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Case Study No. 19

Traffic Calming, Auto-Restricted Zones and Other Traffic Management Techniques– Their Effects on Bicycling and Pedestrians

National Bicycling And Walking Study

U.S. Department of Transportation
Federal Highway Administration

Foreword

This case study was prepared under contract for the Federal Highway Administration by Andrew Clarke and Michael J. Dornfeld.

Notice

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Executive Summary

Traffic calming is becoming a popular traffic management tool in many areas of the world including Europe, Japan, and North America. In addition to requests from neighborhood groups, pedestrians and bicyclists have gotten involved in supporting traffic calming. The reasons these groups are supporting traffic calming varies. However, some of the most important reasons are for safer and more pleasant neighborhoods, environmental concerns, and places for people to walk and bike.

The body of this report can be divided into three parts. The first two major sections examine the history and traffic-calming techniques installed in Europe, Japan, and the United States. The final section of the report examines the practical and policy implication of traffic calming.

Key Findings

European Traffic Calming

Traffic calming can be traced to the development of three types of methods: environmental areas, pedestrianization, and the Dutch "woonerven." The origin of traffic calming can be traced to Germany where downtown shopping areas were converted into pedestrian areas.

The Dutch were the first to create traffic-calmed residential areas with the woonerf or "living yard." The impetus for the development of the woonerf was to calm motor vehicle traffic that was becoming a nuisance and a threat to residents. The woonerf became very popular because motor vehicle volumes and accidents were reduced.

The next step in the development of traffic calming was the German concept of "verkehrsberuhing" or area wide traffic calming. A strict 30 km (18 mph) speed limit was implemented, but over time it became clear that physical changes to the street were needed to control the speed of motor vehicles. An analysis of these areas found little change in traffic volume, a reduction in motor vehicle speeds, and high approval of the traffic-calming technique by both residents and motorists.

Europe also saw other types of traffic-calming techniques developed. "Traffic Cells" are sections of a city that allow internal movement of motor vehicle traffic, but prohibit direct motor

vehicle travel to adjacent sections. They were created to prevent motor vehicles from crossing the boundaries between cells. Public transport, pedestrians, and bicyclists can move freely between the cells. Many other European cities' centers simply restricted nonessential motor vehicle traffic.

In recent years, traffic calming has moved from Northern Europe to Japan. The "road-pia" or area wide traffic-calming concept was used to provide a safe area for pedestrians and residents.

Traffic Calming in the United States

A variety of United States traffic-calming experiences are reviewed in this report. Traffic-calming attempts in the United States tend to focus on spot locations and most have resulted in lower motor vehicle speed and fewer motor vehicle accidents. In general, acceptance of traffic calming is high with many neighbors believing that traffic calming was responsible for making their street more livable. Local residents also felt the benefits of traffic calming outweighed any minor inconveniences or other concerns.

While information exists on the effects of traffic calming on motor vehicle accidents and speeds, there is little information on the effects on bicycle and pedestrian use. However, evaluations of the Palo Alto, California bicycle boulevard and Seattle channelization changes showed increases in the amount of bicycle traffic. Evaluations of similar treatments are needed as they are implemented in the future.

Practical and Policy Implications

Seven issues regarding traffic calming are discussed. They are traffic-calming goals, need and support for traffic calming, benefits to bicyclists and pedestrians, potential opposition, costs and benefits, traffic-calming effects, and new concepts.

I. INTRODUCTION

Over the last thirty years, most of Western Europe, North America, Japan and Australia have been engaged in a struggle to manage the motor vehicle—to retain both the value of the car in providing mobility and access, and the quality of life in urban and suburban areas. Increasing environmental awareness over the last decade has added urgency to the issue.

In Western Europe a wide variety of traffic management techniques have been developed to provide alternatives to the automobile, improve public safety, and enhance the urban environment. These measures have included pedestrianization, extensive bicycle facility networks, improved public transport, and most recently, traffic calming.

In the United States, the pressure for such measures has been less severe, and the solutions less widespread and well developed than in Europe. With notable exceptions such as Seattle, Boulder, and Californian cities such as Berkeley and Palo Alto, there have been few efforts to restrain traffic in the way that has now become common in European towns and cities.

As traffic has grown both in Europe and the United States, bicycling and walking have become less attractive and feasible alternatives to many people. Traffic calming offers a way out of this Catch 22 situation and, as in Europe, bicyclists and pedestrians are at the forefront of efforts to initiate traffic calming in urban areas.

What is traffic calming? Four quotations from the literature provide some insight:

> *Traffic calming aims to reduce the dominance and speed of motor vehicles. It employs a variety of techniques to cut vehicle speeds. Normally traffic calming should be applied as an area-wide technique. To apply it only to a particular street is to run the risk of pushing accidents, pollution and "rat-running" into neighboring areas.*[1]

> *Traffic calming was initially applied primarily in residential areas but is now starting to be extended to whole cities. It is an attempt to mix the different transport modes and create a form of "peaceful coexistence" between them which will vary according to the character of the built-up area and the road.*

[1] Cleary, *Cyclists and Traffic Calming,* Cyclists Touring Club, 1991, Godalming, U.K.

> *The result is that in most cases the urban environment is considerably improved.*[2]
>
> *However, traffic calming is far from being a witch hunt policy against the car. It simply means motor traffic has to lose its dominance in those cases where it has become a nuisance and a danger. It will be the struggle for the emancipation of the pedestrian, the reclamation of public and cycle transport, the preservation of the historic built environment and the residential neighborhoods.*[3]
>
> *Verkehrsberuhigung (German for traffic calming) ...means more than making the traffic quiet, it means making surrounding areas better. Verkehrsberuhigung means to lessen the disadvantages of traffic yet still to keep all the advantages of transport. Verkehrsberuhigung means, it is argued, improvements for pedestrians, cycles, buses and trams, an increase in traffic safety, an improvement in the environment where you live, a stimulation of central living and shopping, less noise, less exhaust fumes, a more pleasant appearance and less traffic signs, greenness and less comfort and speed for car traffic.*[4]

Three decades of experience have shown that traffic calming can solve many but not all traffic problems. Reductions in speed, accidents, noise, pollution, and congestion have been achieved, as have more liveable neighborhoods, vibrant shopping streets, and malls, and improved conditions for bicyclists and pedestrians. Public transport has been well served by the goals and implementation of traffic calming in Europe.

This report examines the development of traffic calming in Europe and the United States, with a particular emphasis on the impacts of such traffic management on bicyclists and pedestrians.

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[2] Hass Klau, *An Illustrated Guide to Traffic Calming*, Friends of the Earth, 1990, London.

[3] Ibid.

[4] Tolley, Rodney, *Calming Traffic in Residential Areas*, 1990, Brefi Press, Wales.

II. The History and Development of Traffic Calming

> *I think, though others may not agree with me, that the term "traffic calming" was originated by me in the mid-1980s when making a direct translation from the German "verkehrsberuhigung." Traffic calming as a device may have originated in the Netherlands, where the concepts of "woonerven" (living yards) and "winkelerven" (shopping yards) were applied respectively to residential and shopping areas.*[5]

In a report for the United Kingdom environmental group, Friends of the Earth, Hass Klau traces the roots of traffic calming back to three sources. In addition to the Dutch "woonerven," she identifies Buchanan's "Traffic in Towns," in which he described the importance of having environmental areas, and pedestrianization as being the major influences.[6]

Few would argue that the development of traffic calming has been led by European countries such as the Netherlands, Germany, and Denmark. Although many of the engineering techniques and facilities used in traffic calming have always been a small part of the United States traffic engineers toolkit, they have not been utilized in quite the same way and not to nearly the same extent as in Europe or, more recently, in Japan and Australia.

Much of the reason for this is purely practical. European cities tend to be more compact than United States cities and cannot cope with the volume of traffic experienced in the United States. Car ownership is still higher in the United States than in most European countries. European cities tend to have better public transport services already in place and local governments have much greater control over land use planning and development than their counterparts in the United States

However, these differences should not mask the real reason for the much wider acceptance and implementation of traffic calming in Europe than in the United States. As a matter of policy, the overwhelming majority of European cities have determined they do not want

[5] Roberts, John, "Traffic Calming," *Pro Bike '90 Proceedings*, Bicycle Federation of America, Washington, D.C.

[6] Hass Klau, *An Illustrated Guide to Traffic Calming*, Friends of the Earth, 1990, London.

to accommodate the level of car use experienced in the United States as the economic, social, cultural, and environmental cost of doing so would be unacceptably high.

A study into the likely economic impact of increasing car use from 36 percent of trips to 76 percent of trips in the Dutch city of Groningen—and a fall in bicycle use from 50 percent to just 5 percent—estimated an annual cost per car of approximately $250 to make up for the increased air pollution, noise nuisance, parking costs, and energy consumption. Traffic accidents, congestion and health impacts were not quantified. The additional parking required for the increase in traffic represented one quarter of the entire downtown area of Groningen.[7]

Buchanan warned in 1963:

> *The briefest acquaintance with the conditions that now prevail in towns makes it clear that traffic congestion has already placed in jeopardy the well being of many of the inhabitants and the efficiency of many of the activities. Unless something is done about the potential increase in the number of vehicles that come together in neighborhoods the conditions are bound to become extremely serious within a comparatively short period of years. Either the utility of vehicles in towns will decline rapidly, or the pleasantness and safety of the surroundings will deteriorate catastrophically—in all probability both will happen together.*[8]

Countries such as Germany paid heed to these warnings. While they developed the most extensive freeway system in Europe they also invested heavily in public transport, bicycling, and walking facilities. According to Hall, "German cities have led and the rest of the world—including Britain—have followed at a distance."[9]

1. Pedestrianization

Throughout the 1960's pedestrianization of downtown shopping streets was undertaken across Germany. Streets were reserved exclusively for use by pedestrians. Initially, pedestrian streets were provided as part of a general re-design of city centers to make way for the automobile—including central city ring-roads, multi-story car parking garages, and rear access streets for delivery vehicles. However, as a result of their economic success and changes in attitude towards historic preservation, the environment, safety, and pedestrianization of large areas of downtowns became a symbol of enlightened town planning. In western Germany alone, there

[7] Kromendijk, Erma, *Policy and Provision for Cyclist in Europe*, Commission of the European Community, 1989, Brussels.

[8] Buchanan, *Traffic in Towns*, HMSO, 1963, London.

[9] Hall, Peter. *New Life for City Centers: Planning, Transport and Conservation in British and German Cities*, Anglo-German Foundation, 1988, London.

are over 1,000 pedestrian areas and traffic-calmed town centers. All cities and almost all towns with a population of over 50,000 have central pedestrian areas. Almost three-quarters of towns with populations of 20,000–50,000 have a pedestrian area or a traffic-calmed shopping area.[10]

Most pedestrian areas in Germany began as short stretches of street, typically quite narrow and with a high density of pedestrians. Newly established pedestrian areas usually cover 100-300 meters (300-1,000 feet) and most are subsequently extended. In the older and larger cities such as Munich, Frankfurt and Hanover networks of pedestrian streets and arcades extend from 4 to 7 kilometers (2.5 to 4.5 miles). Similar development is evident in eastern Germany as well.

Pedestrianization is now a feature of most European cities, to the extent that cities without them are considered backwards. In 1975 Monheim surveyed 120 German towns to determine why they had implemented pedestrianization. He found the most important reason was "to have an up-to-date town layout and attractive image." Other popular answers were:

- Improvements for traffic and safety
- Leisure use of the center, especially for evening use
- Attracting shoppers from surrounding countryside
- Less noise and pollution
- Preservation of historic townscape
- Prevent loss of trade to competing towns[11]

Discussion of the success or desirability of pedestrian areas focuses not on safety but economics. Roberts sums up the argument:

[10] Monheim, H., "The Evolution and Impact of Pedestrian Areas in the Federal Republic of Germany," *The Greening of Urban Transport*, Belhaven Press, U.K. 1990.

[11] Ibid.

> *There is now a wealth of evidence to show that pedestrianization, unless it is mis-designed or located, benefits retail turnover. This is probably attributable to three phenomena: pedestrian flows increase by at least 50 percent; pedestrians are more relaxed when freed from the hassles of vehicular traffic; they can more easily compare what is on offer and, in fact, see things they probably would have missed in a traffic congested street.*[12]

As evidence of this, Roberts cites a 1978 study by the Organization for Economic Cooperation and Development (OCED). More than 100 cities with pedestrian areas responded and, worldwide, turnover in city centers with pedestrian areas increased in 49 percent of cities, remained stable in 25 percent, decreased by 10 percent in 18 percent of the cities, and by 25 percent in the remainder. Cities in Austria, Germany, and Scandinavia experienced increases in turnover of more than 60 percent.[13]

Roberts warns of the mis-design and location of pedestrian streets, while Monheim details the possible negative effects of pedestrian areas. Some of the issues that arise in their discussions include:

- Streets should already have significant pedestrian activity before motor vehicle traffic is removed.

- Pedestrian areas should not usually be introduced as isolated measures, but as part of a package designed improve the whole downtown area. For example, the extensive pedestrianization in Munich was complemented by construction of the very successful U-bahn and S-bahn rail systems, which feed directly into the pedestrian areas.

- The increased attractiveness of pedestrian areas can significantly increase shop rents. For example, the pedestrianization of Stonegate in York, England led to rent increases from $400 to $1500 per square meter. While this demonstrates success, it can lead to "nightmare pedestrian areas" where only nationally franchised chain stores can afford to remain, leaving every pedestrian area looking exactly the same.

- The type of shopping found in pedestrian streets tends to be comparison shopping rather than convenience shopping, as shoppers feel more comfortable browsing in the unhurried auto-free atmosphere.

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[12] Roberts, John, "The Economic Case for Green Modes," *The Greening of Urban Transport*, Belhaven Press, 1990, U.K.

[13] *Results of Questionnaire Survey on Pedestrian Zones*, Organization of Economic Cooperation and Development (OCED), 1978, Paris.

- Other locations, especially those on the periphery, do less well after pedestrianization. Competing town and city centers may also suffer a loss of business. In some locations traffic calming, rather than full pedestrianization, has been introduced in the peripheral areas to make them more attractive.[14]

Despite these potential problems, both Monheim and Roberts speak in glowing terms of the importance of traffic free downtown areas, and the way in which pedestrian activity builds on itself to create an attractive place to be.

