and behavior. In Sorton's and Walsh's preliminary studies, even "experienced" cyclists reported higher stress levels when streets were narrower, busier, and faster (pp. 8-9). Cyclists who tolerate traffic well may feel exhilarated by the stress. But for many others, city cycling means either taking a route that is too far and time-consuming, or one that is too nerve racking; in either case, the bike stays home. So far, we have seen two possible remedies for this. We can use a program like Effective Cycling to train cyclists and build their skill and their trust in traffic. Or we can change the system image of the streets themselves with bike lanes.

Bike lane design and mental models

Whatever bike-facility choices we make, we need to be aware of what the system image of our streets—and this includes the entire street system, not just a single avenue in isolation—says to bicyclists and motorists about how to behave. Streets are more than just smooth surfaces on which to travel. Their nonfixed, semifixed, and fixed-feature elements are nonverbal cues, mnemonic devices. As Rapoport points out, the various elements of the built environment have meanings that we can infer by observing how people behave (or don't behave) in a setting. We can also learn a lot by listening to what people say about a setting. Do they feel welcome there? Does the setting support or hinder what they want to do?

Of course, nonverbal cues cannot tell bicyclists everything they need to know. Any cyclist needs some knowledge in the head in order to ride safely, just as any motorist does to drive safely. Ideally, though, the street system would communicate in a way that would help bicyclists and motorists form accurate mental models of the safest and most efficient ways in which to interact:

> The power of mental modes is that they let you figure out what would happen in novel situations. Or, if you are actually doing the task and there is a problem, they let you figure out what is happening. If the model is wrong, you will be wrong too (Norman, 1988, p. 71).

Some elements of bike lane designs commonly used today aid bicyclists in understanding how best to get through traffic. Unfortunately, there are other elements that seem to contradict a good mental model for how bicyclists and motorists should mix. Among the good things is that bike lanes can help cyclists move away from the curb when that's the safest thing to do. For example, a bike lane that runs to the left of a right-turn-only lane helps cyclists and motorists understand that a bicyclist riding straight through the intersection needs to move out into the through lane. When there is no bike lane, many cyclists hug the curb and try to cross the intersection from the right of the right-turn-only lane, which puts them in conflict with right-turning motorists. Likewise, a bike lane that runs to the left of a bus bay keeps cyclists from getting stuck between the curb and busses that are stopping. This is a blessing not only for cyclists and bus drivers, but also for bus passengers as they get on and off the buses. Without a bike lane, few cyclists would have the nerve to ride way out between the bus lane and the car lanes. Moreover, cyclists who did have the guts to do it might get a cool reception from motorists; without the bike lanes it just doesn't look like bicycles belong there.

Direction arrows on bike lanes would appear to promote a good mental model by discouraging wrong-way riding. In the chapter on bicyclist behavior we saw that this appeared to be the case in one Oregon study, but in another part of the country bike lanes seemed to invite wrong-way cycling. For some cyclists—this may depend a lot on the local cycling culture—the seemingly-protected space in a bike lane creates an affordance that encourages wrong-way riding more than direction arrows discourage it.

Perhaps the worst way in which bike lanes allegedly *contradict* a good mental model has to do with the behavior of left-turning bicyclists and right-turning motorists:

> Bicycle lanes tend to complicate both bicycle and motor vehicle turning movements at intersections. Because they encourage bicyclists to keep to the right and motorists to keep to the left, both operators are somewhat discouraged from merging in advance of turns. Thus, some bicyclists will begin left turns from the right side bicycle lane and some motorists will begin right turns from the left of the bicycle lane. Both maneuvers are contrary to established Rules of the Road and result in conflicts (American Association of State Highway and Transportation Officials, 1991, pp. 18-19).

Oregon Department of Transportation bikeway specialist Michael Ronkin's bike-lane-advocate reply is that these problems "are dealt with by dashing the bike lane stripe before intersections and dropping the markings altogether across intersections" (Clarke & Tracy, 1995, p. 81). The *Manual on Uniform Traffic Control Devices (MUTCD)* (Federal Highway Administration, 1988) recommends dropping the line "not less than 50 feet" before an intersection (p. 9B-12). Once again, there are two problems with this remedy. First, a bicyclist or motorist who waits until he is just 50 feet from an intersection to merge is one who waits until the last moment, then cuts across at the turn; not a safe practice. Second, even if dropping the line before an intersection was helpful, it wouldn't help bicyclists turning left into a mid-block driveway. Lott and Lott found that bicyclists making left turns from the right side of the road is a type of car-bike collision that increases with bike lanes (Wilkinson, et al., 1994b, p. 25).

The question, then, is whether it's possible to create bike space on the road without creating a system image that contradicts the rules of the road. One possible way to minimize the problem is to change the way bike lanes are delineated. Typically, a lane is marked off with a solid white line, often an imposing six-inch-wide line. When not referring to bike lanes, the *MUTCD* recommends such a wide line only for "areas where it is advisable to discourage lane changing" (p. 3B-2). Usually, these hefty lines are reserved for chores such as marking the edge of a highway, or for *intersection approaches* where the goal is to discourage motorists from changing lanes at the last minute. Bike lane striping seems to have this concept backward. Contrary to the wisdom behind standard street lane markings, bike lane lines seem designed to discourage lateral movements mid block and to encourage mad-dash turns at intersections.

