Designing the Walkable City

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Abstract: With federal policy beginning to shift from auto-centric planning, provision for pedestrian and bicycle access is now mandated in federally supported projects. However, the field of transportation planning has little in the way of theory and methods to guide design and planning for walkable cities. Walkability is increasingly valued for a variety of reasons. Not only does pedestrian transportation reduce congestion and have low environmental impact, it has social and recreational value. Recent research suggests that walking also promotes mental and physical health. The quality of the pedestrian environment is key to encouraging people to choose walking over driving. Six criteria are presented for design of a successful pedestrian network: (1) connectivity; (2) linkage with other modes; (3) fine grained land use patterns; (4) safety; (5) quality of path; and (6) path context. To achieve walkable cities in the United States it will be necessary to assess current walkability conditions, revise standards and regulations, research walking behavior in varied settings, promote public education and participation in pedestrian planning, and encourage collaboration and interdisciplinary education between transportation engineers and the design professions.

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Introduction

Over the past decade the quality of the walking environment has become a significant factor in transportation planning and design for American cities. Previously, movement by foot and bicycle was viewed as recreational, rather than legitimate transport to be seriously considered (Wigan 1994). With the Federal Highway Program's Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the 1998 Transportation Equity Act for the 21st Century (TEA-21), there has been a major shift in policy away from auto-centric planning, to mandated accommodation of the pedestrian and bicycle in federally supported transportation projects. Walking and bicycling are now viewed as valid modes of transport. TEA-21 states: "Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation projects, except where bicycle and pedestrian use are not permitted" (Federal Highway Administration 2003).

The consequences for planning at the local, regional, and state levels have been significant, with numerous pedestrian and bicycle policies, plans, and built projects across the country. Pedestrian and bicycle needs are now considered in transportation planning at all scales, from local streets to regional arterials (Chauncey and Wilkinson 2003). Walking and bicycling are viewed as essential ingredients in an integrated, intermodal transportation system to give travelers transportation options and to provide continuity from home to destination. Although the situation has improved, it has been estimated that Federal expenditures on automobile transport still exceed the amount spent on walking and bicycling by perhaps 1,000:1 (Frank et al. 2003).

This paper considers pedestrian needs in urban and suburban environments, focusing on the performance dimensions and criteria for a walkable city. Although bicyclists share many of the same needs and values as pedestrians, there are some clear differences, as well. The special needs of bicyclists are not addressed here.

Transportation Planning, Urban Design, and Pedestrians

Urban design and transportation planning have evolved over the past century along distinctly different tracks, urban design focusing on the concrete experiential qualities of the built environment, generally at small to medium scale, and transportation planning focusing on more abstract function and efficiency, particularly for the motorist, at the scale of cities and regions. Before the "scientific" revolution in transportation planning, civil engineers in the United States were trained to deal with the character of the locale they were working in. The road was engineered to serve transportation needs, but also to fit in with the landscape and to enhance the experience of the user. One example of this blending of engineering with design is the highway designed in Oregon in 1913 by Simon Benson, a Norwegian engineer, and Samuel C. Lancaster, a railway and highway engineer. Situated in the Columbia River Gorge, the road dramatizes the spectacular views of the 2,000 ft deep gorge and the many long waterfalls that come into view at strategic points along the route. In contrast, the modern highway far below the old road is straight, fast and efficient, but has none of the interaction with the landscape. There is no incentive or even possibility to stop and enjoy the view.

Beginning in the 1930s the profession of street and road de-

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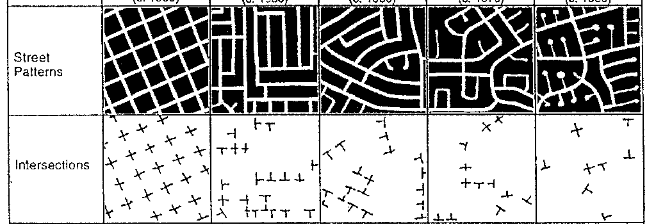
sign split in two separate directions: those who specialized in the technical aspects of transportation planning and engineering, and those who dealt with place-based design. While transportation planners have focused on abstract "macro" variables like capacity, demand, volume, rate of flow, trip origin/destination analysis, congestion patterns, and regional land use patterns, urban designers and landscape architects have looked at "micro" variables, the form and use of local places. Transportation analysis rarely addresses quality of the environment and user perceptions, and treats pedestrians negatively because they slow down the flow of vehicles at street crossings (Ramsey 1990). The consequences for the urban environment and for pedestrians have been enormous.