> *The sheer attractiveness of a reborn city center, resulting from less vehicular traffic and concomitant environmental improvements, can introduce less tangible benefits. It will become a magnet for tourists. It will be a better place for working, so employees and employers will have greater satisfaction. It will permit on-street entertainment, political meetings, concerts—all contributing not only to a better quality of life but also to economic enhancement. New buildings will arise and old ones will be renovated, shop fronts will be renewed or repainted. And it will become a mecca for green travelers—a good place to walk, cycle and perhaps tour around in a minibus. There is an interactiveness about all these events, one stimulating another.*[15]

2. Woonerven

In the 1970's the focus shifted from city centers to residential streets and neighborhoods, where traffic was becoming a significant nuisance and threat to residents. The Dutch, and in particular the city of Delft, were at the forefront. According to Tolley:

> *Planners there began to ask why it was that their residential streets were so dull and so unsafe, and why was it impossible to do anything else there except drive cars—even though most of the time there were no moving cars. Traffic was seen as one of the greatest sources of blight, causing unsafety, discomfort and taking most of the space.*[16]

The result of their thinking was development of a new concept in traffic management: the woonerf, or living yard. Experiments with these new street designs, in which there was no segregation between motorized and nonmotorized traffic and in which pedestrians have priority

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[14] Roberts, J., and Monheim, H., "The Economic Case for Green Modes" and "The Evolution and Impact of Pedestrian Areas in the Federal Republic of Germany," *The Greening of Urban Transport*, Belhaven Press, 1990, U.K.

[15] Roberts, John, "The Economic Case for Green Modes," *The Greening of Urban Transport*, Belhaven Press, 1990, U.K.

[16] Tolley, Rodney, Chapter 4, *Calming Traffic in Residential Areas*, Brefi Press, 1990, Wales.

in the whole street area, became Dutch law in 1976. In the 7 years after the new traffic law defining woonerven was passed a total of 2,700 such features (average size: two streets of approximately 200 meters (600 feet) in length) were built.[17]

The 1976 law lists some important characteristics of a woonerf (pl. woonerven) that differentiate it from any other type of street. These include some very specific design requirements such as:

- The impression that the highway is divided into a separate roadway for motor vehicles and a footpath must be avoided. There should, therefore, be no continuous difference in cross-sectional elements along the length of the road. Breaks should therefore occur in features which can give the impression of the existence of a footpath and should be at intervals of approximately 25 meters (75 feet); this should be quite clear to the motorist.

- On those parts of the highway intended for motor vehicle use, features must be introduced which will restrict the speed of all types of vehicles. These features should not be more than 50 meters (150 feet) apart.

- These features should not be located so as to cause vehicles to pass too close to housing which fronts directly onto the road.

- Adequate street lighting must be provided to ensure that all features, especially those referred to above, are fully visible at night.[18]

These main features, along with 10 others, were required in every woonerf. As a result, it was also felt necessary to publish a new set of traffic regulations especially for the woonerf. Five basic principles were outlined:

- Pedestrians may use the full width of the roads within a woonerf which is designated as such; playing is also permitted on the roadway.

- Drivers within a woonerf may not drive faster than at walking pace. They must make allowance for the possible presence of pedestrians, including children at play, unmarked objects, and irregularities in the road surface, and the alignment of the roadway.

- Traffic from the right has priority over traffic from the left in a woonerf. (Normally, fast traffic has priority over slow traffic.)

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[17] Ministerie van Verkeer en Waterstaat, *Residential Neighborhoods and Traffic Zones*, The Hague, 1986.

[18] ANWB (The Royal Dutch Automobile Club), "Woonerf," The Hague, 1980.

- Drivers may not hinder pedestrians within a woonerf. Pedestrians shall not unnecessarily hamper the progress of drivers in a woonerf.

- Drivers of motor vehicles with more than two wheels are not permitted to park in a woonerf except at places which are identified by the appropriate traffic sign or the letter P marked on the pavement.[19]

The biggest change, of course, was the notion that all road users should be integrated, not separated, for their mutual safety and benefit. The legal change was backed up with quite radical new street designs and layouts and every feature of the woonerf encourages drivers to drive at walking pace.

Figure 1 on the next page shows the typical features of a woonerf.

Drivers entering a woonerf must pass by a sign indicating the new rules that apply. No sidewalks are provided—the whole street is on the same level. Regular shifts in the vertical and horizontal alignment, street furniture, play areas, designated parking spots and different surface materials all contribute to the feeling that priority rests not with the motor vehicle, but with residents on foot, children playing, and nonmotorized users.

Other important principles inherent in the original woonerf design included:

- Woonerven were only appropriate for streets with an already low flow of through traffic.

- Woonerven should always be two-way streets, with passing places where necessary.

- Access for emergency and service vehicles is always maintained.[20] Planners, engineers, and residents alike clamored for the introduction of woonerven. Indeed, one problem experienced with their use was that residents living on the streets wholly inappropriate for implementation of a woonerven, pressured their governments to have their street changed.

The widespread introduction of woonerven was closely evaluated:

- Nationally, 70 percent of the Dutch population thought woonerven attractive or highly attractive.

- Nonmotorized users assessed them more positively then motorized users.

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[19] Ibid.

[20] Ibid.

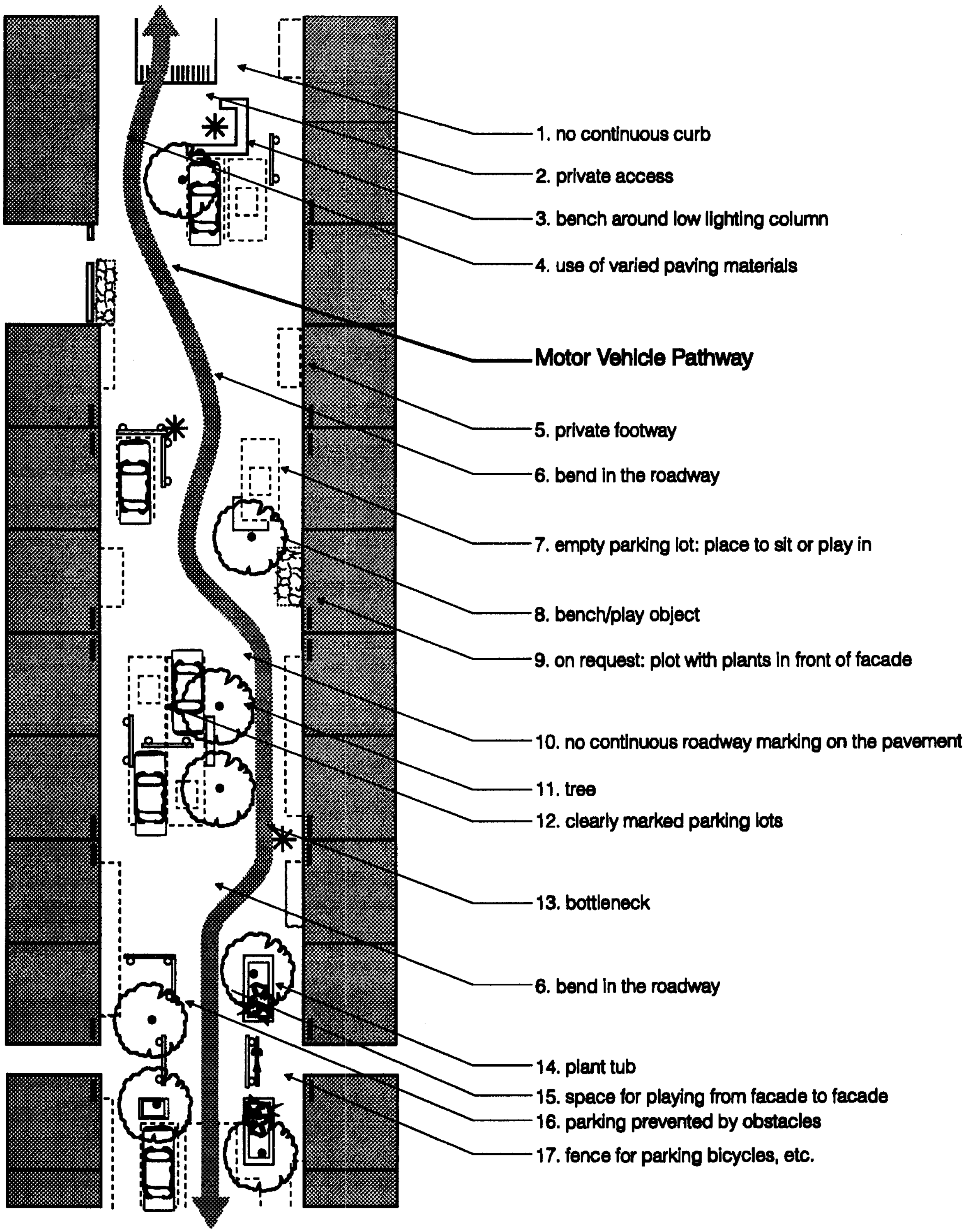

Figure 1. A Model "Woonerf"

- Residents appreciated the low traffic volumes and absence of through traffic, but the bigger play areas and environmental improvements were even more of a benefit.

- Injury accidents were reduced by 50 percent.

- Vehicle speeds were reported to average 13-25 km/hour (8-15 mi/hr.).

As a result of this success, woonerven have become a routine feature of new residential area design. However, there have also been a number of problems identified with woonerven. Retrofitting existing neighborhoods to become woonerven was prohibitively expensive. The very strict design requirements of woonerven often could not be met. For example, traffic flows in inner city neighborhoods might exceed the low volume required for a woonerf and cause an overflow of traffic onto neighboring streets. Pedestrians complained that there was no designated or protected space for them without raised sidewalks. Finally, the principles of woonerven could not legally be extended to shopping streets or village centers (winkelerven and dorpserven).

Thus, in 1984, a Review Panel established by the Dutch Government reviewed the woonerf law and made a number of substantial changes. The 14 strict design rules were reduced to just six basic principles, close to the original concept of the woonerf, but allowing more flexibility.

1. The main function of the "erf" shall be for residential purposes. Thus, roads within the "erf" area may only be geared to traffic terminating or originating from it. The intensity of traffic should not conflict with the character of the "erf." In practical terms, conditions should be optimal for walking, playing, shopping, etc. Motorists are guests. Within woonerven, traffic flows below 100 vehicles per hour should be maintained (300 vehicles per hour for winkelerven).

2. To slow traffic, the nature and condition of the roads and road segment must stress the need to drive slowly. Particular speed reducing features are no longer mandated, so planners can utilize the most effective and appropriate facilities.

3. The impression shall not be created that the road is divided into a carriageway and sidewalk. Therefore, there shall be no continuous height differences in the cross-section of a road within an "erf." Provided this condition is met, a facility for pedestrians may be realized. Thus, space can be designated for pedestrians and a measure of protection offered, for example, by use of bollards or trees.

4. The entrances and exits of "erven" shall be recognizable as such from their construction. They may be located at an intersection with a major road (preferable) or at least 20 meters (60 feet) from such an intersection.

5. The area of a section of the road surface intended for parking one or more vehicles shall be marked at least at the corners. The marking, and the letter P

shall be clearly distinguishable from the rest of the road surface. In winkelerven special loading spaces can be provided, as can short term parking with time limits.

6. Informational signs may be placed under the international "erf" traffic sign to denote which type of "erf" is present.

These new laws were effective July 16, 1988. In the 12 years between the first "woonerf" law and the revised version, Dutch traffic engineers were busy with much more than just woonerven. In addition to the problems identified above, woonerven were only applicable in a particular type of low-volume street. The need to tame traffic was far more widespread, and many of the techniques used in woonerven could readily be applied to other residential streets without some of the substantial costs involved in implementing full-scale woonerven.

Two demonstration projects were established in 1977 in residential areas of Eindhoven and Rijswijk to compare the costs and benefits of a full-blown woonerven with Buchanan-style one-way street systems. In between was a third trial area: streets with many woonerf style treatments such as speed humps, carriageway narrowing and parking management. The woonerven was effective but expensive. The simple traffic diversion method was cheap and largely ineffectual. In between came what is now known as the 30 km/hr zone (18 mi/hr) where significant speed and accident reductions could be achieved without the high costs of a woonerven.

3. Verkehrsberuhigung

The Netherlands and their North European neighbors watched the development of the woonerf and learned from the shortcomings of the concept. The Eindhoven and Rijskwijk experiments prompted the Dutch to create regulations for 30 km (18 mi/hr) zones such that the character of the street dictated a maximum speed of 30 km/hour (18 mi/hr).

As with woonerven, Dutch local authorities greeted this opportunity to calm traffic with enthusiasm. Close to two hundred 30 km/hr (18 mi/hr) zones were created in the first 3 years and a series of evaluation studies was set in motion. In one such area in 's-Hertogenbosch results show:

- 33 percent reduction in through traffic
- 85 percent of vehicle speeds between 20 and 30 km/hr (12-18 mi/hr) at speed humps, rising to 30 and 35 km/hr (18-21 mi/hr) between the humps.

Tolley reports this level of success has been repeated in the first 10 studies completed. Mean speeds have fallen from 27 to 22 km/hr (16 to 13 mi/hr) with speed humps (less than 60 meters apart (180 feet)) and mini-roundabouts being the most effective measures.[21]

German traffic planners and engineers took up the lead from the Dutch and quickly developed their equivalent of the woonerf: wohnstrasse. The province of North-Rhine Westphalia asked for neighborhoods to volunteer, and 130 responded. Thirty areas were eventually selected. Three years later an evaluation reported that injuries had been reduced by 44 percent and serious injuries and deaths by 53 percent.[22]

Keeping in step with the Dutch, the Germans then developed their version of the 30 km/hr (18 mi/hr),or Tempo 30, zone: area-wide traffic calming, or "verkehrsberuhigung." As with the 30 km/zones (18 mi/hr), they combined the best features of the woonerven with Buchanan's concept of environmental areas. The road system remained fully connected—unlike in Buchanan's model, where road closures, diversions and one-way streets kept unwanted traffic away—but traffic speeds throughout the system were to be significantly decreased.

> *Short-cut traffic would be deterred, yet residents could still reach their homes directly. There would be a more uniform distribution of traffic across the area and traffic volumes would be brought into line with area functions and land use policies. The speed reductions would be achieved by applying at critical areas in the network some of the same sort of [traffic-calming measures].*[23]

The results of Verkehrsberuhigung in Berlin:

Table 1. Injury Accidents per 1000 Children

LOCATION	1977-79 (before)	1982-84 (after)
Berlin-Charlottenburg (with VB)	11.2	4.0
Berlin-Moabit (without VB)	7.6	11.3
Berlin West (Total)	8.6	7.1

VB = Verkehrsberuhigung

[21] Tolley, Rodney, Chapter 5, *Calming Traffic in Residential Areas*, Brefi Press, 1990, Wales.