This is not to say that anyone *means* for bike lanes to have this effect. Surely, the solid line is there to give bicyclists a sense of protection from traffic. Also, the *MUTCD* does recommend solid lines for what it calls "special secondary lanes" (p. 3B-2), which include uphill truck lanes and transit bus lanes; so it could be argued that its a case of bike lanes being consistent with these uses. Overall, the practice of dropping the bike lane line before an intersection is simply meant to recognize that bicyclists need to match lane position to destination. Even so, bike lanes might promote better mental models for bicyclists and motorists if, instead of solid lines, the lanes were set off for their entire length with broken lines to indicate that bikes may merge out of the lanes to turn left and cars may merge into them to turn right:

> ... knowledge in the world is useful only if there is a natural, easily interpreted relationship between that knowledge and the information it is intended to convey about possible actions and outcomes.
>
> Note, however, that when a user is able to internalize the required knowledge—that is, to get it into the head—performance can be faster and more efficient. Therefore, the design should not impede action, especially for those well-practiced, experienced users who have internalized the knowledge. It should be easy to go back and forth, to combine the knowledge in the head with that in the world. Let whichever is more readily available at the moment be used without interfering with the other and allow for mutual support (Norman, 1988, p. 189).

Some variations on the standard bike lane design have recently been proposed or tried that may offer more "natural, easily interpreted" relationships between design and desired behavior. The New York-based Transportation Alternatives has illustrated its *Bicycle Blueprint* with pictures of bike lanes that are delineated with double stripes, solid on the motor vehicle side and broken on the bicyclists' side (Herman, et al., 1993, p. 32). That's a good idea for left-turning cyclists, but does nothing for right-turning cars. Denver, Colorado, is trying out a promising concept dubbed "hybrid lanes" (Clarke & Tracy, 1995, p. 80; MacKay, 1994, sec. A-10; Zehnpfenning, Cromar & Maclennan, 1993, pp. 38-39). The city dropped the lane line and instead just paints the bike lane symbol (See Figure 9) in the middle of the zone where a traditional bike lane would be. This gives more freedom to bicyclists who felt hemmed in by traditional bike lanes, gives some reserved space to those who need a comfort zone, reinforces the proper riding direction, and reduces bike lane maintenance costs by using less paint.

Figure 9

Hybrid lane pavement marking.

Source: MacKay, 1994.

Zehnpfenning, Cromar, and Maclennan (1993) describe a number of hybrid lane benefits:

- it provides a space for bicyclists to ride out of high-speed/high-volume traffic, except at intersections;
- the markings indicate and designate an area for bicycling where new bicyclists may feel more secure;
- it legitimizes the presence of bicycles on the road;
- it helps motorists be more alert for bicyclists;
- it generally ensures adequate width for bicycles, which is not the case on many existing bicycle routes;
- it helps ensure the space will not be usurped by a future traffic lane;
- directional arrows may reduce wrong-way riding;
- incorrectly painted lines do not lock bicyclists in an unsafe location for safely negotiating a traffic intersection;
- it does not constrain bicyclists against the right curb where they are not visible to

motorists at intersections;

- it does not present a feeling that on-street bicycling is safer than it actually is, and lead to lack of caution;
- it does not discourage the "sweeping" motion of cars (that helps clear away debris); and
- markings are less likely to be worn (off) by car tires because of their location (pp. 38-39).

Like so much that is written about the pros and cons of various facilities, the above list contains a fair amount of speculation. One further bit of speculation: it seems fair to say that bicyclists with low tolerance for traffic would not feel as protected while riding in a hybrid lane as they would with a solid stripe. However, the amount of stress bicyclists feel while riding in traffic increases on a continuum as the road gets narrower and the traffic gets faster and heavier. More than that, the relationship between bicyclists and motorists changes as the difference in their speeds increases. Remember, even Forester admits that in high-speed traffic bicyclists must play "road sneak" because negotiation becomes impossible. In other words, the degree to which bicyclists can communicate with motor traffic and participate in its flow is also a continuum. The bike lane system image could reflect this continuum if, for example, it employed hybrid lanes when the traffic was slower, dashed lines in medium-speed traffic, and solid lines where the motor traffic travels at full highway speed. I speculate that a bike lane system with this kind of flexibility would be less likely to frustrate vehicular-style cyclists and yet would change the system image enough to make it less stressful for cyclists with low traffic tolerance. The hybrid would also be less likely than current bike lane design to perpetuate mental models that inhibit bicyclists and discourage them from learning or practicing vehicular cycling techniques.

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Chapter 9
Conclusions and Recommendations

Summary

Crash Statistics

At the beginning of this paper we dove right into crash statistics. The argument against bike lanes and other bike facilities can sound very scientific and authoritative through the use of such numbers. Car-bike collisions seldom involve bicyclists getting hit from behind by motorists, the argument goes. By far, most car-bike collisions are the result of cyclists' and motorists' crossing and turning movements. The main reason people build bike lanes and side paths, however, is to protect cyclists from being hit from behind, opponents maintain. So these facilities, according to detractors, represent huge expenses and efforts frittered away on dangers that barely exist.

Worse yet, the argument goes, these efforts to improve bicyclists' safety backfire. They make cycling less safe by making cyclists less visible and by complicating the crossing and turning movements that cause the lion's share of car-bike crashes. Separate facilities promote and perpetuate misconceptions about bicyclist safety. These beliefs inhibit cyclists and keep them from learning and practicing safe vehicular-style cycling techniques. According to bike facility opponents, these misconceptions also lead motorists, law makers, and law enforcers to believe that bicyclists, for their own good, should keep to these "protective" facilities and not stray onto busy streets, except those equipped with special facilities. As a result, cyclists who choose to ride on streets that may be busy, but are also the most efficient and safest way to get where they need to go, suffer harassment from motorists and restrictive sanctions from law makers and enforcers.

To the true believers who embrace this kind of argument, there is only one course of action that will have any significant impact on bicyclists' safety: an intensive training program, like Effective Cycling, that will enlighten cyclists to the true hazards of the road, will teach them techniques to avoid those hazards, and will build their confidence in using those techniques.