Some transportation planners acknowledge that micro design qualities such as landscape, path design or street furniture might be important factors affecting pedestrian behavior. Susan Handy states that "because the pedestrian sees, hears, smells, and feels much of the surrounding environment, urban form is likely to play a greater role in the choice to walk" (Handy 1996). However, urban design variables are almost always excluded from consideration in part because of data limitations. Although some transportation planners have tried to model relations between nonmotorized travel and the built environment, it has been difficult to characterize design qualities of places using the large scale databases typical in transportation research. Compared with databases related to vehicular transport, there is very little solid information on pedestrian and bicycle behavior and needs (US Department of Transportation 2000; Schwartz and Porter 2000). Moreover, most information on quality of the built environment such as grain, street scale, transparency, landscape character, or views simply does not exist at this scale. Transportation planner Robert Cervero states: "Statistical analyses like ours should be supplemented by microlevel analyses, including qualitative case studies and quasi-experimental comparisons, that account for possible influences of street-scale design elements" (Cervero and Duncan 2003).

	Gridiron (c. 1900)	Fragmented Parallel (c. 1950)	Warped Parallel (c. 1960)	Loops and Lollipops (c. 1970)	Lollipops on a Stick (c. 1980)



	Gridiron (c. 1900)	Fragmented Parallel (c. 1950)	Warped Parallel (c. 1960)	Loops and Lollipops (c. 1970)	Lollipops on a Stick (c. 1980)
Lineal Feet of Streets	20,800	19,000	16,500	15,300	15,600
# of Blocks	28	19	14	12	8
# of Intersections	26	22	14	12	8
# of Access Points	19	10	7	6	4
# of Loops & Cul-de- Sacs	0	1	2	8	24

Fig. 1. Over the past century residential street grids in the United States have lost connectivity and walkability (Michael Southworth and Peter Owens; with permission)

Walkable Cities of the Past

Walkability was essential in cities before the automobile era. Streets of the preindustrial city were by necessity walkable, since everyone depended upon ready access by foot or slow moving cart, wagon, or carriage for access to jobs and the marketplace. Activity patterns had to be fine grained, density of dwellings had to be relatively high, and everything had to be connected by a continuous pedestrian path network. Cities of the middle ages were remarkable in their walkability and typically packed all the necessities of urban living into an area no more than $\frac{1}{2}$ mi from the central square. For example, the entire built-up area of Urbino, Italy occupied an area of only 300 acres yet housed 30,000 people. Early American cities were highly walkable, as well. Boston, Mass. is the classic example, a town of diverse districts and an intense mix of uses. Before major land filling operations began in the early 19th century, everything was on a tiny peninsula of little more than 800 acres where every point could be reached in a walk of less than 1 mi or $\frac{1}{2}$ h. Despite enormous growth and modernization, the central area still maintains its walkability, a rare situation for the American city.

Industrial cities of the 19th century, too, maintained good walkability, since most workers did not have access to horse-drawn carriages or even streetcars. Although the industrial city was walkable, it was not necessarily healthful due to poor air and water quality and lack of sanitation. Interestingly, while the environment contributed to the major public health problems of 19th century cities because of poor sanitation infrastructure and industrial pollution, today the environment contributes to significant public health problems by encouraging and supporting a sedentary life style dependent upon the automobile (Frank et al. 2003).