[22] Citizens Against Route Twenty, *Traffic Calming*, 1989, Queensland, Aus.

[23] Tolley, Rodney, Chapter 5, *Calming Traffic in Residential Areas*, Brefi Press, 1990, Wales.

The importance of reducing traffic speed cannot be overemphasized. While the overall goals of traffic calming may include environmental improvements, better conditions for bicyclists and pedestrians, accident reductions, and more space for children to play—the reduction of vehicle speeds is crucial to each.

When the European Commission surveyed the attitudes of bicyclists in 11 countries, the strongest and closest agreement came for the statement "Most cars drive too fast."[24]

Cleary details 15 specific speed reducing "techniques" in the Cyclists' Touring Club's (CTC) excellent guide to traffic calming.

1. Road Humps and Speed Tables

   Raising the surface of the road over a short distance, generally to the height of the adjacent curb. Humps can be round or flat-topped—the latter being known as speed tables, which can extend over many meters.

2. Chicanes

   Physical obstacles or parking bays, staggered on alternate sides of the highway so that the route for vehicles is tortuous.

3. Traffic Throttles (pinch points)

   The narrowing of a two-way road over a short distance to a single lane. Sometimes these are used in conjunction with a speed table and coincident with a pedestrian crossing.

4. Curb extension (sidewalk widening)

   The sidewalk on one or both sides of the road is extended to reduce the highway to a single lane or minimum width for two-lane traffic. This reduces crossing distances and discourages parking close to intersections and crosswalks.

5. Central refuges (medians)

   Islands situated in the middle of the road to reduce lane widths and provide a refuge for pedestrians and bicyclists crossing major roads.

6. Mini-roundabout (traffic circle)

   Small roundabouts situated at an intersection. Some have raised centers, others are just painted circles on the road.

[24] Commission of the European Communities, *Policy and Provision for Cyclists in Europe*, 1989, Brussels.

7. Raised Intersections

   The highway is raised at an intersection, usually by brickwork or a plateau with a ramp on each approach. The platform is a curb level and may well have distinctive surfacing.

8. Entry Treatment Across Intersections

   Surface alterations at side road intersections, generally using brickwork, setts or other textured surface materials. Level of the road may be raised to the level of the sidewalk.

9. Environmental Road Closure

   Road closures, generally in residential streets, designed to remove through traffic or prevent undesirable turns.

10. No Entry—with "cycle-slip"

    Access to a road is barred in one direction by a No-entry sign. The rest of the road remains two-way, and bicyclists and pedestrians can pass the No-entry sign.

11. Textured Surface

    The use of nonasphalt surface such as setts, brickwork, paving or cobbles to reinforce the concept of a traffic restricted area.

12. Shared Surfaces

    The traditional distinction between sidewalk and pavement is removed, leaving pedestrians, bicyclists and motor vehicles to share a common space.

13. Tortuous Roads

    Roads are designed to meander, occasionally quite sharply, reducing the view of any stretch of "open road" and thereby encouraging lower vehicle speeds.

14. Rumble Strips

    Lines of cobbles or other raised surfacing designed to warn drivers of excessive speed or of the proximity of a hazard area where lower speeds are desirable.

15. Transverse Bands

> Painted lines oriented as transverse bands across the highway at decreasing intervals. They are intended to give drivers the impression they are traveling with increasing speed, so they will react and slow down.[25]

The CTC technical note provides considerably more details, discusses the advantages and disadvantages of each measure, and addresses ways of ensuring each one benefits bicyclists and does not make the street more complicated, unsafe, or unattractive.

All of these features are used to some extent in the examples of traffic calming cited in this report, and there are a number of other good sources of technical information on the design and implementation of these features.[26]

One important feature of traffic calming not mentioned by Cleary in the CTC guide are, in fact, special bicycle facilities. In many traffic-calming projects road space is reallocated to provide bicyclists and pedestrians more and/or dedicated space.

The Germans began to treat the urban street system according to a new kind of hierarchy:

- Arterials and major routes should have a maximum speed of 50 km/hr (33 mi/hr), synchronized traffic lights, bike lanes, marked crosswalks, medians and attractive sidewalk areas for people to linger.

- Collector/distributor streets should have a maximum speed of 30 km/hr (18 mi/hr) with design features—such as narrower lanes, bike lanes, wider sidewalks, speed tables—to make this limit self-enforcing.

- Residential streets should be woonerf-type streets with carefully managed parking, very slow speeds (walking pace), chicanes, play areas, speed humps, and environmental road closures to deter through traffic.

Adopting an approach dealing with the whole street system has helped avoid some of the pitfalls of just concentrating on woonerven and residential streets. Accident problems and excess traffic cannot simply be shunted off to another street. Traffic calming has truly become area-wide in scope.

In the early 1980's German planners and traffic engineers started to develop Tempo 30 zones: Areas where traffic signs and minimal changes to the infrastructure sought to reduce traffic speeds. In 1983, a 5-year experiment with Tempo 30 zones prompted work in more than 5,000 areas. In Hamburg, 30–40 percent of the highway system is designated 50 km/hr (30 mi/hr) and the remainder is—or will become—Tempo 30 areas (18 mi/hr).

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[25] Cleary, *Cyclists and Traffic Calming*, Cyclists Touring Club, 1991, Godalming, U.K.

[26] Tolley, Rodney, *Calming Traffic in Residential Areas*, 1990, Brefi Press, Wales.

As experience grew, however, it became clear that physical changes to the street were needed to really control vehicle speeds. All of the features listed above have been used in thousands of areas where traffic calming has been implemented in recent years. Monheim estimated that in 1987 there were 4,000 traffic-calming areas in North-Rhein Westphalia alone. A 1989 study puts that figure at 8,147. The province has an ambitious, ongoing program featuring 126 projects in 94 cities and towns with a total investment level of close to $100 million.[27]

The Federal Government was anxious to know how these different approaches were working and in 1981 set up a major research project to study traffic-calming projects in six very different settings. Communities in one major city (Berlin), three medium sized cities (Mainz, Ingolstadt and Esslingen), a small town (Buxtehude) and a village (Borgentreich) were selected.

Initial results of the project were very encouraging. Monheim provides an overview:

- Little change in overall traffic volumes.
- Average vehicle speeds fell from 39 km/hr to 20 km/hr (25 to 12 mi/hr).
- Average journey time for motorists increased 33 seconds.
- Fatalities fell by 43-53 percent and injuries by 60 percent. The total number of accidents remained the same.
- Air pollution decreased by between 10 and 50 percent; noise levels fell by 14 decibels; fuel use was cut by as much as 10 percent (depending on driving style and behavior).
- 67 percent of motorists and 75 percent of residents approved of the changes (an improvement from 27 percent and 39 percent respectively prior to the work.)[28]

Since then, more specific results have appeared from the different areas involved in the experiment.

Bicycle use has doubled in Buxtehude in the 4 years since the traffic-calming project was finished. Bicycle accidents have also risen—but primarily noninjury accidents.[29]

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[27] Whitelegg, John, "The Principle of Environmental Traffic Management," *The Greening of Urban Transport*, Belhaven Press, 1990, London.

[28] Citizens Against Route Twenty, *Traffic Calming*, 1989, Queensland, Aus.

[29] Doldissen and Draeger, "Environmental Traffic Management Strategies," *The Greening of Urban Transport*, Belhaven Press, 1990, London.

In addition, the proportion of bicyclists considered to be "at fault" in any accident fell from 45 percent to 35 percent.[30]

Overall, serious traffic related injuries in Buxtehude fell by two-thirds and light injuries by one-third. There were no pedestrian injuries reported in the after-study period.

In the Berlin-Moabit area, bicycle use increased by 50 percent.[31]

There were significant accident reductions for most categories of road user:

- 57 percent reduction in fatal accidents.
- 45 percent reduction in severe accidents.
- 40 percent reduction in slight injuries.
- 43 percent reduction in pedestrian accidents.
- 16 percent reduction in cyclist accidents.
- 16 percent reduction in traffic crash costs.
- 66 percent reduction in child accidents.

In addition, street activity in the Moabit area reportedly increased by as much as 60 percent.[32]

These results represent a considerable success. The original goals of the traffic-calming research project were to prioritize walking, bicycling, and public transport use, improve traffic safety for all users, and improve the overall quality of life and environment in the affected areas. The measures employed have achieved this.

Other studies of traffic calming, both in Germany and elsewhere,bear this out. Hass-Klau reports on successful traffic-calming projects in Heidelberg and Hamburg. In Heidelberg there was a 31 percent fall in accidents and a 44 percent decrease in injuries. In Hamburg, over 260 Tempo 30 zones were installed, resulting in a 23 percent reduction in casualties. Hass-Klau also reports that in some Tempo 30, areas vehicle standing times decreased 15 percent, gear changing fell by 12 percent, use of brakes by 14 percent and gasoline consumption by 12 percent.[33]

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[30] Commission of the European Communities, *Policy and Provision for Cyclists in Europe*, 1989, Brussels.

[31] Ibid.

[32] Tolley, Rodney, *Calming Traffic in Residential Areas*, 1990, Brefi Press, Wales.

[33] Hass Klau, *An Illustrated Guide to Traffic Calming*, Friends of the Earth, 1990, London.

4. Traffic Calming in Denmark

The Danish city of Odense has, for the last 10 years, been developing a "Safe Routes to School" project, concentrating traffic-calming efforts on areas close to schools and on popular school routes. Seven major slow-speed areas have been developed using a mix of the techniques listed above—and the results have been remarkable. Average vehicle speeds have fallen from 50-55 km/hr to just 20-25 km/hr (approx. 30 mi/hr to 13 mi/hr) and truck traffic has all but disappeared. Accidents have been reduced by 85 percent—down from 9.65 per annum to just 1.5 per annum.[34]

5. Traffic Calming in Japan

The Japanese have also experimented with woonerven and traffic calming in recent years. The first "community street" was installed in Nagaike-cho, a suburb of Osaka, based on the woonerf design in 1980. Pedestrian traffic in the street increased by 5 percent, bicycle traffic rose by 54 percent and car traffic entering the street fell by 40 percent. Average vehicle speeds were as low as 5 km/hr (3 mi/hr), with a maximum speed observed of 8 km/hr (5 mi/hr). Over 90 percent of residents highly praised the community street.

In 1984, the Japanese moved on to area-wide traffic calming with the "Road-Pia" concept—an area where pedestrians and residents have safety and comfort secured for them. The principle was tested in the Koraku section of Minato-ku, Nagoya, with before and after studies revealing:

- Overall vehicle traffic volumes decreased, particularly on the community streets.
- Vehicular traffic coming into the area decreased.
- Pedestrian and bicycle traffic volumes rose along most routes.
- Average vehicle speeds fell by 3.5 km/hr (2 mi/hr), with a much greater fall in the maximum speed of cars.
- Parked cars became less intrusive.
- Traffic accidents fell from 32 in the 4 years prior to the project to just two in the first 2 years following implementation.[35]

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[34] Nielsen, "Safe Routes to School in Odense," *The Greening of Urban Transport*, 1990, Belhaven Press, London.

[35] "The Wheel Extended," *Toyota Quarterly Review*, Vol. 73, Tokyo, Japan.

6. Other Traffic-Reduction Strategies

The three philosophies of pedestrianization, woonerven, and verkehrsberuhigung have dominated urban traffic management for the last 30 years in Europe. However, they are far from the only innovative and successful transportation initiatives that have taken place during this time.

Traffic Cells

Traffic chaos during the 1969 Christmas season was, apparently, the inspiration for the city of Gothenburg in Sweden to restrain traffic for the economic survival of the city. The downtown area of the city was divided into five "cells" and cars were prevented from crossing the boundaries between these cells. Instead, to move from one to another drivers have to return to an inner ring-road and circle around to the entrance to the next cell. Public transport vehicles, bicycles and pedestrians are allowed to cross the cell boundaries.

In addition to the traffic cells, public transport was improved, parking spaces were reduced and made more expensive and an extensive public information system was put in place. The combination of measures worked well with results including:

- 45 percent reduction in traffic entering the central area between 1970 and 1982.[36]
- 50 percent reduction in injury accidents inside the ring road and a 25 percent cut on the ring-road in the first 5 years. This freed up 20-30 policemen for other work.
- 8 percent increase in transit ridership, 1970-75.
- Increase in travel speeds on the ring-road from 16 to 23 km/hr (10 to 14 mi/hr)—reduced radial traffic meant longer green times for the orbital route.
- A markedly improved environment for people living, working or walking in the central district. Noise levels fell from 74 to 67 decibels and carbon monoxide from 65 to 5 parts per million in the traffic-free area.[37]

The Dutch city of Groningen introduced a similar traffic circulation plan in 1977 and achieved a 44 percent reduction in the number of cars and vans in the central area in the first

[36] Mathew, D., "Calming the Traffic—Exciting the Cyclist," *Cycletouring and Campaigning*, Feb/March, 1989, Godalming.

[37] "Center City Environment and Transportation: Transportation Innovations in Five European Cities," United States Department of Transportation, 1980, Washington, D.C.

year. Bus travel rose 12 percent and bicycling and walking increased substantially. Bicycle use in Groningen is now well over 50 percent of all trips.[38]

In each of these cities, cars can still reach all parts of the city center—if they need to. For most people it makes more sense and is more convenient to go by some other means. Once in the center, the absence of traffic has made the shopping and working environment very attractive.

Italian Auto-free Zones

Motor vehicle traffic in many Italian cities has become unbearable for residents and visitors alike in the last decade. The impact of traffic accidents, congestion and extremely destructive air pollution has prompted a number of cities to close off large downtown areas to all but essential traffic—i.e. noncommuters and those with a final destination in the downtown such as residents and merchants.

Both Florence and Milan introduced such measures, usually involving complete closure of the central area to all but those with permits, after citizen referenda confirmed popular support for them. Even the chaotic Milan experiment cut motor vehicle travel to the central area by half.[39]

The most successful of the Italian cities to introduce this kind of area-wide traffic restraint is Bologna. Under a slogan of "A City for Living" authorities have tightened access restrictions to streets in the historic central district while improving bus, trolley, and metro services.