Indeed, we found that overtaking collisions do make up a relatively small fraction of all car-bike collisions, especially of daytime urban collisions. Even so, overtaking collisions, Type 13 in particular, contribute to serious and fatal crashes way out of proportion to their total numbers. In general, high speeds make overtaking collisions more destructive than other types of collisions. Also, there are certain locations and conditions where overtaking collisions make up a higher-than-average percentage of total car-bike crashes. Statements that motorist-overtaking collisions make up only X percent of car-bike crashes in certain places, at certain times, for a certain group of cyclists are interesting and do help us understand the problems of car-bike interactions. But such statements also can create a false sense of precision when they ignore the more risky scenarios and fail to weigh how destructive overtaking crashes can be. Such statements create tunnel vision when they are presented as the only worthy criteria for defining the bicycle-transportation problem. And these simplistic statistical analyses can be downright insidious when they are used to dismiss and belittle bicyclists' discomfort in traffic.

Bicyclist education

It is pretty much taken on faith throughout the bicycling community that Effective Cycling techniques and principles provide a sound basis for safe cycling. The direct impact of education programs on bicyclist safety is hard to measure, though. And indirect approaches to estimating an education program's potential for improving bicyclist safety are fraught with sources for error. Individual cyclists will attest to the sense of freedom and security they get from vehicular cycling, and that's great. But over the years the ranks of certified Effective Cyclists have been filled mostly from a self-selecting sample of bike club enthusiasts. It would be a mistake to assume that the general population would experience and respond to Effective Cycling in the same way.

Cyclists' behavior

Free of many of the physical and social constraints that shape motorists' behavior, cyclists take advantage of a wide variety of affordances. Often, this makes their behavior appear chaotic. Even experienced and knowledgeable cyclists bend and break the rules of the road, often with good reason, although the reasoning may not be immediately evident to others. So it is difficult to come up with a legitimate measure of appropriate and inappropriate bicyclist behavior. We know it is dangerous (usually) to ride at night without lights, to ride on the wrong side of the road, and to dart out of driveways—kids do this a lot—without looking for approaching traffic. But the more subtle rules of the road for bicyclists can be, and sometimes are, justifiably interpreted in diverse ways. Some cyclists may choose to follow orderly patterns of behavior rooted in a careful analysis of crash statistics. For others, though, bicycling is folk transportation. It is informal, a break from rules and structure. It is wind-in-you-hair freedom. It is human:

> Even though principles of rationality seem as often violated as followed, we still cling to the notion that human thought should be rational, logical, and orderly....
>
> But human thought—and its close relatives, problem solving and planning—seem more rooted in past experience than in logical deduction. Mental life is not neat and orderly. It does not proceed smoothly and gracefully in neat, logical form. Instead, it hops, skips, and jumps its way from idea to idea, tying together things that have no business being put together, forming new creative leaps, new insights and concepts. Human thought is not like logic; it is fundamentally different in kind and in spirit. The difference is neither worse nor better. But it is the difference that leads to creative discovery and to great robustness of behavior (Norman, 1988, p. 115).

Bike lanes, behavior, and culture

Because of that “great robustness,” it is hard to say how the built environment shapes bicyclists’ behavior. Individual bicyclists respond in individual ways to bike lanes, for example. Studies of bicyclists’ behavior in this country suggest that, the more affordances you build into the environment, the more diverse the behavior. Wrong-way cycling seems to be most rare on narrow, busy streets. That kind of environment scarcely *affords* such behavior. Allow more room for comfort, though, and you seem to get more wrong-way riding, an unfortunate side effect of an otherwise desirable accommodation.

This observation would appear to imply that with bike lanes there would be more wrong-way riding and that, since wrong-way riding increases a bicyclist’s risk of being hit by a car, bike lanes would therefore increase car-bike collisions. In real life, though, the link between bike lanes and collisions is not very clear, despite miraculous claims by bike lane advocates and catastrophic predictions by opponents. We cannot even point to a definite real-life relationship between the presence of separate facilities and what we might call "colorful" bicyclist behavior. Melissa Marion (1992), a bike facility specialist with the North Carolina Bicycle Program, found that in Holland, where the people are famous for using bicycles for a large percentage of their transportation, the cyclists have not been transformed into raging scofflaws by that country's extensive use of bicycle facilities; the motorists have not become anti-bicycle terrorists, either:

> For me, the single most encouraging aspect of Dutch cycling was the attitude of cyclists toward traffic regulations. In overwhelming numbers, they obey the array of special signals, signs and stripings for bicyclists.
>
> I was dumbfounded the first time I watched an intersection and saw every cyclist pull up to the red light and stop. I wondered if other American bike programmers would be similarly speechless–on one level, I never believed cyclists were "trainable."
>
> Again and again, there were variations on the same scenario of law-abiding cyclists, and I was repeatedly taken aback by these commonplace occurrences.
>
> Finally, they began to seem more or less normal. I returned to the United States believing American cyclists just might be teachable.
>
> In general, I found that the Dutch motorists knew how to react properly to cyclists. While cycling in Holland, I was rarely cut off at intersections, and motorists typically slowed down behind cyclists on roadways and waited for a proper space to pass.
>
> I noted very little impatient behavior and never felt resented as part of the traffic mix. (One English visitor, not knowing I was a cyclist, said he didn't like driving his car through Holland because he and everyone else had to keep stopping for cyclists.)
>
> Such experience weakened another of my almost unconscious attitudes–that motorists as a group could never learn to be considerate and accepting of cyclists (pp. 11-12).