High speed transport and the quest for efficiency killed the walkable city. Each advance in transportation technology—from horse drawn cart or carriage, to horsedrawn streetcar, to electric streetcar, to automobile and superhighway—seems to have had negative impact on the pedestrian environment. The walkable city came to an end in the 1920s with the appearance of the automobile, coupled with the emergence of Modernism. The pedestrian environment was ignored in favor of the automobile, which allowed things to be much farther apart. Moreover, hazardous high speed traffic broke up the fine grained pedestrian network and imposed barriers to free movement on foot. In ignoring the pedestrian experience, the street lost its intimate scale and transparency, and became a mere service road, devoid of public life. Modernist planning and design separated pedestrians from the automobile, shunting them off to raised plazas, skywalks, barren "greenways," and sterile pedestrian malls (Robertson 1994). The automobile oriented values of Modernism have been codified in the transportation and street design standards that we struggle with today.

In the late postindustrial city it is impossible for the pedestrian or bicyclist to navigate freely. The street patterns of most residential areas built after 1950 are based on the discontinuous cul-de-sac rather than the interconnected grid. Block sizes are too large to permit a range of route choices and land use patterns are coarse with activities widely spaced and segregated by type. Streets are often over scaled and inhospitable to pedestrians and frequently lack sidewalks in order to reduce infrastructure construction and maintenance costs. The entire system has been designed for the convenience of the motorist (Southworth and Ben-Joseph 2003, 2004), (Figs. 1 and 2).

Defining Walkability

What is "walkability"? The quality is widely referred to, but poorly defined. If we are to design more walkable cities, it will be necessary to define the term and make it operational through performance criteria. We offer the following definition: Walkability

Fig. 2. Streets of postindustrial suburbs have little to offer pedestrians (Michael Southworth; with permission)

is the extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network.

A highly walkable environment invites walking by means of a richly connected path network that provides access to the everyday places people want to go. It is safe and comfortable, with streets that are easy to cross for people of varied ages and degrees of mobility. Spaces are attractive and engaging to be in, with street trees or other landscape elements, coherent but varied built form, and visual connection with the life of the place. The pedestrian network links seamlessly, without interruptions and hazards, with other transit modes such as bus, tram, or subway, minimizing automobile dependence. The path system is sufficiently complex to be explorable over time, offering varied visual experiences with repeated encounters. It supports walking for utilitarian purposes such as shopping or the journey to work, as well as for pleasure, recreation, and health.

The *Wisconsin Pedestrian Policy Plan 2020* describes a walkable community well: "Ultimately, the goal of any effort to facilitate pedestrian travel is walkable communities. A walkable community is thoughtfully planned, designed, or otherwise retrofitted to integrate pedestrian travel into the community's fabric. In a walkable community, walking is considered a normal transportation choice and is not a distraction or obstacle to motor vehicle traffic." The plan also provides a useful definition of "pedestrian" that includes the handicapped: "A pedestrian is any person walking, standing or in a wheelchair" (Wisconsin Department of Transportation 2002). The *Boulder Transportation Master Plan 2003* expands on this to offer a standard for pedestrian mobility: "Pedestrian mobility and accessibility is the ability of a wheelchair user to move safely and conveniently through the transportation system" (City of Boulder 2003).

Walkability Values and Constraints

The pedestrian plans for Boulder and Vermont strongly assert that walking is essential in all transportation: "Pedestrian travel is involved in every trip and is the basis for all other modes of travel" (City of Boulder 2003). Vermont's *VTrans Pedestrian Policy* asserts that: "Everyone is a pedestrian; Walking is part of every trip; and Pedestrian travel is to be expected on all highways except where prohibited by state law." It goes on to state that pedestrian facilities should be planned and designed to the maximum extent possible, rather than the minimum (State of Vermont Agency of Transportation 2002).

Not surprising, Europeans make many more trips by foot and bicycle than do Americans (Crawford 2000). In the United States, only 9% of total trips were by foot but 84% were by car in 1990, whereas in Sweden 39% were by foot and 36% were by car. In The Netherlands and Germany walking and bicycle trips increase with age and account for over half the trips for people age 75 and older (Pucher and Dijkstra 2003). In contrast, for Americans age 75 and older, only 6% of trips were by foot in 2000 (Frank et al. 2003).