Many other cities in Europe have taken quite remarkable steps to reduce the impact of cars in their central areas. For example:

- The city of Freiburg, Germany (pop. 175,000) has 5 kms (3 miles) of pedestrianized streets, 125 kms (78 miles) of quiet traffic-calmed streets, 135 kms (84 miles) of bike paths and an efficient tram and bus system. Bicycle use doubled between 1976 and 1986 and with the introduction of a cheap, integrated transit pass, transit use rose 20 percent and 18 percent of car users switched to transit.[40]

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[38] Clarke, A., *Bicycles Bulletin*, July–December 1987, Friends of the Earth, London.

[39] Roberts, John. "Traffic Calming," *Pro Bike '90 Proceedings*, Bicycle Federation of America, Washington, D.C.

[40] Roberts, J., and Monheim, H., "The Economic Case for Green Modes" and "The Evolution and Impact of Pedestrian Areas in the Federal Republic of Germany," *The Greening of Urban Transport*, Belhaven Press, 1990, U.K.

- In 1989, the Mayor of Paris (pop. 2.3 million) announced plans to ban on-street parking from 200 miles of central city streets—close to 100,000 spaces—and to use the additional space for transit lanes and pedestrian facilities.[41]

- Residents of Amsterdam, Netherlands voted by a narrow majority in 1992 to severely restrict car access to the central area and to reduce the number of car parking spaces by half.

Traffic Calming Through Roads

In addition to causing problems in large urban areas, motor vehicle traffic, especially through traffic, is a significant problem in many small towns and villages sitting astride major roads. For decades the solution to this problem has been to build costly by-passes around the affected area. In Denmark and France, however, traffic engineers and planners have successfully adapted the principles of traffic calming to major routes.

As with traffic calming in residential streets, a key objective is the reduction of vehicle speeds. Once again, the results are quite impressive.

- France: "A general speed reduction in a number of such small towns has been observed to be between 10 and 20 km/hr (7-13 mi/hr). So the average speed and especially excessively high speeds have been decreased, while free-flowing traffic conditions have been preserved at moderated speeds. In most cases, capacity and average travel time were maintained in these small towns."

- The average number of accidents dropped by over 60 percent in the 10 towns studied.

- Denmark: A general speed reduction of between 8 and 10 km/hr (5-6 mi/hr) was achieved. Both the total number of accidents and injury accidents were reduced in the three experimental towns by 50 percent, and the number of injuries by one third.

Estimates suggest that a traffic-calmed street costs 10 percent more than regular reconstruction of a street and three to four times less than a by-pass. In addition, maintenance costs on the by-pass are likely to be 50-70 percent greater than on the reconstructed through road.[42]

Bracher reports on the impact of these projects on bicyclists. In Vinderup, Denmark the speed limit was lowered to 40 km/hr and cycle paths were constructed along the road. Seventy-five percent of bicyclists said they felt safe riding on the street after the changes, compared to

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[41] "Paris Pushes out the Motorists," *Manchester Guardian*, October 22, 1989.

[42] Djurhuus, "Through Traffic in Small Towns," *Permanent International Association of Road Congresses*, 1991, Paris.

just 17 percent before. In addition, 54 percent felt it had become easier to cross the road, compared to 9 percent previously.[43]

In another Danish town, Skaerbaek, cyclepaths were also included in a package of measures to reduce the speed of through traffic on the main road. Car speeds fell from 58 to 51 km/hr (36 to 31 mi/hr) small truck speeds fell from 60 to 49 km/hr (37.5 to 30 mi/hr) and large trucks from 55 to 46 km/hr (34 to 28.5 mi/hr). A total of 68 percent of people find it easier to move around town, including the majority of car drivers.

Although bicyclists actually now take longer to get across the main road, they approve of the measures. Almost half (47 percent) actually think it is easier for bicyclists to cross the road and 17 percent say it is more difficult. Only 6 percent (compared to 38 percent previously) are impeded by parked cars and 90 percent(compared to 37 percent) feel safe as bicyclists.[44]

7. Summary

Controlling and managing traffic has been the challenge of traffic engineers and planners throughout Europe for the last 30 years. The fact that Germany, the Netherlands, Denmark, and Scandinavian countries were first to grapple with the issue reflects the higher levels of car ownership and use experienced in those countries. As these levels have risen in other countries, so they too have had to rise to the challenge and determine how to manage cars in cities.

Five key themes have emerged. First and foremost has been the acceptance that cars must have a limited place in the life of cities—and this is often contrasted with the experience of cities in the United States, where the car has been accommodated at all costs.

Second, a new hierarchy of roads and streets has emerged. Major roads (nonfreeways) should have speed limits of 50 km/hr (31 mi/hr) with priority given to public transport and dedicated space given over to pedestrians and bicyclists. On collector and distributor roads, speeds should be limited to 30 km/hr (18 mi/hr) and speed reducing designs such as speed tables, crosswalks, bike lanes, sidewalks, and controlled parking methods should be utilized. Pedestrian areas, woonerven and very low speed routes complete the hierarchy in purely residential low-volume streets and shopping streets.

Third, this reflects a new paradigm: pedestrians, bicyclists and public transport are prioritized. Motor vehicles are the least desirable means of transport for most journeys in urban areas and should be discouraged at the expense of these other alternatives.

Fourth, all the modes, together with land-use planning are completely inter-connected and must be integrated. Implementing special bicyclists networks or pedestrian areas on their own

[43] Commission of the European Communities, *Policy and Provision for Cyclists in Europe*, 1989, Brussels.

[44] Ibid.

will have limited overall impacts—a combination of measures is required to reduce the impact of motor vehicles in particular and transport in general.

Finally, the spirit of innovation is alive and well in the planning and engineering disciplines in Europe. Coupled with a willingness to involve the public in the process of determining the future shape of their neighborhoods, this willingness to experiment has been quite remarkable.

III. Traffic Calming in the United States

Adverse effects of motor vehicle traffic on the grid pattern emerged in the United States in the 1920's, but little was done to alleviate the problem. Although suburban curvilinear streets were developed to reduce these impacts. It was in the 1940's and 1950's when the first diverters and cul-de-sacs were installed to protect neighborhoods in Montclair, New Jersey, and Grand Rapids, Michigan.[45]

Early traffic calming focused on improving specific locations. Over time, a shift in neighborhood traffic management occurred: instead of reacting to community concerns, local governments moved to be more proactive. Today there is less concern with improving single locations, but more emphasis on traffic calming as a neighborhood transportation problem that needs to be evaluated on an area-wide basis. Now, a variety of techniques are being implemented and refined.

Types of United States Traffic-Calming Techniques

Traffic-calming devices of various types have been installed in many parts of the United States. The most active jurisdictions appear to be cities on the west coast.

United States traffic-calming techniques can be classified into three main types: residential treatments, pedestrian zones, and arterial treatments.

Traffic calming can have different effects on bicyclists and pedestrians depending on how they interact with the device. One group—those who live or work in an area that has received some type of traffic calming—is most directly affected by the traffic calming. The other group most likely to be affected by traffic calming are the bicyclists and pedestrians who pass through a traffic-calmed area.

Traditionally, the traffic-calming target group has been those people who live in the area where a traffic-calming device has been installed. However, popular contention is that traffic-calmed areas can also serve as places for people to walk or bike. As a result this group must also be considered.

[45] Smith, Daniel T., and Appleyard, Donald, *State of the Art: Residential Traffic Management*, FHWA No. FHWA/RD-80/092, December 1980.

The following 10 topics are a sample cross-section of the United States experience with traffic calming. For those looking for more information on the range, planning process, design, and implementation of traffic-calming techniques, in 1980 the Federal Highway Administration has published a document titled "State of the Art: Residential Traffic Management," Report Number FHWA/RD-80/092.

Figure 2 shows an array of typical traffic-calming devices installed in the United States:

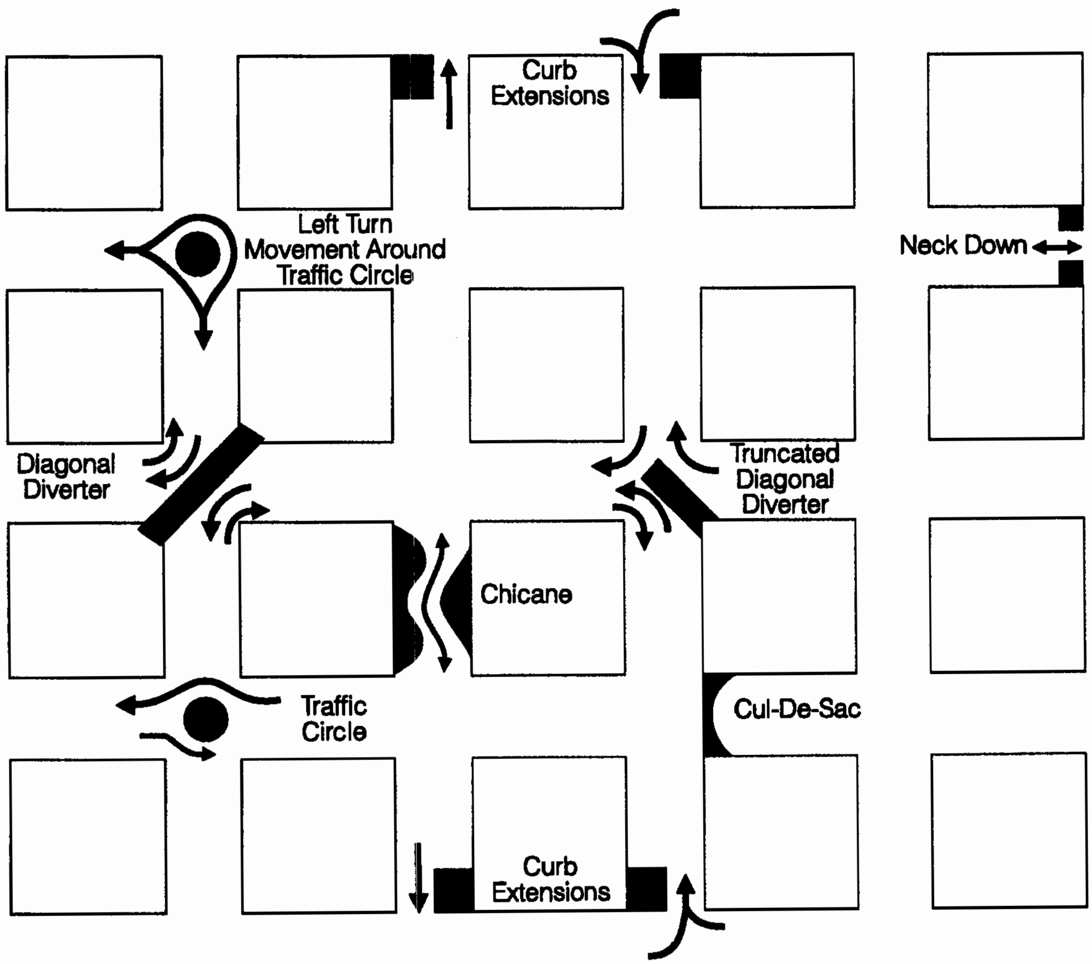

Figure 2. Typical Traffic Calming Devices

1. Speed Hump Installations

The installation of speed humps has been difficult in the United States. Many traffic engineers—and the municipalities for which they work—aren't anxious to install any type of traffic control device that isn't in the Manual on Uniform Traffic Control Devices (MUTCD). Many localities have been reluctant to install speed humps because they are concerned about the possibility of liability, potential loss of vehicle control, potential vehicle damage, traffic diversion to other streets, increased emergency vehicle response time, bicycle safety and other reasons[46]. However, the Institute of Transportation Engineers—after examining the pros and cons of speed humps—has developed a set of guidelines for the design and application of speed humps.[47] In some cases, municipalities have experimented with designs and placement as a way to overcome apprehension about the installations of speed humps.

Seminole County, Florida, has found speed humps to be beneficial in controlling neighborhood traffic problems. Prior to the installation of speed humps, they consulted with the county attorney's office. The county attorney felt the "action (to build speed humps) must be based on ideas that the action be reasonable and responsible and in accordance with standards of care and common sense."[48]

Seminole County has also experimented with the traditional design of the speed bump. Instead of installing a traditional hump, the design they used is similar to a European speed table. Their design consists of a segment of a circle with an approximate radius of 72 feet followed by a 3-inch-high, 10-feet-long raised section and a similar arc on the opposite end. Seminole County speed bumps are very popular with residents in the neighborhoods where they are installed.[49]

The city of Bellevue, Washington experimented with speed humps by installing a total of fourteen humps in five different residential neighborhoods. The streets had become cut-through routes for motor vehicles, and the residents of these streets were looking for a solution to restore quality of life and improve safety in their neighborhoods.

The speed humps installed in Bellevue are similar to humps developed in Thousands Oaks, California. They are 12 feet wide and 3 inches high at the center. This design allows for little or no discomfort at speeds of 15-25 mph, but will cause discomfort at higher speeds. In

[46] ITE Technical Council Committee 5B-15, "Road Bumps—Appropriate for Use on Public Streets?" *Institute of Transportation Engineers Journal*, Vol. 18, November 1986.

[47] *Recommended Guidelines for the Design and Application of Speed Humps—Proposed Recommended Practice*, Institute of Transportation Engineers Special Task Force, March 9, 1990.

[48] Nicodemus, David A., "Safe and Effective Roadway Humps: The Seminole County Profile," Seminole County Traffic Engineering Division.

[49] "New Road Hump Designs Shows Continued Success in Reducing Speeds," *The Urban Transportation Monitor*, November 8, 1991, p. 4.

order to clearly mark the speed humps and distinguish them from crosswalks, Bellevue developed a unique marking system. The markings also draw motorists' attention to their driving lane. White reflectors were used to provide night time visibility.

Figure 3 shows the speed hump marking and signing technique used by the City of Bellevue.