No doubt, bicyclists and motorists are "trainable" and can learn to coexist in a remarkably civilized fashion. But there are two kinds of training: enculturation and acculturation. The Dutch come by their exceptional road manners through enculturation. That is, they grow up in a society for which the bicycle has long been a valued form of transportation. The bicyclists' good behavior and the motorists' patience are part of the culture and are mutually supportive. Perhaps at the root of it lies a constellation of beliefs and attitudes about not only bicycling, but about other things as well, such as time, speed and the purpose of a road.

Acculturation, on the other hand, means adopting the traits and patterns of a group that is not your own. The Dutch bicyclists' behavior "began to seem more or less normal" to Marion as she became acculturated. Of course, she was a willing participant in the process. The English visitor was not. Judging by his statement, I don't think there is much hope that he would willingly become acculturated to the Dutch way of viewing the role of bicyclists in the transportation system.

When we American cyclists look at the Dutch, we must keep in mind that their behavior takes place in a culture that differs from ours in significant ways. They have a very homogeneous population that is smaller than the state of New York's (Johnson & Daily, 1994, pp. 237, 828). The unity in their thinking has allowed them to achieve what would be unthinkable in this country. While the United States had a 45 percent sales tax on gasoline in 1982, for example, the Netherlands had a 245 percent tax. While the United States had a five percent sales tax on automobiles in 1987, the Netherlands' was 47 percent (Lowe, 1989, p. 40). On the whole, U.S. policy has been to aid and abet private-vehicle motoring in every way possible. This policy both reflects and perpetuates attitudes that make it hard for bicyclists to get respect.

So when we look at Dutch behavior and feel tempted to hold it up as something to which Americans should aspire, we must remember that the Dutch come by their training through enculturation. When we talk about training American cyclists and motorists to act like the Dutch, we are talking acculturation: teaching Americans behaviors that are neither so common nor so heavily reinforced within their native culture—except, perhaps, within the bike club culture.

The advocate's challenge

Bicycling in America is an eclectic activity. The cyclist who wants to pursue bicycle advocacy in this country with both eyes open must understand, and embrace, the diversity that makes up the United States' transportation culture. This is no easy task. Thoughtful discussion of bicyclist issues can sound like a scene from *Fiddler on the Roof:* on the one hand this, on the other hand that. At some point you have to take a stand and act on it, or else it's all so much hot air. I offer the following recommendations as guidelines by which advocates may chose both viewpoints and actions without succumbing to one-eyed prophesy.

Recommendations

- Replace "experience" or "skill" levels theories with the concept of a normal and natural continuum of levels of traffic tolerance. Drop the idea that there are two kinds of bicyclists; one kind described by terms such as experienced, skilled, expert, real, serious, assertive, knowledgeable, vehicular, adult, commuter, fearless, elite; and the other kind falling into categories like inexperienced, unskilled, occasional, recreational, timid, phobic. An either/or, right/wrong, black/white way of thinking is the one-eyed prophet's trade mark. The built environment is a form of nonverbal communication. It's meaning is imprecise and subject to various interpretations. It will elicit different emotions and behaviors from different cyclists.
- Know, but don't worship, crash statistics; *and* respect cyclists with all levels of traffic tolerance. Some people think skydiving is life's ultimate experience. Some would not dream of engaging in what to them would be such a frightening activity, no matter how much training they were offered. This second group is not phobic and neither are those who feel uncomfortable bicycling in heavy traffic.
- Advocate more flexibility in bike lane design to make the system image more closely reflect an accurate mental model of healthy car-bike interactions.
- Take a problem-solving approach to bicycle transportation planning. That is, start by gathering information about the bicycling obstacles and opportunities specific to a site, analyze the problems, then—and only then—choose fitting solutions from among many possibilities.
- Beware of miracle cures and silver bullets. When someone claims fantastic accident-reducing powers for bike lanes, or bicyclist education, or whatever, you can bet it's an *estimate*, not documented fact, and that it's based on limited and biased information. There is no single "miracle drug" that alone will create a healthy bicycling environment.
- Broaden safety-oriented and comfort-oriented programs by striving to nurture bicyclists' "sense of competence."

Why the term "sense of competence"

At first glance, "sense of competence" may seem like an odd term, or at least a vague one. But look at the commonly-used alternatives. One catch word, for example, is "safety." Public officials seem fond of proclaiming that their primary concern for bicyclists is safety. Many believe that this means creating places where cyclists can ride out of the flow of traffic. As we have seen, this approach tends to put cyclists in conflict with the flow of traffic, or else it ignores the real day-to-day problems of bicycle transportation. Safety might also be defined as reducing the number of car-bike crashes. One way to do that might be to make the city so inhospitable to bicycling that fewer and fewer cyclists ride there. This could be accomplished simply through filling the streets with cars by making it easier and easier for motorists to drive, while ignoring bicyclists' needs. Moreover, it could be done while appearing to serve bicyclists by spending millions of dollars on rail trails that isolate minority transportation cultures in out-of-the-way places so the dominant culture wouldn't have to deal with them. Safety can also be defined as teaching bicyclists, especially children, to *be careful* out there with all the dangerous automobiles. This kind of teaching does little to make cycling more comfortable and desirable. Safety is an admirable, but limited, goal that does not necessarily suggest admirable solutions.

I could go on like this, listing the shortcomings of "safety" and other words like bicyclists' "comfort," or cycling "skill." I want neither to disparage perfectly good words, nor to start a "sense of competence" movement, though. There are three points I want to make about the words that bicycle advocates and planners *commonly* use to describe their goals: 1) the words appear to be clear cut, 2) they aren't as clear cut as they appear, and 3) the first two points make it too easy to believe that you have a noble goal and you know how to reach it when, in fact, it's much more complicated.