The benefits of increasing walking are widely recognized. Walkability is the foundation for the sustainable city; without it, meaningful resource conservation will not be possible. Like bicycling, walking is a "green" mode of transport that not only reduces congestion, but also has low environmental impact, conserving energy without air and noise pollution (Newman and Kenworthy 1999). It can be more than a purely utilitarian mode of travel for trips to work, school, or shopping, and can have both social and recreational value. It is also a socially equitable mode of transport that is available to a majority of the population, across classes, including children and seniors. The poor, children, and elderly suffer disproportionately from living in auto-dependent environments, since they are most dependent upon other forms of transport. Walking may also promote sociability. A study in Galway, Ireland suggests that people who live in walkable neighborhoods have higher levels of "social capital," and are more likely to know their neighbors, participate politically, trust others, and be socially engaged (Leyden 2003).

Finally, walking can promote mental and physical health. Among the health benefits are improved cardio-vascular fitness, reduced stress, stronger bones, weight control, and mental alertness and creativity. Given the environmental, social, and health benefits of walking, it is not surprising that a number of recent studies have examined the health impacts of walking in depth. Walking is the most accessible and affordable way to get exercise. As obesity has now become a major public health problem in the United States, several studies have been done that make connections between health and the design and planning of cities. Lack of physical activity has been related to numerous health problems besides obesity, from mental health, and osteoporosis, to cardio-vascular disease (Frank et al. 2003). Three quarters of United States adults do not get enough physical activity, and one quarter is inactive in their free time. Nearly two thirds (64.5%) of United States adults are overweight and almost one third are obese according to a recent National Health and Nutrition Examination Survey (Ewing et al. 2003). Forty percent of the United States population leads a sedentary life style, and only 5% gets enough exercise to meet public health standards. In contrast, European countries with the highest rates of walking and bicycling have less obesity, diabetes, and hypertension than the United States (Pucher and Dijkstra 2003). Many researchers have found that as little as $\frac{1}{2}$ h moderate activity such as walking or bicycling may be adequate for long term health, but only one quarter of the population achieves this (Frank et al. 2003; Powell et al. 2003). As little as 15 min/day of moderate or brisk walking, or 30 min of slow walking, can help prevent weight gain (Morabia and Costanza 2004). Obviously, the built environment is not the only cause of obesity; genetics, diet, and personal life style play an important role, as well.

A widely publicized large scale study of urban form and health in the United States concluded that there might be a relation between urban pattern, forms of physical activity, and some health outcomes (Ewing et al. 2003; McCann and Ewing 2003). The study looked at health data of more than 200,000 people in relation to urban form in the 448 counties and 83 metropolitan areas they lived in. Residential areas were rated according to a "metropolitan sprawl index" that considered residential density, land use mix, degree of centralization of development, and street accessibility, which considered length and size of blocks. Given the large sample and wide range of development types across the country, the index was by necessity highly simplified and unsympathetic to subtleties of local places. Nevertheless, the study concluded that people who lived in "sprawl" were likely to walk less, weigh more, and have greater incidence of hypertension than people living in more compact areas. People in the most sprawling areas weighed 6.3 lbs. more on average than people in the most compact areas. Residents of more compact areas were more likely to walk for leisure than were residents of sprawl areas. The study was widely publicized and caused a minor uproar. Many planners and designers found the anti-suburban biases justified, while defenders of the status quo criticized the study and felt that 6.3 lbs. wasn't much to argue about (Cox and Utt 2003). The question remains: does the environment cause obesity? Or do people who prefer a "fat" lifestyle also prefer suburban places? The question has not yet been addressed in systematic research.

Some studies have suggested that quality of the walking environment influences the amount of walking people will do. A study of the relations between neighborhood form and obesity in San Diego, Calif. rated neighborhoods on a "walkability" scale. Residents of higher walkability neighborhoods engaged in 70 min more of physical activity in the previous week and had less obesity; 60% of residents in low walkability neighborhoods were overweight. The walkability scale considered a variety of factors: density, land use mix and diversity, access to a mix of uses, street connectivity, walking and bicycling facilities, street aesthetics, level of traffic, and street crime (Saelens et al. 2003). In Perth, Australia researchers found that people were 50% more likely to walk at the recommended levels on higher quality streets (Giles-Corti and Donovan 2003). A study of pedestrians in four European countries examined relations between street appearance and the distance people would walk. Researchers rated streets on a seven point "pleasantness" scale and then tested walking behavior. They found that in good weather people were willing to walk 160 m more for each point on the pleasantness scale (Westerdijk 1990).