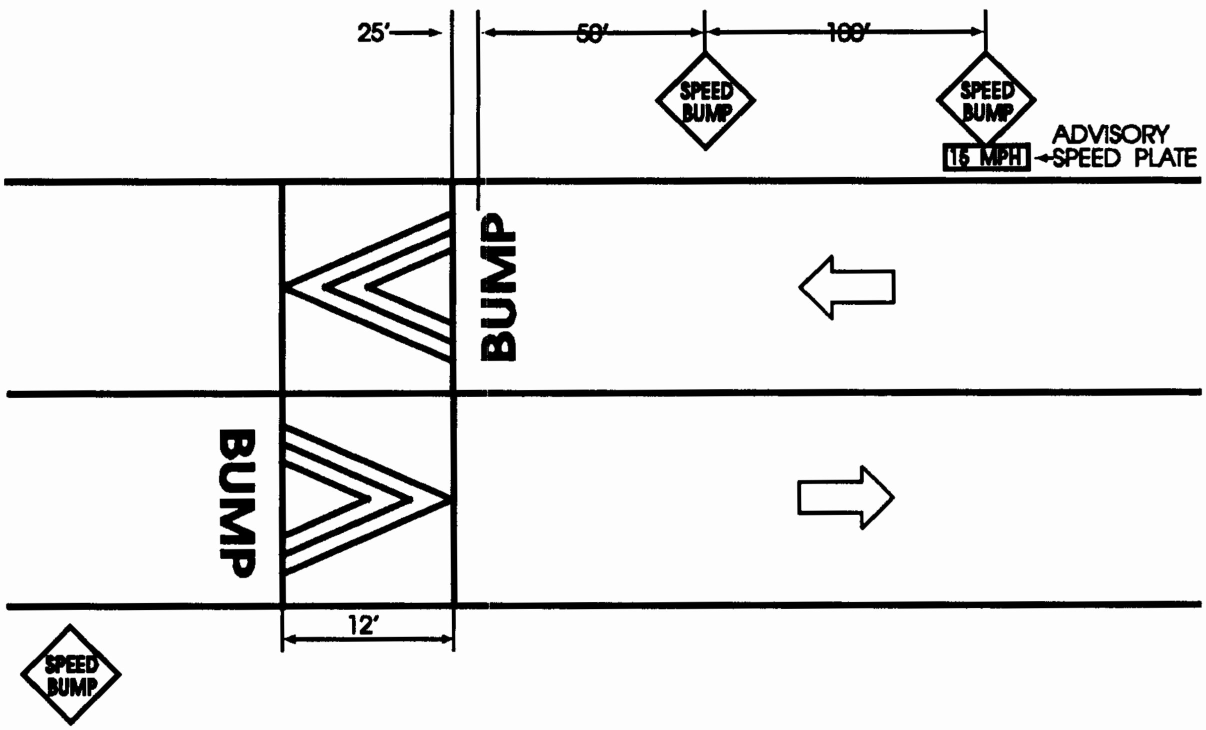

Figure 3. Speed Hump Marking and Signing

The installation of speed humps produced both positive and negative results. The most positive result was the reduction in speeds. A majority of residents felt the humps were effective and supported their permanent retention. Traffic volumes were reduced on the treated streets where nearby arterial streets could handle additional traffic. The city was also pleased because the positive reaction to the installation of the speed humps created a high degree of public support and enhanced the relationship between the city and its residents.

Table 2 provides geometric, before and after speed and vehicle per day data (VPD).

Table 2. Bellevue Speed Humps Findings

LOCATION	STREET TYPE/ WIDTH	# OF HUMPS	HUMP SPACING	SPEED LIMIT	Before:		After:	
					85TH % SPEED	VPD	85TH % SPEED	VPD
Somerset Drive SE	Two-way, 40 feet wide local residential neighborhood street	2	340'	25 mph	39 mph	795	27 mph	541 (VPD increased to 746 when the hump was reduced from 3/4" to 3")
Highland Drive SE	Two-way, 35 feet wide neighbor-hood collector	3	220'	25 mph	36 mph	1,700	25 mph	No change because no alternative route exists
166th/ 162nd Avenue SE	Two-way, 36 feet wide local residential street; walk to school route	2 2	600' 580'	25 mph 25 mph	37 mph 37 mph	655 472	24 mph 27 mph	.017 .017
SE 63rd Street	Two-way, 35 feet wide local residential street temporarily serving as a connection between two minor arterials	2 3	1,000' 500'	25 mph	36 mph	2,456	27 mph	2,802
Yarrow Bay neighbor-hood	Primarily a neighborhood connector	2	400		39 mph	3,685 1,641	25 mph	2,931 1,653

Three negative issues were raised:

- The Bellevue Fire Department was concerned about the possibility of increasing emergency response time. They requested that speed humps not be installed on primary emergency access routes.

- Residents were also unhappy with the signing and pavement markings for the humps. They felt this made the speed humps unattractive. However, they felt the reduction in speeds was more than enough compensation for the appearance of the humps.

- The final issue was that the speed humps created a localized effect on motor vehicle speeds. The amount of space between speed humps affected vehicle speeds. The greater the distance between the humps the less effect there was on traffic speeds. The city of Bellevue found that the maximum spacing between speed humps should be approximately 500 feet. The long term effectiveness of speed humps was questioned because of the tendency for motor vehicle speeds to creep upwards over time and between the humps.

The Bellevue Department of Public Works concluded that speed humps were an effective way to control speed on residential streets and recommended their continued use. However, the installation of speed humps occurs only after other less restrictive, more passive measures have been tried.[50]

2. Traffic Circles (Mini-Roundabouts)

In Washington, the Seattle Engineering Department (SED) has gained a national reputation for its responsive and innovative neighborhood traffic control program. Since the 1960's, Seattle has experimented with many types of neighborhood traffic control devices including signing, channelization, diverters, curb extensions, cul-de-sacs, chicanes, and traffic circles.

The SED also has a program that loans radar guns to community groups to check speeds on their streets. The license plates of speeding vehicles are recorded and the owner is sent a letter explaining the problem of speeding on local streets. Often it is local residents who are speeding in their own neighborhood.

The major emphasis of the SED Neighborhood Traffic Control Program is installing traffic circles at residential street intersections. According to Jim Mundell, SED Neighborhood Traffic control Program, about 30 circles are built each year, a total of approximately 400 circles

[50] "Bellevue's Experience with Speed Humps as a Speed Control Device," Department of Public Works and Utilities, City of Bellevue, Washington, September 1989.

have been installed throughout residential areas in the city. Each circle costs about $5,000 to $6,000.

In Seattle, a traffic circle is an island built in the middle of a residential street intersection. Each circle is custom fitted to the intersection geometrics; every circle is designed to allow a single unit truck to maneuver around the circle without running over it. A two-foot concrete apron is built around the outside edge of the circle to accommodate larger trucks. Large trucks, when maneuvering around the circle, may run over the apron. The interior section of the circle is usually landscaped.

The SED coordinates the design and construction of each circle with the Seattle Fire Department and school bus companies.

Traffic circles are installed at the request of citizens and community groups. Because there are more requests than funding to build them, SED has created a system for evaluating and ranking the requests. Before a request can be evaluated, a petition requesting a circle must be signed by 60 percent of the residents within a one block radius of the proposed location. Then the intersection's collision history, traffic volume, and speeds are studied.[51]

Traffic circles have become very popular in Seattle because they reduce motor vehicle speeds and the number of collisions at the intersections where they are installed. In a study of traffic accidents at 14 problem intersections, the total number of collisions dropped from 51.6 to 2.2 after the installation of the circle. Accidents within a one block radius also decreased, from 101 to 33.

In another study of traffic circle intersections, fifteen intersections were studied for the same period of time before and after the construction of a circle. There was an average reduction from 1.94 to 0.18 collisions per year per location. Total collisions dropped from 33 to 3 per year. The decrease in collision rates is believed to be due to increased reaction time because of a reduction in motor vehicle speeds.[52]

3. Chicanes

The Seattle Engineering Department has also experimented with chicanes as a neighborhood traffic control device. Chicanes are barriers placed in the street that require drivers to slow down and drive around them.

SED has found that the installation of chicanes are an effective means of reducing speed and traffic volumes at specific locations under specific circumstances. In an evaluation of a

[51] Conversation with Jim Mundell, Neighborhood Traffic Engineer, Seattle Engineering Department.

[52] Dare, James W., and Schoneman, Noel F., P.E., "Seattle's Neighborhood Traffic Control Program," *Institute of Transportation Engineers*, February 1982.

demonstration project, two sets of chicanes were installed and found to be very effective in reducing the volume of traffic on the street. There was little increase in traffic on adjacent residential streets. The reduced volume and congestion caused by the chicane also helped to reduce motor vehicle speeds and collisions. However, the speeds between the two sets of chicanes were not significantly changed.

In a survey of neighborhood residents, 79 percent of the respondents felt the chicanes were either very effective or somewhat effective in slowing traffic; 53 percent of the residents felt there was a considerable or slight decrease in the number of vehicles using the street; and 64 percent of the residents felt the chicanes made the street safer. When questioned, 68 percent of the residents supported permanent retention of the chicanes.[53]

4. Bicycle Boulevard

The city of Palo Alto, California, has moved beyond spot traffic-calming treatments and created a priority street for bicycles. The purpose of a bicycle boulevard is to provide a throughway where bicyclists have precedence over automobiles, a direct route that reduces travel time for bicyclists, a safe travel route that reduces conflicts between bicyclists and motor vehicles, and a facility that promotes and facilitates the use of bicycles as an alternative transportation mode for all purposes of travel.[54]

The Palo Alto bicycle boulevard is a 2-mile stretch of Bryant Street—a residential street that runs parallel to a busy collector arterial. It was created in 1982, when barriers were fitted to restrict or prohibit through motor vehicle traffic but allow through bicycle traffic. In addition, a number of stop signs along the boulevard were removed. An evaluation after 6 months showed a reduction in the amount of motor vehicle traffic, a nearly two-fold increase in bicycle traffic, and a slight reduction in bicycle traffic on nearby streets.[55]

The city also found anticipated problems failed to materialize and concluded that a predominately stop-free bikeway—on less traveled residential streets—can be an attractive and effective route for bicyclists. The bicycle boulevard bicycle traffic increased to amounts similar to those found on other established bike routes.[56]

[53] *NE 70th Street Chicane Evaluation*, Seattle Engineering Department, Transportation Division, September 1988 (Unpublished Report).

[54] *Bryant Street Bicycle Boulevard Extension Report*, prepared by the Transportation Division, City of Palo Alto, September 1991.

[55] Fletcher, Ellen, "Palo Alto Bicycle Facilities," *Bicycle Forum*, Vol. 24, Summer/Fall 1989.

[56] Likens, Gayle, "Bicycle Boulevard Demonstration Study—Evaluation," Transportation Division, City of Palo Alto Staff Report, December 9, 1982.

The bicycle boulevard continues to function as a normal local city street, providing access to residences, on-street parking, and unrestricted local travel. The city received complaints about the visual appearance of the initial street closure barriers (since upgraded with landscaping) but is unaware of any other serious concerns of nearby residents.[57]

Plans for the extension of the bicycle boulevard through downtown Palo Alto were approved by the city council in the summer of 1992. Included in this extension was the installation of a traffic signal to help bicyclists cross a busy arterial.

5. Channelization Changes

The Seattle Engineering Department is changing some of its streets from four lanes to two lanes with a center left turn lane. These channelization changes often provide extra room for bicycle lanes or a wide lane for cars and bikes to share.

Numerous comments from users of some of those streets say motor vehicle speeds seem to have decreased. One street in particular, Dexter Avenue North, is a popular commuting route to downtown Seattle for bicyclists. Traffic counts on the street show bicyclists make up about 10 to 15 percent of the traffic at certain times during the day. The rechannelization has little or no effect on capacity, reduces overtaking accidents, and makes it easier for pedestrians to cross the street (by providing a refuge in the center of the road).

Figure 4 shows a typical two-way center left turn conversion that provides extra space for bicyclists.

Conversion 58' roadway elimination of one travel lane in each direction creates space for bicyclists.

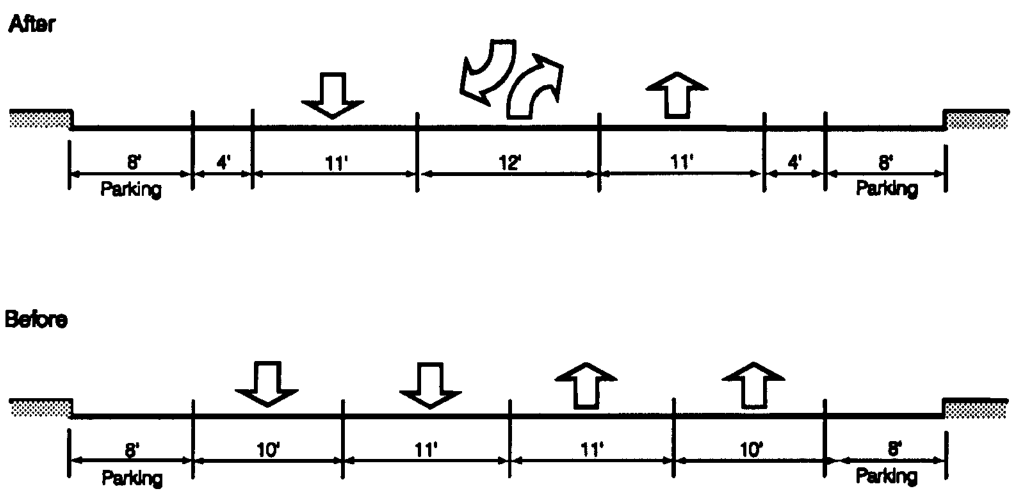

Figure 4. Two-Way Center Left Turn

[57] *Bryant Street Bicycle Boulevard Extension Report*, prepared by the Transportation Division City of Palo Alto, September 1991.

On some streets, citizen groups have requested elimination of the Two-Way Center Left-Turn Lane (TWCLTL) to build a planted median. Such a treatment was done in the spring of 1992 with the approval of 60 percent of the residents along the street. The goal of the project is to reduce speeds, provide space for bicyclists, and provide space for tree planting. No evaluation of the effects of the median on speed has been done yet.

6. Slow Streets

Berkeley, California's slow street is the United States best adaptation of the Dutch woonerf concept. According to Chuck DeLeuw, Berkeley Department of Public Works, the idea behind the slow street is to slow and divert motor vehicle traffic, provide space for pedestrians and bicyclists, and create more of a neighborhood feel.

The Berkeley slow street is six blocks long. Originally the street was classified as a collector street carrying between 4,000 and 6,000 vehicles per day. It has a combination of commercial and residential uses.

To create the slow street, the Berkeley Department of Public Works combined speed humps, shifting travel lanes, and channelization patterns. Preliminary findings indicate a reduction in motor vehicle speeds and a diversion of traffic to adjacent arterial streets. Bicycle traffic along the slow street appears to have increased. However, the diverted traffic has made residents living on adjacent streets unhappy.

While speed hump installations have been widely identified as a key to making the slow street concept work, the Berkeley bicycle community was reluctant to fully endorse the idea of speed humps. Some of that reluctance may be due to the speed humps' formidable appearance, but there is no documented adverse affect to bicyclists crossing the hump.[58]

Berkeley also presented a stop sign placement strategy as part of the initial planning for the slow street. It was abandoned in the face of opposition from bicycle and community groups.