One of the prime advantages of the term "sense of competence," is that, when bandied about, it is more likely than most alternatives to elicit the reaction: "Huh?" It helps cut through restrictive preconceptions. At the same time, "sense of competence" is a descriptive term, not some nonsense phrase like "Class I." The word "sense" embraces the subjective feelings that bicyclists have in response to the environments in which they ride. The word "competence" embraces the more objective questions of how efficiently and safely bicyclists succeed in getting around. In linking these two realms, "sense of competence" covers a lot of ground.

Measurement tools and future directions for research

As transportation professionals become more concerned with the ways that bicyclists respond to various transportation system images, planners and researchers face the new challenge of finding ways to measure the effectiveness of what they do. Crash statistics and observed behavior patterns don't get to the heart of the emotional responses that determine whether people feel encouraged or discouraged from riding.

Sorton and Walsh (1994) are exploring one method of measuring bicyclists' feelings as they develop a "stress level" scale. Their idea is to give public agencies a way to determine how well streets serve bicyclists, a method that's quick and convenient and doesn't require the agencies to survey groups of bicyclists about each street. Sorton's and Walsh's scale ranks streets with five stress levels:

Table 11

Sorton and Walsh street stress levels

Stress Level	**Interpretation**
1 (very low)	Street is reasonably safe for all types of bicyclists (except children under 10).
2 (low)	Street can accommodate experienced and casual bicyclists, and/or may need altering* or have compensating conditions** to accommodate youth bicyclists.
3 (moderate)	Street can accommodate experienced bicyclists, and/or contains compensating conditions** to accommodate casual bicyclists. Not recommended for youth bicyclists.
4 (high)	Street may need altering* and/or have compensating conditions** to accommodate experienced bicyclists. Not recommended for casual or youth bicyclists.
5 (very high)	Street may not be suitable for bicycle use.

*"Altering" means that a street may be widened to include wide curb lanes, paved shoulder

addition, etc. **"Compensating condition" can include streets with wide curb lanes, paved shoulders, bike lanes, low volume, etc. (Sorton and Walsh, 1994, p. 5.)

A wide, low-speed, low-volume, street will score low. A narrow, fast, congested street will score high, which is not good. A more refined assessment accounts for commercial driveways, parking, and the number of heavy vehicles.

Sorton and Walsh are now testing the validity of their assumptions by asking bicyclists to watch video tapes of various types of streets and to rate each on a scale of 1 to 5, with 1 being very comfortable and 5 being a place they would not want to ride "under any circumstances." In an initial test with a small group, the cyclists seemed to shy away from the extreme ends of the scale.

Once it has been fully tested and adjusted, this rating system may well serve it's purpose: to assess the relative comfort levels of various streets for average bicyclists. The stress level is not the same as the actual *danger* level, though. Remember, for example, that the relationship between traffic volume and the risk of a car-bike collision is weak at most. Yet, volume is one of the three major criteria in this rating system because heavy traffic is a major stressor to most bicyclists.

Ideally, a system image should "make things visible," as Norman puts it, should help users correctly understand how the system works:

> In making things visible, it is important to make the correct things visible. Otherwise people form explanations for the things they can see, explanations that are likely to be false. And then they find some reason for poor performance.... People are very good at forming explanations, at creating mental models. It is the designer's task to make sure that they form the correct interpretations, the correct mental models: the system image plays the key role (Norman, 1988, p. 198).

Of course, what makes the designer's task particularly difficult is that different bicyclists will interpret a given bicycling environment in different ways. If we want to thoroughly explore bicyclists' reactions to different environments, we need to take an approach that's somewhat different from Sorton's and Walsh's. For if all we do is ask bicyclists to rate streets from most comfortable to least comfortable, we cannot compare one cyclist to another. That is, if Frank and Franny both give a street a "4" because it is most uncomfortable, but not totally unridable, this doesn’t tell us if that street is equally uncomfortable for Franny as for Frank. If we want to get at which situations create what amount of stress for whom and why, we need to measure stress more directly.

Psychologists have developed a number of ways to measure stress through the body’s physical responses (Asterita, 1985, pp. 160-167). They can analyze blood and urine for chemicals that increase when a body is under stress. There are also measures of muscle tension, heart and breathing rates, brain waves, skin temperature and galvanic skin response. If you actually put subjects into traffic situations, though, the physical effects of the act of bicycling would make many of these measures difficult to use.

These measures might be of use for studies where subjects passively watch videos, as in the Sorton and Walsh study. Hughes and Harkey (1996) have explored using virtual reality simulations to test bicyclist responses to various cycling conditions. If it is done very well, this approach has the potential to be more realistic and stimulate these physical responses even better than a straight video. Unfortunately, in this case the simulation was not fully interactive; you couldn’t steer the bike or control its speed. So the trials didn’t simulate the difficulties in, say, trying to turn left. By the way, Hughes and Harkey asked cyclists to rate “perceived risk” on a six-point scale. Roads with bike lanes and shoulders scored the lowest perceived risk, followed by wide curb lanes. Not surprisingly, a standard 12-foot street scored the highest. There was no significant difference between the responses of the “casual” and “experienced” groups. But again, this kind of rating method would not necessarily uncover a difference if it did exist.

Another approach might be to use a variation on the Mood Adjective Checklist developed at the University of Wales Institute of Science and Technology, which asks subjects to look at a list of adjectives and choose those words that best describe how they feel (Matthews, Jones & Chamberlain, 1990). Closer to the subject of bicycling is the Driving Behavior Inventory developed by Gulian et al., which has subjects choose from a list of statements such as “I feel anxious when overtaken at a junction” (Glendon et al., 1993). This approach could be used to get specific information about bicyclists’ reactions to types of facilities, to particular street or intersection configurations, or even to the layout of neighborhoods or cities. It has the potential to assess not only what is stressful, but what is helpful, which is just as important. The results could also be correlated with cyclist attributes, such as training, club membership, and basic beliefs about car-bike interactions. One of the problems with the stress-oriented research projects is that if we get very focused on which environments create the most stress, it is easy for us to forget that it's not just the environment that creates stress, it's our *interpretation* of the environment–the old primary and secondary appraisals. Change the interpretation and you can help the bicyclist ride more comfortably in any environment, whether or not it has special facilities. This is why it is important that researchers find ways to go beyond measuring stress, risk assessment, and bicyclist behavior. We also need to find ways to uncover how bicyclists *interpret* the environments in which they ride. Both education and engineering can influence bicyclists' and motorists' abilities to form accurate mental models of car-bike interactions. When we understand the potential and the limits of that influence, then we will be able to choose the kinds of programs that do the most good.