Walking may also contribute to mental health. A recent study of nearly 19,000 older women between the ages of 70 and 81 suggests that those who do more walking and other physical activity tend to have better cognitive function and less cognitive decline than those with less activity. Those with the highest levels of physical activity had 20% lower risk of cognitive impairment (Weuve et al. 2004). In another study of 2,000 men over 71, those who walked the least (less than $\frac{1}{4}$ mi/day) had nearly twice (1.8 times) the risk of developing dementia as those who walked the most. One caution: health problems that contribute to dementia may reduce the ability to walk or do other physical activities (Abbott et al. 2004).

Why don't people walk and how could design change that? Design of the path network and its environs is one factor, but not the only one. Several other considerations affect whether or not people decide to walk instead of using a vehicle. Functionality of the network is obviously important: the path system needs to be in place, serviceable on foot or by wheelchair, and well connected with places people want to go. Weather, terrain, and safety from crime or dangerous traffic are other significant environmental factors. Personal factors such as age and health are also determinants. Finally, visual interest along the path network is important. A walk that is pleasurable, offering changing scenes and social encounters, is more likely to be repeated than one that is boring or unpleasant. This has been the least understood and most ignored variable in walkability planning and design.

Criteria for Walkable Cities

What are the performance dimensions of a walkable city? Studies have indicated that distance to destinations is the single factor that most affects whether or not people decide to walk or to take the car, and is more of a determinant than weather, physical difficulty, safety or fear of crime (Funihashi 1985; Komanoff and Roelofs 1993; Handy 1996; Smith and Butcher 1994). Research to date on pedestrian walking behavior is very limited. Several studies have found that the distance Americans will walk for typical daily trips is quite limited, ranging from 400 ft to about $\frac{1}{4}$ mi (Weinstein 1996). Untermann found that 70% of Americans would walk 500 ft for daily errands and that 40% would walk 1/5 mi; only 10% would walk $\frac{1}{2}$ mi (Untermann 1984).

Simple measures of distance to destinations are not an adequate predictor of walkability. The quality of the path network is key (Jaskiewicz 2001). To encourage walking it is necessary to go beyond utilitarian access. Several qualities of the path network affect likelihood of walking, and can be improved through design.

A walkable network has several of the following important attributes:

1. Connectivity of path network, both locally and in the larger urban setting;
2. Linkage with other modes: bus, streetcar, subway, train;
3. Fine grained and varied land use patterns, especially for local serving uses;
4. Safety, both from traffic and social crime;
5. Quality of path, including width, paving, landscaping, signing, and lighting; and
6. Path context, including street design, visual interest of the built environment, transparency, spatial definition, landscape, and overall explorability.

These six criteria are discussed in more detail below. In order to effectively plan and design for urban walkability, it will be essential to make the criteria operational and introduce them into practice. Several are already well developed and are increasingly used by transportation planners and cities in planning for pedestrian access.

Connectivity

Connectivity of the path network is determined by the presence of sidewalks and other pedestrian paths and by the degree of path continuity and absence of significant barriers. While it is tempting to prescribe walking distance to destinations radially "as the crow flies" for simplicity, this approach can be misleading, especially when street patterns are coarse and fragmented. However, as patterns become finer grained and more interconnected, blocks become smaller with higher connectivity of paths, and the ratio of access for the "crow fly" measure to actual walking distance approaches one. In addition to path distances to various points, it is important to examine the amount of path choice. Density of path intersections and block sizes can be revealing: a high density of intersections and small block sizes usually correlates with a high degree of connectivity. Barriers to pedestrian access such as cul-de-sacs and dead end streets, or busy arterials, railroad or power line rights-of-way, rivers, or topographic features must be minimized.