The Seattle Engineering Department has also experimented with woonerfs. The most successful installation was in a new large- scale housing development. Dead end streets were given typical European woonerf treatments: neckdowns (curb extensions), street pavement and sidewalks are at the same level, motor vehicle parking areas are clearly distinguished, and signs have been placed to identify the areas as a woonerf and a slow speed area.

[58] Conversation with Chuck DeLeuw, Traffic Engineer, Berkeley Department of Public Works.

7. Transit Street and Pedestrian Zones

The 16th Street Mall in Denver, Colorado is a successful blending of transit and pedestrian improvements, according to Bill Jorgensen, Deputy Director of Planning and Development, Regional Transportation District. While the original goal of the project was to improve transit service to downtown Denver, the mall has become an attractive area for pedestrians.

The mall is a 13 block-long shuttle system that operates between two regional bus intercept stations. It was designed to relieve bus congestion by removing busses from downtown streets.[59]

Two regional bus stations, situated at either end of the mall, serve all bus trips into the downtown area. From there, connections to destinations along the mall can be made via a "horizontal elevator." The horizontal elevators are 100-person capacity diesel busses.

Motor vehicle traffic has been restricted, although deliveries to businesses and access to parking garages is still allowed. The street and sidewalks along the mall are made of granite pavers. There is no difference in color of the granite to denote the change from sidewalk to street, although there is a curb.

Land use surrounding the mall is a mix of retail, commercial, and office developments; as a result pedestrian amenities were included in the development of the mall. Sidewalks 10-16 feet wide were built. In addition, the street was built to be nonlinear: the roadway shifts from side to side along different blocks of the mall. The extra width of the sidewalks and the shifting street have created space for sidewalk cafes and landscaping. Open and green space is rare in downtown Denver and found primarily along the mall, which helps attract pedestrians to the area.

Although conflicts have developed between pedestrians and busses along the mall, one of the reasons the conflicts have occurred is that ridership on the mall shuttle is higher than was expected, and the mall has become the primary pedestrian activity center in downtown Denver.[60]

There is no history of bicycle and pedestrian conflicts along the mall. Bicyclists are prohibited from using the street; it is reserved for busses only. Bicyclists are allowed to use the sidewalk along the mall, but are required to walk their bikes.

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[59] Zehnpfennig, Gary, "Denver's 16th Street Mall," *Transit, Land Use & Urban Form*, pp. 127-134.

[60] Ibid.

8. Signing Techniques

Many communities use some type of signing to discourage traffic in residential areas. Unfortunately, signs like "RESIDENTIAL STREET" "NO THROUGH TRAFFIC" or "LOCAL ACCESS ONLY" become beacons to mark routes for cut-through traffic.

According to Jim Stahnkey, the city of Saint Paul, Minnesota, has installed a "basket weave" stop sign pattern to manage neighborhood traffic, especially traffic that was avoiding arterials by cutting through residential neighborhoods. Stop signs are placed at every other intersection in most of the city's residential neighborhoods. Placement of the signs is based on engineering judgement.

The majority of the city's residential neighborhoods have now been controlled with the basket weave stop sign pattern. Installation of the signs began in the 1970's in the Summit-University neighborhood.

The pattern is installed on a systematic basis on local neighborhood access streets only; the basket weave pattern isn't placed on arterial or collector streets.

St. Paul has found the basket weave pattern effective in reducing right angle accidents at residential intersections. Overall accident rates at these intersections have also been reduced. However, there has been no reduction in speed or change in the volume of traffic on these streets. In other traffic-calming applications a reduction in speed or number of motor vehicles have been identified as keys to improving conditions for pedestrians and bicyclists.

The city feels that stop sign compliance remains high, even in the neighborhoods that were signed in the 1970's. There has been a positive reaction from neighborhood residents. The only complaint has been about an increase in noise from motor vehicles stopping and starting.

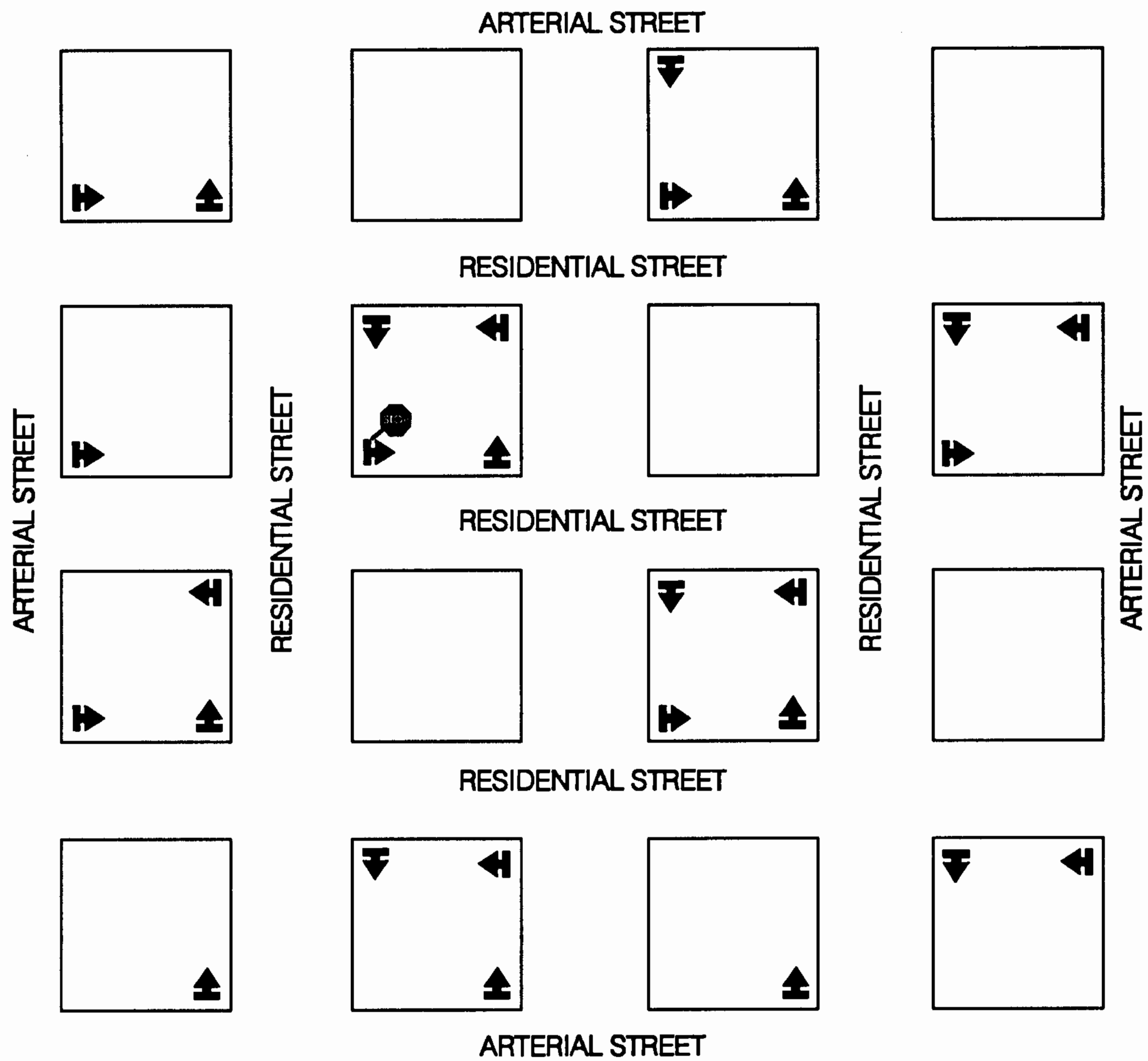
Figure 5 on the next page shows a basket weave stop sign pattern.

A serious drawback is lack of compliance by bicyclists. The city representative felt that bicyclists weren't likely to stop at the basket weave stop sign pattern or other types of traffic control.

9. Traffic Diverters

Traffic diverters, curb extensions, cul-de-sacs, and neckdowns are used to discourage cut-through traffic in residential areas. Curb extensions and neckdowns are used at entrances to neighborhoods to discourage motor vehicle traffic from entering. Traffic diverters and cul-de-sacs are placed to prevent through traffic.

Eugene, Oregon has used both diagonal diverters and curb extensions and has received positive community response. Although the city has little data on the results of installation of the



(Arrows point in direction that the signs face. Motor vehicles must stop every other block.)

Figure 5. Basket Weave Stop Sign Pattern

diverters and extensions, there is support for them from the nearby residents. Eugene installs their traffic-calming devices on a temporary basis and seeks reaction from the neighborhoods before making the installation permanent.

The city installs curb extensions at entrances to neighborhood areas, usually where a residential street intersects an arterial. The curb extension is placed to prevent motor vehicle traffic from cutting through the neighborhood. The curb extension will also be signed as either a neighborhood entrance or exit. Most of the length of the street remains a two-way street, but one end becomes a one-way street. Compliance by motor vehicles is mostly good. Bikes are allowed to travel both ways at all the curb extensions.

Diane Bishop, city of Eugene bicycle coordinator, said the city also installs two types of diagonal diverters at residential intersections. Some are landscaped, while others are just guard rails. Both types have openings for bikes. The diagonal diverters also enjoy the support of nearby residents.

Seattle, Washington has also installed curb extensions and diverters, created cul-de-sacs, and built truncated diagonal diverters. The truncated diverter allows a right turn movement around one end of the diverter; the SED has found these types of traffic-calming devices to be the most disruptive to normal neighborhood traffic.

While there is no argument to their effectiveness in reducing cut-through traffic, these types of diverters do create problems for neighborhood motor vehicle traffic:

- Travel time and distance for all users are increased.

- Local residents are diverted to other streets, visitors and delivery services are confused and delayed.

- Emergency vehicle response can be delayed.[61]

Consequently, Seattle has focused on installing traffic circles to control neighborhood traffic control problems.

10. Corner Radii Treatments

Very simple solutions can produce almost the same results as more traditional traffic-calming techniques.

One example of a such a treatment is the reduction in corner radii at intersections. Efforts to accommodate larger trucks in cities have decreased safety for pedestrians and allowed for higher speeds for other vehicles. Increasing the radius of corners allows larger trucks to turn more easily. However, it can increase the crossing distance a pedestrian has to negotiate at an intersection by approximately 4 feet or more, depending on the radius. Larger radii allow smaller motor vehicles to turn the corner at a faster speed. Because of their higher speeds, motor vehicle drivers are less likely and have less time to be checking for pedestrians.

The street corner radii is a small but important detail to keep in mind on high-pedestrian streets or where young children, disabled, and elderly pedestrians are likely, or where a pedestrian

[61] Schoneman, Noel F., "A Guide for Residential Traffic Control based on Seattle's Experience," *University of Washington Thesis*, 1981.

environment is being created. Reducing the corner radii can also be an effective way to reduce the number and speed of vehicles as they enter a residential area or other area of reduced speed.

Figure 6 shows a number of curb radii.

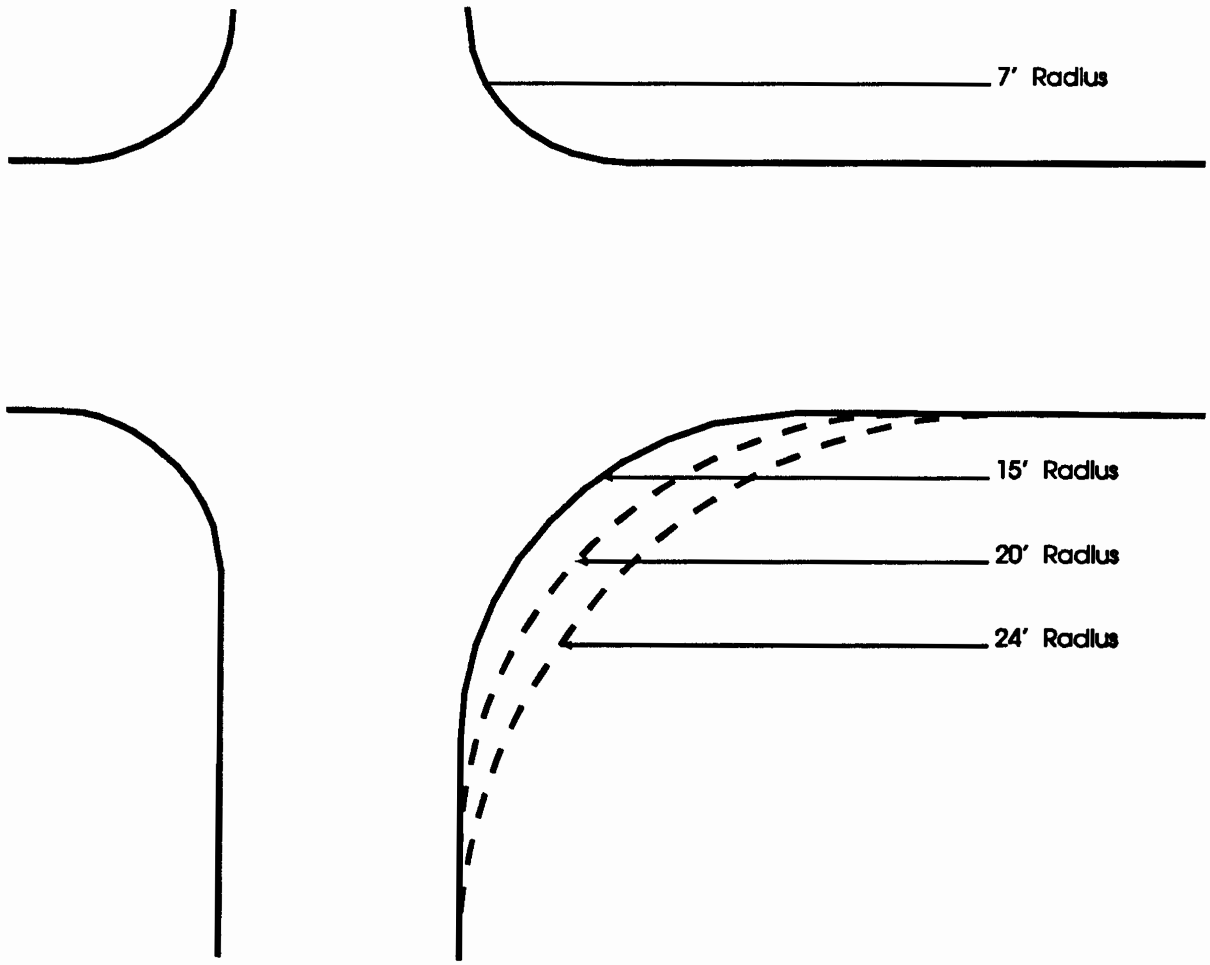


Figure 6. Corner Radius

IV. Practical and Policy Implications

1. The goals for traffic calming must be clear.

Traffic calming is much more than just a traffic safety program. The British Department of Transport carried out an "Urban Safety Project" in five cities in the latter half of the 1980's and concluded that the comprehensive redesign of streets cannot be justified solely on the grounds of improved traffic safety.