The bicycle transportation planner or advocate without a vast research budget can learn a lot just by watching bicyclists negotiate city streets. It helps to do this in a city that has loads of bicyclists. But once you develop an interest in watching, you'll find yourself stopping frequently to see how some bicyclist gets through a tricky intersection, even in more ordinary locations. The most important thing is to give up labeling this cyclist as "experienced" and that one as a victim of a "cyclist inferiority phobia." Instead, pay attention to how the bicyclist is responding to the nonverbal messages he gets from the world though which he moves.

Obstacles

If I had to express in one short sentence the overall message I want this paper to convey it would go something like: Bicycling is not an exact science, so keep an open mind. As I promised in the first chapter, my recommendations outline a general *philosophy;* they aren't meant to advocate specific facilities. True, I do make a case for hybrid lanes, but only to illustrate that there are alternatives to current bike lane designs that are worth pursuing.

Whether or not hybrid lanes have a future, the philosophy I advocate does encourage experimental designs, whether for bike lanes, traffic calming, or whatever. Unfortunately, this runs against the grain of current transportation planning practices. The most commonly-used guidelines for bike-related projects are in the *Guide for the Development of Bicycle Facilities* published by the American Association of State Highway and

Transportation Officials (AASHTO) (1991) and in the *Manual on Uniform Traffic Control Devices* (MUTCD) published by the Federal Highway Administration (1988). Both recommend marking a bike lane with a solid white line from one intersection to just before the next.

It takes courage for a city to implement facilities that aren't in the official guides. Traffic planners and engineers who have little experience with or understanding of bicycle facilities will be especially likely to stick by the book rather than try something unproven. Plus, it may be hard to get state or federal funding for unorthodox designs.

This means that those cities known for and used to innovation are most likely to lead the way in alternative bike lane designs. Unfortunately, many progressive bike towns have already embraced the idea of painting solid white lines. That commitment may impede innovation. My guess is that the most fertile ground for new designs would be in cities that have some experience with bike lanes, but have not gone hog wild with them. Such a city would be comfortable with the general idea of bike lanes, and with the process of implementing them, without being so deeply entrenched in a particular design.

In any case, if just a few cities try a new design, that design will soon become a proven commodity that will be much easier to sell, even if it's not in the official guides. Keep in mind that everything that *is* in the guides once went through this process. Now that Denver, Colorado, has taken the initiative to try hybrid lanes, that city's bicycle planner, James Mackay, has written a from-one-engineer-to-another position paper for advocates in other cities to use if they want to promote those facilities. Mackay points out that it is not at all unusual for cities to implement, and even secure federal funding for, signing that is not included in the MUTCD.

So the guides are *just* guides and not insurmountable obstacles. In fact, as discussed on page 120 of this paper, the AASHTO Guide quite clearly explains how bike lanes encourage behaviors that are "contrary to established Rules of the Road and result in conflicts." That part of the guide supports alternative designs.

Implementing bike lanes of any design may be most difficult in areas that do not already have high levels of bicycling. Goldsmith (1993) searched for factors that correlated with bicycle commuting in U.S. cities. In addition to finding a strong relationship between bicycling and bike lanes (see the discussion on page 96 of this paper), he found an *inverse* relationship between bike *paths* and bike commuting:

> Indeed, one might wonder whether somehow bike paths are a disincentive to commuter cycling! A careful look at the cities with the highest ratio of bike paths indicates that many of these are the same cities with little, if any, bike lane mileage and low levels of bicycle commuting. The reason for this seemingly non-intuitive pattern may simply be that bike paths follow scenic corridors and do not necessarily lead to major destinations. But a high ratio of bike paths is also an indication that bicycling has not been incorporated into the transportation network and is limited to its recreational function.

Again, we have a chicken-or-egg question. Bike lanes take up street space, often at the expense of automobile parking spaces or driving lane width. In a city with numerous cyclists, the need to make room on the streets for bicycling is clearly visible. In places where bikes are rarely seen on the streets, it is more difficult to rally political support for taking space from motorists. In such cases, rail trails and side paths (however ill advised) may be the only politically feasible facilities; and this condition would be the *result* of a low level of bicycling, not the cause of it.

In that case, a would-be bike lane advocate may have two options. One would be to work on trail and path projects in hopes of encouraging enough bicycling to eventually achieve a visible presence on the streets. Another strategy would be to seek out a street, maybe near a school, that has more than its share of bicyclists and that is wide and has a minimum of on-street parking. If such a road exists, even though it may not be where bike lanes are most needed, it can serve as a low-risk demonstration project to help make the city more receptive to on-street facilities. This strategy may make a good starting point even for cities that do have significant levels of bicycling.