Connectivity is best addressed when an area is being designed, of course, and is much more difficult to remedy once a place is built. Most of the postindustrial suburban landscape suffers from lack of pedestrian connectivity, typically with a pattern of disconnected cul-de-sacs and barrier arterials and highways. In some cases, connectivity retrofits might be possible, with pedestrian overpasses or underpasses across barriers, or traffic calming devices. Unused railroad rights-of-way have sometimes been converted to trails for hiking, biking, and riding, providing regional connectivity. Cul-de-sacs might be connected to provide a continuous bicycle and pedestrian system (Southworth and Ben-Joseph 2003, 2004).

Linkage with Other Modes

Beyond providing an internally well-connected pedestrian network, it is important to provide connectivity with the larger city and region through convenient and accessible links to other modes such as bus, streetcar, subway, or train within a reasonable time–distance. This means that stations need to be spaced frequently enough to allow pedestrian access for residential and commercial zones, usually $\frac{1}{4}$–$\frac{1}{2}$ mi, or a 10–20 min walk. A complete pedestrian network will offer full connectivity between all modes so that one can navigate seamlessly from foot to trolley or subway to train or air without difficult breaks (Garbrecht 1981). The "pedestrian pocket" concept promoted by New Urbanists has suffered from lack of understanding of the larger transportation/land use framework; a small pedestrian district, no matter how well designed, cannot contribute to a reduction in automobile use if it is not well supported by transit and situated within an accessible mix of land uses (Cervero 2002; Cervero and Kockelman 1996).

Fine Grained and Varied Land Use Patterns

A walkable neighborhood or city has an accessible pattern of activities to serve daily needs. This means that one can reach most local-serving uses on foot within 10–20 min or up to $\frac{1}{2}$ mi. The types of activities that fall within this "neighborhood access" category include such uses as shops, cafes, banks, laundries, grocery stores, day care centers, fitness centers, elementary schools, libraries, and parks. A survey of 60,000 readers of *Better Homes and Gardens* magazine revealed that 88% of respondents wanted to live in a walkable neighborhood, and 68% would like to work at home in the next 5 years. However, most postindustrial development in the United States has lost walkability and the necessary fine-grained pattern of uses so that it is impossible in many areas to reach even one everyday activity on foot within $\frac{1}{2}$ mi. The elementary school is a particular problem. In the 1920s Clarence Perry conceived the "neighborhood unit," a residential district focused on an elementary school and park which children could easily walk to from home, protected from high speed traffic. The school has now become so overblown in space requirements that it is usually situated at the edge of communities where it is in accessible to nearly everyone except by car.

Could a very low density city ever become walkable? Land use intensity and diversity, like connectivity of the path network, are best established at the very beginning of the development process. Once a low density coarse grained pattern is put in place, it is a legal and physical challenge to insert density and variety. Ironically, Phoenix, Ariz. has produced a pedestrian plan (Maricopa Association of Governments 1999). Without major transformation of the city, it would seem impossible to create a fully functional pedestrian city in such a situation. No doubt small districts could be densified and mixed uses could be inserted, but the best one might hope for are recreational paths and islands of walkability within overall sprawl.

Safety

Perhaps the best understood and most fully developed aspect of walkability is pedestrian safety. In most United States cities transportation and land use policies have made walking and bicycling inconvenient, unpleasant, and dangerous. Environments that support fast and efficient auto travel are not enjoyable, safe, or interesting for pedestrians and bicyclists. Not surprising, there is much more likelihood of injury or death for pedestrians or bicyclists than motorists. Each year 6,000 pedestrians and bicyclists are killed in traffic in the United States: pedestrians are 23 times more likely to get killed than automobile passengers. In contrast, it is much safer for pedestrians and bicyclists in most European countries because of the many improvements that have been made in pathways, signing, regulations, education, traffic calming, and enforcement (Federal Highway Administration 2003). People who are aware of safe and convenient places to walk are much more likely to walk (41.5%) than people who are not aware of such places (27.4%) (Powell et al. 2003).