"The objectives underlying the programs of road design in the Netherlands, West Germany, Denmark, and France are all wider than simply reduced accident risk. In most cases the initiative started with concern about the quality of the environment in residential areas. The proportion of accidents occurring on local access streets is small (about 20 percent), and even if large proportionate reductions in accident numbers can be achieved does not, in safety terms alone, justify comprehensive treatment of such streets."[62]

While safety is an important element of traffic calming, the improvement of the residential (or shopping) environment is also a vital goal. According to Hass Klau, traffic calming has three main objectives:

- to reduce the severity and the number of accidents in built up areas,
- to reduce air and noise pollution,
- to improve the urban street environment for nonmotor users and to reduce the car's dominance in ways that vary according to the street type.[63]

Tolley lists 23 advantages of traffic calming in residential areas and Citizens Against Route Twenty (CART) provide details of 11 specific results that have been identified from traffic calming. Both lists include fewer accidents, less pollution, noise and congestion, increased bicycling and walking, increased vitality of life and reduced speeds of vehicles.[64, 65]

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[62] Lynam, "Urban Safety Management," *PTRC Traffex Paper*, 1989, London.

[63] Hass Klau, *An Illustrated Guide to Traffic Calming*, Friends of the Earth, 1990, London.

[64] Tolley, Rodney, *Calming Traffic in Residential Areas*, 1990, Brefi Press, Wales.

[65] Citizens Against Route Twenty, *Traffic Calming*, 1989, Queensland.

Time and again the literature on traffic calming singles out the speed of vehicles as the biggest single influence on all of these goals. Equally common is the realization that simply lowering speed limits, without any further physical changes to the street or better enforcement, will not achieve the desired results.

2. Is there a need and the support for traffic calming?

The current transportation system does not work for a great many people. The Florida Pedestrian Safety Plan points out that only 63 percent of residents are legally able to drive in the state, leaving 37 percent dependent on walking, bicycling, transit or sharing a ride with others.[66] These modes have to made viable.

Recent opinion polls have shown a considerable latent demand for bicycling and walking. Recreational walking and bicycling has yet to translate into significant mode shifts because the transportation system is not sufficiently attractive and convenient for walking and bicycling.[67]

Figure 7 shows commuting habits and preferences: (Source: "Pathways for People," Rodale Press.)

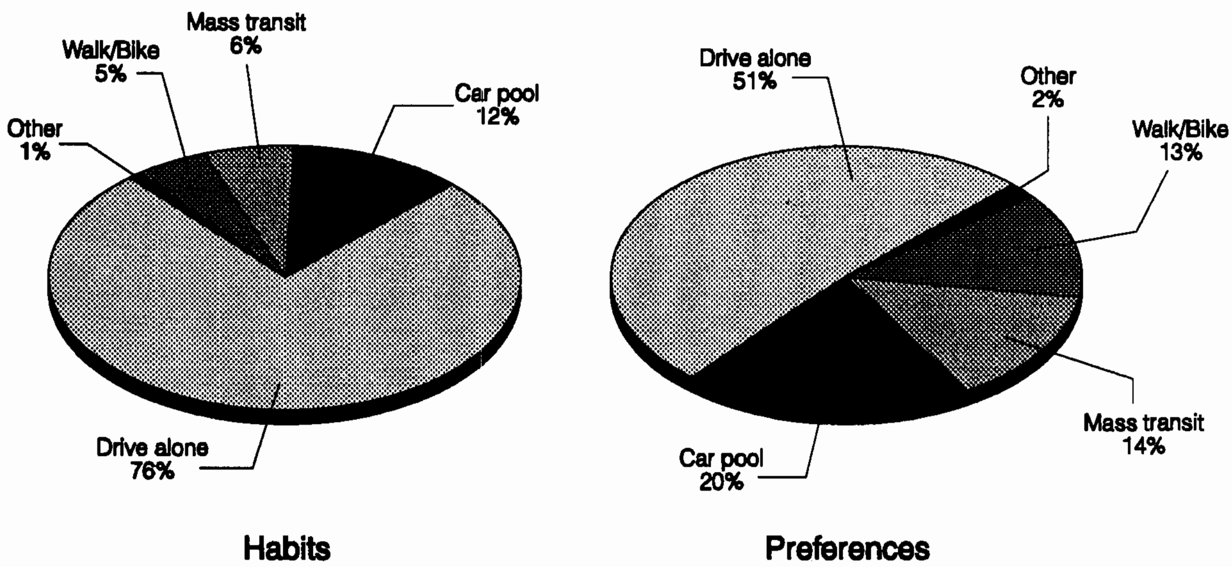

Figure 7. Commuting Habits and Preferences

[66] *Pedestrian Safety Plan*, Florida Department of Transportation, 1992, Tallahassee.

[67] *Pathways for People*, Rodale Press, 1992, Emmaus, PA.

More than 7,000 pedestrians and bicyclists are killed in traffic accidents every year in the United States The majority of these occur in urban and suburban areas. Pedestrian fatalities often comprise as much as one half of all urban traffic deaths.[68]

Traffic-related issues feature prominently in local politics, newspapers, and surveys of neighborhood concerns. Congestion, pollution, and traffic safety are the subject of frequent complaints. The danger to children from traffic drastically limits the freedom children have to move around independently.[69]

In the city of Seattle, traffic-calming measures such as traffic circles cannot be introduced without the initial support of more than 60 percent of affected residents. More than 200 have been installed, demonstrating widespread support for such measures.

All of these trends, opinions, and facts suggest a real need for the development of a transportation and street system that is more attractive, safe, and convenient for pedestrians, bicyclists, transit users, the physically challenged, and for motorists themselves. Where traffic calming has been implemented throughout Europe, widespread public support for the measures has followed.

A 1980 report on woonerven lists a number of benefits and drawbacks of the new type of residential street design. One of the drawbacks is said to be:

> *The type of solution supplied in "woonerven" can create unreasonable expectations on the part of residents of areas not suitable as "woonerven."*[70]

This apparent need and desire for traffic calming and better conditions for bicyclists and pedestrians is often not reflected in the views of the media or local government officials.

In a fascinating study of public opinion versus the media's perception of public opinion, authors Brog and Erl discovered the media routinely—and quite significantly—underestimate public demand for calming traffic.

Respondents in 17 towns and cities in Germany, Austria, and the Netherlands were asked a number of questions to indicate their preference for traffic priorities and their perceptions of what others felt about the same issues. For example, in one town 77 percent of the public would favor bicycle priority over car priority where the two conflict. Only 33 percent of the media agreed with this and the media believed only 37 percent of the public would agree. The same trend was evident in relation to public transport.

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[68] *Fatality Facts 1991*, Insurance Institute for Highway Safety, 1992, Arlington, VA.

[69] Hillman, Dr. Mayer, et al, *One False Move...*, Policy Studies Institute, 1991, London.

[70] ANWB, "Woonerven," 1980, The Hague.

Whereas, 85 percent of the public believed bicycling is an environmentally-friendly mode worth supporting, the media believed only 59 percent of the public would support this statement. Conversely, only 20 percent of the public supported encouraging private motor transport but the media believed 44 percent of people would do so.

Finally, the researchers discovered the extent to which both the general public and the media underestimate the actual levels of bicycle and pedestrian use in their own towns. In the three sample towns, nonmotorized transport comprised 39 percent of all trips (24 percent foot and 15 percent bike). The public put this figure at just 18 percent and the media at 16 percent. The use of cars and public transport was overestimated quite substantially.[71]

3. Will bicyclists and pedestrians benefit from traffic calming?

The simple answer is: Yes. The experience from Europe clearly show that bicycle use has been encouraged by traffic calming and that walking has been made much more attractive and levels of activity have increased in residential and shopping streets that have been calmed.

This should not be a surprise. One of the key goals of traffic calming is the reduction of vehicle speeds, from which both bicyclists and pedestrians benefit. The European Commission report on bicycle policy and provision revealed almost unanimous and strong agreement among European bicyclists that the speed of traffic was a major concern.[72]

Safety for children playing in their neighborhoods is improved by reducing the speeds of motor vehicles and can be accomplished by traffic calming. In a study of children and motor vehicles in Montreal, Quebec the leading cause of accidents was a combination of high speed motor vehicles and children darting into traffic at mid-block locations. The recommended solution was to slow motor vehicle traffic speeds in residential areas to reduce the number of children pedestrian accidents.[73]

[71] Brog and Erl, "Influencing Behavior by Public Awareness, as Illustrated by the Encouragement of Cycling," Paper to UITECH Conference, 1991, Berlin.

[72] Commission of the European Communities, *Policy and Provision for Cyclists in Europe*, 1989, Brussels.

[73] Kupferberg, N., David, B., and Rice, R.G., P.E., "The Effect of Road Design and Traffic Control in Child Pedestrian Safety," 1988 Compendium of Technical Papers, *Institute of Transportation Engineers*, 1988, pp. 55-59.

Figure 8 shows the effect of traffic calming on motor vehicle speeds before and after traffic calming in Buxtehude, Germany:

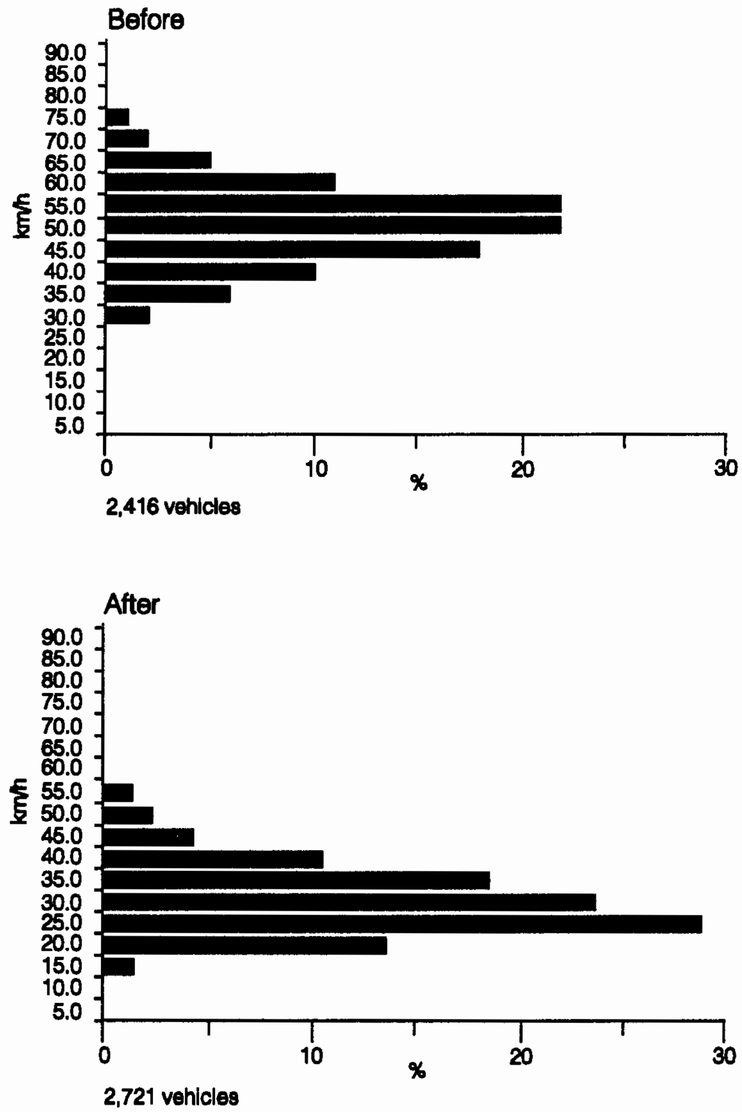

Figure 8. Traffic Calming on Motor Vehicle Speeds

Descriptions of good pedestrian environments match very closely with descriptions of traffic-calmed areas. Ramsey lists seven such basic requirements for acceptable walking conditions:

- **Availability:** the system must be accessible by right to all users, within reason.

- **Negotiability:** the routes, surfaces etc., should not present a real barrier to any significant group.

- **Safety:** the pedestrian must use the system with a good prospect of traffic safety and personal security.

- **Economy:** pedestrians should not be subject to congestion or undue delay, whether caused by lack of footpath capacity or obstructing streams of vehicles.

- **Convenience:** any implied detours should be limited.

- **Comfort:** users should not have to suffer distressing conditions (climatically or socially).

- **Amenity:** every effort must be made in planning, design, construction and management to provide as pleasant and enjoyable an environmental experience as possible.[74]

The European Parliament passed a European Charter of Pedestrians Rights in 1988 which, once again, argues strongly for the kind of improvements offered by traffic calming:

- The Pedestrian has the right to live in a healthy environment and freely to enjoy the amenities offered by public areas under conditions that adequately safeguard his physical and psychological well-being.

- The pedestrian has the right to live in urban or village centers tailored to the needs of human beings and not to the needs of the motor car and to have amenities within walking and bicycling distance.

- Children, the elderly, and the disabled have the right to expect towns to be places of easy social contact and not places that aggravate their inherent weakness.

- The pedestrian has the right to urban areas which are intended exclusively for his use, are as extensive as possible and are not mere "pedestrian precincts" but are in harmony with the overall organization of the town.

- The pedestrian has the right to complete and unimpeded mobility which can be achieved through the integrated use of the means of transport."[75]

The Charter also lists a number of specific features that make up a better pedestrian environment and these include lower speeds, better public transport, more continuous facilities, and a ban on aggressive advertising of motor vehicles.

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[74] Ramsey, Arthur. "A Systematic Approach to Planning of Urban Networks for Walking," *The Greening of Urban Transport, Belhaven Press*, 1990, London.

[75] "European Charter of Pedestrians' Rights," European Parliament, 1988, Strasbourg, France.