Another obstacle to approaching bicycle issues with both eyes and both ears open is the political power of certainty and fear. The more closely we watch and listen to bicyclists, the more we appreciate bicycling's subtle complexities. But clear-cut dogma seems to attract ardent supporters far more readily than do philosophies filled with if's, and's, and but's. Dogma mixed with fearmongering can be especially powerful, since fear moves people to action like nothing else. These techniques may tempt us when we want to get something done. If we want bike lanes, for example, we may find ourselves ranting about the grave dangers of bicycling on city streets and about how bike lanes will protect us. Compared with promoting bike lanes for their stress-reducing qualities, the fear factor may seem much more powerful. But it can also backfire if someone calls the bluff and questions the relationship between bike lanes and crash reduction. Worse yet, the fear card sends the message that bicycling in general is very dangerous, a message that may discourage people from riding and may encourage motorists and public officials to believe that bicyclists don't belong on the streets.

Perhaps worst of all, we can box ourselves in with our own dogma, even if we enter a campaign fully aware that our strategy is for political purposes only. As we go about defending one-eyed assertions, it can become hard to back down from our public statements. Before long, we refuse to see and hear things that could deepen our understanding of bicyclists and bicycling.

Finding new stories

In *Technopoly* (1993), Postman argues that what we commonly call "social sciences" are not sciences at all (p. 150). He echoes Karl Popper's refrain that a theory isn't scientific unless it can be proved false. Social research, Postman says, is a form of storytelling, "documenting the behavior and feelings of people as they confront problems posed by their culture."

A man who goes by the title of "traffic engineer" once explained to me that his profession was not the same as that of a "highway engineer." His job was not to calculate the effects of loads and stresses on concrete structures, for example, but to understand the relationships between the design of those structures and human behavior. It seems, then, that a large component of traffic engineering is more akin to social studies than to the hard sciences. Likewise, bicycle transportation planning (bicycle *traffic* planning) is not a highway engineering process guided by formulas that have been developed through empirical research. It's about understanding the behavior and feelings of bicyclists as they confront problems posed by a motorist-dominated culture. It's about understanding bicyclists' stories. It's about seeing the ways in which bicyclists and motorists read what the environment "tells" them. It's about how to make an environment that says "bicyclists welcome"—*and* one that guides bicyclists and motorists toward safe behavior. It is no coincidence that the insightful city-planning commentators Lewis Mumford and Jane Jacobs were great storytellers. It was their ability to see and express the human drama in environmental design that makes their works so compelling. Environmental designers, including designers for bicycling, need to listen to the stories environments and users tell.

In our "technopoly," numbers sound scientific and science seems to have the power and authority to find solutions to all sorts of problems, including those of human behavior. But a theory of environmental design based primarily on car-bike crash statistics, for example, or on the benefits of solid white lines—or any narrowly focused, seemingly scientific criteria—may leave out a very important factor:

> The end product is environmental design that takes its role as seriously as the bus driver who maintained his time schedule simply by not picking up waiting passengers. An inspector stopped him along his route: "That's the only reason you're out on the road, you know." How can we find our way back to such a simple reason for a field whose original validity lies in providing space and shelter for the individual's behavior? (Perin, 1970, pp. 30-31.)

Bicycle advocates and planners must understand the story of bikeway opposition. It is, among other things, a story of cities building narrow, bumpy, dangerous side paths and forcing bicyclists to ride there, either by law or by the hostilities of motorists who lay on their horns, shout obscenities, and throw beer bottles at bicyclists who dare to use streets in defiance of glorified sidewalks. It is a story of individuals struggling to preserve bicycling as a fast and efficient mode of transportation. It is a struggle that can easily make one suspicious of any form of bicyclist-motorist segregation.

We must also understand the story of bicyclists who want to travel to their destinations quickly and directly, as they can only do on a city's arterials. But on those routes they feel crowded by hordes of fast-moving motorists, some of whom lay on their horns and shout obscenities at bicyclists who dare to use the primary streets. It is a story of individuals struggling to preserve bicycling as a fast and efficient mode of transportation. It is a struggle that can easily make one yearn for some sort of visible symbol, at least, to confirm bicyclists' right to be on those roads.

But those are old stories. I predict that the new stories, the ones to move us forward, will come from the details. They will come from planners, engineers, advocates and researchers who try bike lanes, or hybrid lanes, or new intersection designs, or education programs and then have the courage to find out how those efforts affect the beliefs and feelings of bicyclists and motorists and how those meanings in turn affect the ways in which cars and bikes mix on the streets. Instead of being one-eyed champions of a single approach to helping bicyclists, we will be better off when we have many choices and understand each choice enough to know when it is appropriate and when it is not:

> It is impossible for responsible and practical men to discard unfit tactics–even when the results of their own work cause them misgivings–if the alternative is to be left with confusion as to what to try instead and why (Jane Jacobs, 1961, p. 339).

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Please send comments to jeffrey.hiles@wright.edu.

Hiles, Jeffrey A. *Listening to Bike Lanes*. September 1996.

Appendix
Bicycle Advocacy Resources

When I began researching bicycle-related information in 1990, it was extremely hard to find anything on bicycling other than sport-related books and articles. Fortunately, there has been a steady stream of new bike transportation-related materials in recent years. More than three quarters of the items on my reference list have 1990's dates. But you still have to look in not-so-mainstream places. To help others avoid the long search I endured, I recommend the following sources as starting points.

Disclaimer

This appendix is presented as I wrote it in 1996. I don't intend to keep it up to date. Be warned that a lot has changed. For example, the Bicycle Federation of America has become the National Center for Bicycling & Walking and *Bicycle Form* has become the *NCBW Forum*.

To contact the NCBW, call (202) 463-6622, fax (202) 463-6625, email ncbw@bikefed.org, or visit www.bikewalk.org.

I assume the email lists have stayed active. Some of the participants had so much to say that I'd be surprised if they weren't saying it still.

In my opinion, *Bike Plan Source* remains the most reliable and level-headed place to start looking for bicycle planning information on the Web.

-Jeff Hiles, February, 2002

Publications

Bicycle Forum Technical Note Series by John Williams and others.