Many studies have examined pedestrian/automobile accidents and their causes. Safety standards and design handbooks have been developed and are widely used (ITE 1998; Huang et al. 2000; Pucher and Dijkstra 2000, 2003; Huang and Cynecki 2001; Ragland et al. 2003; Staunton et al. 2003; Zageer et al. 2004). Criteria have been formulated for safety from traffic and street crime including crossing times for people of varied mobility, handicapped needs, placement and length of cross walks, traffic speeds, pedestrian and traffic control signing and signals, sidewalk width, sidewalk condition, path surveillance or "eyes on the street," and night lighting.

A recent trend across the country has been "traffic calming," techniques for making streets more pedestrian friendly by slowing down traffic through a variety of devices: chokers, chicanes, speed bumps, raised crosswalks, narrowed streets, rough paving, traffic diverters, roundabouts, landscaping, and other means. Several handbooks on the subject have been developed, including one by Caltrans with traffic calming guidelines to make Main Streets livable and context sensitive (Engwicht 1999; Caltrans 2002). The Federal Highway Administration (FHA) conducted a before/after study of the impacts of traffic calming in three cities and found that the modifications usually slowed down traffic and increased the percentage of pedestrians for whom drivers yielded, but of course they did not guarantee that drivers would slow down or yield to pedestrians. Refuge islands and raised crosswalks tended to channel pedestrians into marked crosswalks, but traffic calming treatments did not significantly affect pedestrian waiting time (Huang and Cynecki 2001). One study in The Netherlands found that traffic calming reduced accidents 20–70%, depending upon the area (Pucher and Dijkstra 2003).

The daily trip to school is particularly problematic in terms of safety. In the past 20 years the number of children and adolescents walking or bicycling to school has declined 40% (Killingsworth and Lamming 2001). A major reason has been parental

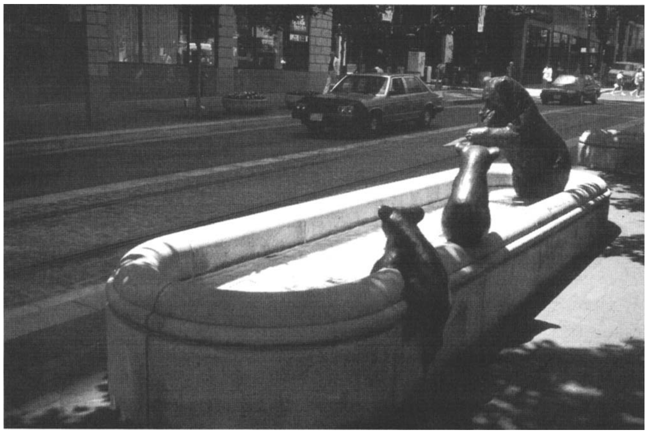


Fig. 3. Portland has done much to promote walkability, including street art (Michael Southworth; with permission)

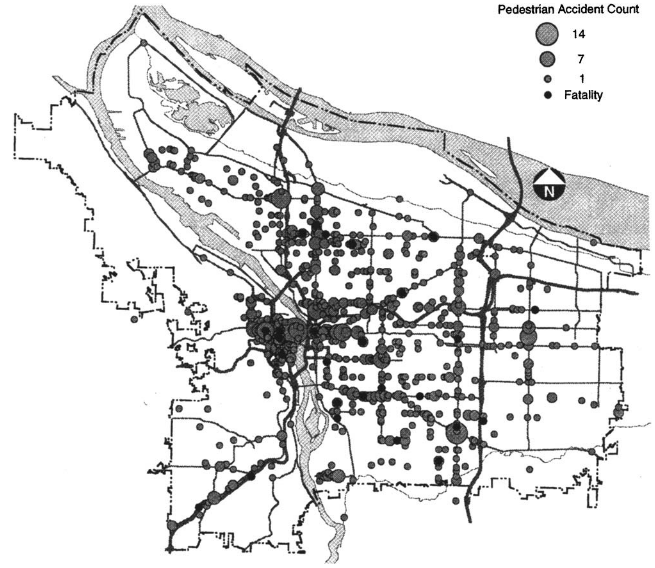


Fig. 4. Automobile–pedestrian crash map, Portland, Ore. (*Portland Pedestrian Master Plan*; with permission City of Portland Office of Transportation)