More importantly, perhaps, is the simple fact that pedestrian movement and bicycle use are consistently listed as among the priorities for traffic-calming projects. Indeed, bicycle and pedestrian facilities are used extensively to reduce the space available to motor vehicles. Bike lanes and wide sidewalks with extensions at intersections are common features of redesigned streets in residential areas.

Mathew writes:

> *Finally, are we as cyclists going to accept these redesigned streets? Hopefully, yes, because the benefits they bring for the great mass of everyday cyclists and local residents far outweigh any concerns about slowing cyclists down too. There is really not much justification for arguing that bikes alone should be allowed to blast their way through local streets. There will still be plenty of "un-calmed" roads for anyone who wants to pedal at speed.*[76]

Mathew considers two further advantages to bicyclists that have quite significant policy and practical implications. Traffic calming accentuates the notion that all road users must coexist, but on more equal terms than is currently the case. Thus:

> *Indeed, traffic calming could offer a way out of a number of problematic areas. Firstly, it might well offer a solution to the increasingly sticky area of [bicyclists access to] wholly pedestrianized streets that is causing so much trouble.*
>
> *Secondly, it might offer an acceptable compromise in the ideological argument about cycle paths that still rumbles on in the bicycling community. Make cyclists co-equal road users, as one side has always said; but offer them the protection the average cyclist wants, as the other side has always argued.*[77]

4. What is the potential opposition to traffic calming?

Some opposition to traffic calming has existed almost everywhere it has been introduced and has come from a variety of sources ranging from the emergency services to residents and shop owners. Motorists have attacked traffic calming as an infringement of their liberty.

First of all, it is important to realize that traffic calming is not simply anti-car. Access for cars is not reduced at all, except to wholly pedestrianized streets, even in woonerven, traffic cells and other design alternatives. Cars can still get everywhere they did before, but it may take

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[76] Mathew, D., "Calming the Traffic—Exciting the Cyclist," *Cycletouring and Campaigning*, Feb/March, 1989, Godalming.

[77] Ibid.

them a little longer and there may be better alternatives to driving. Traffic calming is, however, unabashedly pro-walking, bicycling, transit, environment, safety, and neighborhood.

In the early days of woonerven and traffic calming there were fears that traffic, safety and environmental problems were just being moved around by traffic calming, and not actually solved. Thus, residents of nearby streets feared the impact on them of traffic calming elsewhere. This was quickly recognized in Europe and the focus has been on area-wide solutions ever since.

Another important feature of successful traffic-calming projects has been the early and full participation of the local community and the use of extensive public information once the projects get underway. These two activities will be vital for traffic calming to succeed in the United States.

The early and full participation of local businesses and shop owners has always been essential to the success of pedestrianization and traffic calming in shopping areas, as the loss of car parking space, in particular, is seen as a real threat. Experience in Europe has been positive provided these fears can be overcome and needs accommodated. One often overlooked feature of traffic calming is the better management of parking spaces and the use of parked cars to create streets that lower vehicle speeds.

Objections to motor-vehicle free zones are often led by the businesses along the street proposed for closing as they fear the loss of direct, convenient access to their shops or loss of parking and resulting loss of business. The Organization for Economic Cooperation and Development survey of 1978 suggests this is not the most likely result.[78]

The idea of creating pedestrian malls in United States downtowns has become a controversial issue. Many cities that built malls in the 1960's and 1970's are now reconsidering them and allowing motor vehicles back into all or some of the zones. A 1984 study found that it was difficult to link changes in retail sales with pedestrianization and that while some downtowns benefitted from a mall, others did not. The study also found that the retail decline experienced by businesses in the mall corresponded with a decline suffered throughout the central business district.

Houston also discusses the amount of time downtown workers are willing to travel on their lunch hour. Only 20 percent of workers surveyed would travel more than nine blocks or 20 minutes to reach their destination.[79]

In many downtowns a significant amount of that time will be spent by pedestrians waiting for traffic signals to change. Downtowns concerned with moving pedestrians may want to reconsider their signal timing.

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[78] *Results of Questionnaire Survey on Pedestrian Zones*, Organization for Economic Cooperation and Development, 1978, Paris.

[79] Houston, Jr., Lawrence O., "From Street to Mall and Back Again," *Planning*, June, 1990, Chicago.

Wolfgang Zuckerman, in his book *End of the Road* suggests the changes taking place along pedestrian malls in both Europe and the United States are due to social and demographic changes as much as parking or other access issues.[80]

Emergency response time for police, fire, and EMT vehicles has also been identified as a concern by the affected agencies and local residents. In the United States, a number of solutions have been used to reduce delays for these vehicles.

Studies in Minneapolis and Berkeley found that neighborhoods where access was lowered (usually with diagonal diverters or cul-de-sacs) tended to have less residential crime than blocks with easier access. Additional studies in Berkeley showed that traffic control devices had little or no effect on police emergency response time.[81] The city of Palo Alto found that bicycle boulevard barriers had not impaired police and fire emergency response.[82]

The Seattle Engineering Department works with the Fire Department to make sure that fire trucks can negotiate traffic circles. Each circle is custom-designed for the intersection where it will be installed. Before a design is finalized, SED and the Fire Department meet in the field to lay out the circle and test it to ensure that the fire trucks can get around it.

Other jurisdictions have also worked out solutions for their emergency response providers. The city of Bellevue works with the fire and EMT Departments to make sure speed humps aren't installed on emergency response routes.

So, while there can be opposition to traffic calming, it can and has been overcome. Monheim outlines six important steps to follow to help guarantee the support and success of traffic-calming projects:

1. Develop a political and administrative consensus for traffic calming.

2. Involve the public at an early stage.

3. Convince those who depend on vehicle access with detailed plans, early involvement, experiments, trials and test drives.

4. Develop high quality design to secure public acceptance.

5. Traffic calming must address more than just individual streets.

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[80] Zuckerman, Wolfgang. *End of the Road—The World Car Crisis and How We Can Solve It*, Chelsea Green Publishing Company, 1991.

[81] Smith, Daniel T., and Appleyard, Donald, *State of the Art: Residential Traffic Management*, FHWA No. FHWA/RD-80/092, December 1980.

[82] Likens, Gayle, "Bicycle Boulevard Demonstration Study—Evaluation" Transportation Division, City of Palo Alto Staff Report, December 9, 1982.

6. Include main roads in the plan, as they are main roads for walking, bicycling and transit.[83]

5. What are the costs and benefits of traffic calming?

For most European towns and cities the better question has become "What are costs of allowing cars to take over the city?" The "do nothing" approach is too costly in terms of accidents, congestion, pollution, and a worsened environment.

In the United States too, the costs for failing to address excessive traffic and motor vehicle dependency are escalating. Traffic accidents alone cost the nation up to $137 billion a year in direct costs, lost time and productivity.[84] Congestion is also costly. In correspondence to the Speaker of the House of Representatives, Rep. Joseph Kennedy, estimates congestion costs $40 billion every year in the largest 29 urban areas in the United States Many of the environmental gains to be realized from traffic calming have yet to have an economic value assigned to them.

One of the important features of traffic calming is that it makes more efficient use of the same space—one of the key goals of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).

Lower and more consistent speeds help improve the capacity of roadways, and the dedicated space typically provided for walking, bicycling and transit can help achieve shifts in modal choice towards these more efficient modes.

Beyond these broader societal costs and benefits, traffic-calming features are a very cost-effective method to prevent costly and life-threatening crashes. For example, in Seattle the installation of traffic controls ranges from $50 for a sign to $6,000 for a curb extension or traffic circle. Dare and Schoneman have shown the traffic circles to be very cost-effective in Seattle.[85]

Area wide traffic calming can serve a dual purpose by providing through routes for bicyclists. The Palo Alto bicycle boulevard and Seattle street restriping are deluxe versions of traffic calming for bicyclists. However, connections through neighborhoods where bicyclists don't have to deal with motor vehicle traffic provide places for people to ride.

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[83] Monheim, H., "Traffic Calming in North Rhine Westfalia," *New Life For City Centers*, 1988, Anglo-German Foundation, London.

[84] *The Economic Cost of Motor Vehicle Crashes, 1990*, National Highway Traffic Safety Administration, U.S. DOT, 1992, Washington, D.C.

[85] Dare, James W., and Schoneman, Noel F., P.E., "Seattle's Neighborhood Traffic Control Program," *Institute of Transportation Engineers*, February 1982.

Bicyclists are asking for places to ride separated from motor vehicle traffic. Traffic-calming techniques can provide a desirable place to ride at considerably lower cost than for a separate trail. For example, the extension to the Palo Alto bicycle boulevard will cost $274,000 for just over 1 mile, and much of the cost is for one traffic signal. In contrast, one mile of urban trail can cost close to $1 million per mile as drainage, superelevation, intersections, and pavement make building a trail similar to building to a minor street. Add the cost of acquiring valuable and scarce urban land and the costs continue to escalate.
Rail lines and other corridors are being converted to trails in many urban areas but they may not serve the important origins and destinations bicyclists desire. Creating a bicycle boulevard or installing traffic calming on a neighborhood-wide basis can create corridors for bicycle use at reasonable cost.

In the six experimental areas in Germany, the costs of the traffic-calming work varied quite considerably. Tolley reports the work in Moabit was 29 DM ($18) per square meter of street and in Buxtehude as low as 14 DM ($9) per square meter of street.

The dramatic reductions in accidents in the Danish Safe Routes to School Project were achieved with an annual expenditure of just $160,000 per annum. The main road traffic-calming projects in Denmark were reported to cost three to four times less than the alternative project—a by-pass—and only fractionally more expensive than a conventional reconstruction.

Tolley concludes that:

> *If the cost effectiveness is seen as a relevant criterion, the potential savings in accident costs alone promise to more than recoup the outlay on the environmental traffic management schemes [in Germany].*[86]

He also quotes Doldissen who estimates the costs of the German experimental town projects will be amortized within 3 to 6 years on account of saved accident costs.[87]

6. Traffic calming affects more than just bicycling and walking.

The bicycle and pedestrian community will need to embrace a much wider range of supporters, views and interests in order to make traffic calming a reality. Traffic calming is much more than just a few isolated pedestrianized areas or a few miles of bike lane and bike path in one community.

Traffic calming involves adopting a new hierarchy of streets and a new concept of who has priority and what purpose streets have: They are not just for pedestrians or just for bicycles.

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[86] Tolley, Rodney, *Calming Traffic in Residential Areas*, 1990, Brefi Press, Wales.

[87] Ibid.

Traffic calming means coexistence with all other street users, including motorists, buses, and children.

ISTEA provides an opportunity for this to happen. The new planning process created by ISTEA can create the kind of citizen involvement and public outreach and education that is necessary to make traffic calming a reality in the United States. Bicyclists and pedestrians need to be at the forefront of this effort.

7. New concepts.

While many of the specific techniques of traffic calming are not new to traffic engineers and planners in the United States, the whole concept and principles of traffic calming, including extensive public participation, are very different from the norm. The natural reaction of people to be wary of new things has to be overcome.

In addition, engineers and planners will need to be encouraged and supported in trials and experiments to see how European experience might be adapted to work in the United States. The solutions used in Europe may not be the most appropriate to achieve the same goals.

In the United Kingdom a special Act of Parliament was required to make traffic calming legally possibly—perhaps something similar may be needed in state houses in the United States.

V. Conclusions and Recommendations

The principles of traffic calming are practiced widely throughout Europe, Japan, and the United States. Local governments have installed many types of traffic-calming devices usually at the request of nearby residents. However, in recent years the call for traffic calming has come from bicyclists and pedestrians. In addition the goal of traffic calming has expanded. Neighborhood traffic management is now focusing on area wide improvements instead of spot locations.

Bicycle and pedestrian groups are in the forefront of calling for traffic-calmed areas. A double-edged sword has been created with the huge increase in the number of motor vehicles on the road. Motor vehicle congestion is encouraging people to seek alternative forms of transportation, including walking and bicycling. Yet many bicyclists are uncomfortable sharing the road with motor vehicles and the increase in noise and pollution is discouraging many pedestrian trips.

While traffic calming may not solve every traffic problem, it has, under certain circumstances, been very successful in reducing traffic, speeds, accidents, noise, and pollution. Traffic calming has been used to create more livable neighborhoods, vibrant auto-free shopping streets, and pleasant, convenient bicycle routes.

Pedestrianization, or in the United States the creation of pedestrian malls, was found to create favorable areas for socializing and shopping. European cities found these areas had positive effects on the health of businesses. In the United States, some communities are not certain whether the mall or demographic changes are creating changes in business patterns.

Traffic planners and engineers in the United States are realizing traffic calming must be approached on an area wide basis. The German model of traffic calming all streets from major arterials to residential streets is an excellent example to follow.

A subtle benefit of traffic calming is the creation of better relationships between local governments and its citizens. Citizens who are dealing with a traffic problem in their neighborhood are encouraged when their government listens and works with them to find a solution.

There is a need for more research in the United States on the effects traffic calming has on bicycle and pedestrian use. While the Palo Alto bicycle boulevard has attracted more bicyclists, other facilities, like the Berkeley slow street, need to be evaluated to see if they are drawing bicyclists and pedestrians. If traffic calming is to be implemented on an area wide basis, there may be an opportunity to measure increases in bicycle and pedestrian trips.

Summary

1. Well-designed and implemented traffic-calming techniques can have a number of beneficial impacts for bicyclists and pedestrians. The reduced vehicle speeds associated with such projects can reduce both the severity and incidence of motor vehicle/bicycle/pedestrian crashes and can make bicyclists and pedestrians feel more comfortable in traffic.

2. In certain situations, traffic-calming techniques may be used to reduce the number of motor vehicles travelling along particular streets, and can increase the number of bicyclists and pedestrians.

3. Traffic-calming techniques can be used to provide better roadway conditions for bicyclists and pedestrians by better defining the space available to each mode, by improving intersection designs for nonmotorized users, and by giving greater priority to their movement.

4. Traffic calming may be a more cost-effective and practical means of encouraging bicycling and walking than the development of separate networks of trails and multi-use paths.

5. More research is needed to determine the applicability of extensive European experience with traffic calming to the United States situation. The limited efforts in United States cities do not yet compare to the level of investment and innovation devoted to traffic calming in these other western nations.

6. In the absence of such widespread practical experience with traffic-calming techniques, local action by bicyclists, pedestrians and neighborhood groups is necessary to educate and encourage traffic engineers, planners, and elected officials to implement traffic calming over a wide area.

7. Traffic-calmed residential areas can improve pedestrian safety. This is especially true for children who are more likely to make unexpected movements into the street. The lower speeds of motor vehicles gives drivers more time to react.

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