Compiled by the editor of *Bicycle Forum*, these range from one to four pages and cover, bike path safety, bikeway liability, bike rack design, bicycle parking ordinances and other topics. Technical Note number S1 is an excellent summary of Cross-Fisher car-bike crash statistics. Contact the Adventure Cycling Association, P.O. Box 8308, Missoula, Montana 59807, (406) 721-1776.

Bicycle Safety-Related Research Synthesis by Andy Clarke and Linda Tracy.

This 1995 publication summarizes much of what has been learned to date about bicycle safety, education, and facilities. Published by the Federal Highway Administration, this 145-page book is free from the National Bicycle and Pedestrian Clearinghouse: (800) 760-6272.

Bicycle Transportation by John Forester

Although it is subtitled “A Handbook for Cycling Transportation Engineers,” this is really one long anti-bikeway, pro-Effective-Cycling rant. It contains a lot of information, including some that’s useful, if you’re willing to wade and weed. The book is most valuable as background material to help you understand anti-bikeway passions. The second edition was published by the MIT Press in 1994.

The Death and Life of Great American Cities by Jane Jacobs

This classic critique of cities, city planning, and the relationships between environmental design and quality of life doesn’t specifically address bicycle issues, but offers a way of seeing that can be very helpful to bicycle advocates. The 1961 book is published by Random House.

Effective Cycling by John Forester

The textbook for the League of American Bicyclists’ Effective Cycling program, this book contains some of the best explanations of traffic cycling techniques you are likely to find. Of course, it is also riddled with Forester’s anti-bikeway sentiments.

The sixth edition was published by MIT Press in 1993.

The Effects of Bicycle Accommodations on Bicycle/Motor Vehicle Safety and Traffic Operations by Wilkinson, et al.

This summarizes current information on various bicycle facilities. The authors seem quite partial to bike lanes, but the book is a good source of information and citations. This Federal Highway Administration report is available from the National Technical Information Service, 5282 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650.

Guide for the Development of Bicycle Facilities prepared by the AASHTO Task Force on Geometric Design.

This might best be described as the national guide for bicycle facility planning and design. (Many states have their own guidelines, though.) It's published by the American Association of State Highway and Transportation Officials, 444 N. Capitol St., N.W., Suite 225, Washington, D.C. 2001.

The Psychology of Everyday Things by Donald A. Norman

Norman has rolled cognitive psychology and industrial design into an entertaining and easy-to-understand package. Published by Basic Books, 1988.

Periodicals

Bicycle Forum

"The journal of bicycle advocacy" has been around since 1978. Topics include all aspects of bicycle education, engineering, encouragement and enforcement, including nuts-and-bolts how-to's, with much more emphasis on engineering topics than you will find elsewhere. Also, each issue has a "Library" section that lists new publications in the field. Published quarterly, it's available through the BFA, 1506 21st St. NW, Suite 200, Washington DC 20036-1008; (202) 463-6622.

Pro Bike News

The monthly newsletter of the Bicycle Federation of America covers state-or-the-art bicycle advocacy with an emphasis on topics of interest to advocacy organizations. Contact the BFA, 1506 21st St. NW, Suite 200, Washington DC 20036-1008; (202)

463-6622.

Transportation Research Record

This peer-reviewed publication of the Transportation Research Board is one of the best sources for the most current and respectable transportation research results. Records 1168, 1372, 1405, and 1502 each have bicycle-related themes. Contact the Transportation Research Board, Business Office, National Research Council, 2101 Constitution Ave., N.W., Washington, D.C. 20418, (202) 334-3214. TRB information is also available at the web site: www.nas.edu

World Wide Web sites

The U.S. Department of Transportation's Bureau of Transportation Statistics has a remarkable number of articles on various subjects in its web site's bicycle and pedestrian section:
www.bts.gov/smart/com/SMART-BIKE-PEDESTRIAN@BTS.GOV.html

Williams and Tracy Consulting's web site provides resources for developing a community bike plan. It contains information compiled by *Bicycle Forum* editor John Williams and former Bicycle Federation of America project manager Linda Tracy:
www.bikeplan.com

E-mail mailing lists

For those who aren't familiar with mailing lists: When you send an e-mail message to a mailing list, your message is automatically forwarded to everyone else who subscribes to the list. So you can carry on running, group discussions about the list's topic. The following lists all reside at the same server. To subscribe, just send an e-mail message to:

majordomo@cycling.org

The message itself should be the word "subscribe" followed by the name of the list. To subscribe to the Bikepeople list, for example, your message would read:

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subscribe bikepeople
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Soon you will receive a welcome message confirming your subscription and telling you how to unsubscribe. Then you can participate in discussions by sending messages to the name of the list followed by the server address:

bikepeople@cycling.org

Bikepeople

"Cycling activists from recreational and utilitarian cycling points of view meet here.... Racing, touring, commuting, off-road, tandeming, etc. advocates are welcome. Advocacy can be a copy of a letter written to the local paper, excerpts from a new cycling textbook, testimony before a government committee, notes from a day in court or a report of illuminating encounter with one of our 'friends on the roadway' which provides an insight to an advocacy issue or problem are all legitimate."

Facilities-n-Planning

Issues include safety, facilities design, public/corporate policies affecting bicycles, strategies for educating/informing policy makers, sharing information. The scope includes all developments that affect bicycles: freeway construction, urban land use planning, intelligent vehicles, etc.

Safety-n-Education

According to its welcome message, this list "is for worldwide information exchange and discussion on the topics of cyclist safety, cyclist/motorist/pedestrian education, cycling encouragement, and enforcement programs."

More info

National Bicycle and Pedestrian Clearinghouse

(800) 760-6272, fax: (202) 463-6625, e-mail: nbpc96@bikefed.org

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