concern for children's safety, particularly from traffic. Several cities have developed "paths to school," designated streets that have been made as safe as possible for children. The Marin County Safe Walking and Biking to School program is one example of a promising education and promotion program for getting children to walk or bike to school using "walking buses" and "bicycle buses." Children wait at designated stops along the route, and walk or ride their bicycles to school as a group, led by an adult guide (Engwicht 1999; Staunton et al. 2003). The Safe Routes to School program in Odense, Denmark reduced traffic accidents involving children by 85% (Untermann 1990).

Path Quality

The quality of the path itself is, of course, essential to walkability. Perhaps the least hospitable pedestrian path is the auto oriented commercial strip, a treeless expanse dominated by several lanes of noisy traffic, polluted air, glaring lights, and garish signs. The street has few, if any, designated crosswalks and is much too wide for a pedestrian to cross safely. The chaotic frontage is poorly defined, lined by blank big boxes, large parking lots, and drive-in businesses. Haphazard utility poles and boxes, street lights, traffic control signs, hydrants, mail boxes, and parking meters dominate the sidewalk, which is constantly interrupted by driveways to businesses (Southworth and Lynch 1974).

If the strip is pedestrian hell, then the ideal pedestrian path will provide for the comfort and safety of pedestrians of varied ages and physical abilities. It should be continuous, without gaps, and should have a relatively smooth surface without pits, bumps, or other irregularities that could make walking and wheelchair access difficult or hazardous. It should be at least wide enough for 2–3 people to pass one another or to walk together in groups, and much wider in very urban situations. Terrain can be a significant factor in walkability, especially in cities with snow and ice. Steep hills such as those of San Francisco, Calif. may require steps or even railings in sections to assist pedestrians. Encroachments into the pedestrian right-of-way such as utility poles, mail boxes, or newspaper vending machines can compromise walkability by constricting the pathway or blocking crossings. Landscape elements such as planted verges help insulate the pedestrian from the moving traffic, and street trees provide protection from the sun and help define the street space. Pedestrian scaled path lighting can enhance nighttime walking and provide a greater sense of safety. Given all of the potential problems with path quality, it is not surprising that senior citizens often choose to walk in malls for safety, comfort, and sociability (Emery 2003; Gassaway 1992).

Portland, Ore., a city with a long tradition of pedestrian access, has done much to enhance the pedestrian path network including imaginatively designed fountains, bus shelters, manhole covers, lighting, and street art that also help create city identity (Fig. 3). One of the many policy objectives of the *Portland Pedestrian Master Plan* is to: "Enhance the environment occupied by Portland's pedestrians. Seek to enrich these places with designs that express the pleasure and hold the pleasant surprises of urban living" (City of Portland Office of Transportation 1998b). The plan developed a typology of walkways for different pedestrian path types: pedestrian district, city walkway, local service walkway, and off-street path. A citywide assessment of pedestrian network needs inventoried: (1) all sidewalks, curb ramps, and obstructions such as poles or mailboxes; (2) automobile–pedestrian accident data by street; and (3) neighborhood requests for sidewalk or other pedestrian environment improvements (City of Portland Office of Transportation 1998b) (Fig. 4). The *Portland Pedestrian Design Guide*, provides principles for pedestrian design and very detailed guidelines for sidewalks, street corners, cross walks, and pathways and stairs (City of Portland Office of Transportation 1998a).

Path Context

Perhaps the most problematic and least developed of walkability criteria are those related to quality of the path context. If we wish to encourage walking we need to deal with more than connectivity, land use patterns, safety, and quality of the path itself. A safe, continuous path network in a monotonous physical setting will not invite pedestrians. The path network must engage the interest of the user. Many aspects of the path context can contribute to a positive walking experience: visual interest of the built environment, design of the street as a whole, transparency of fronting structures, visible activity, street trees and other landscape elements, lighting, and views. The postindustrial city has become

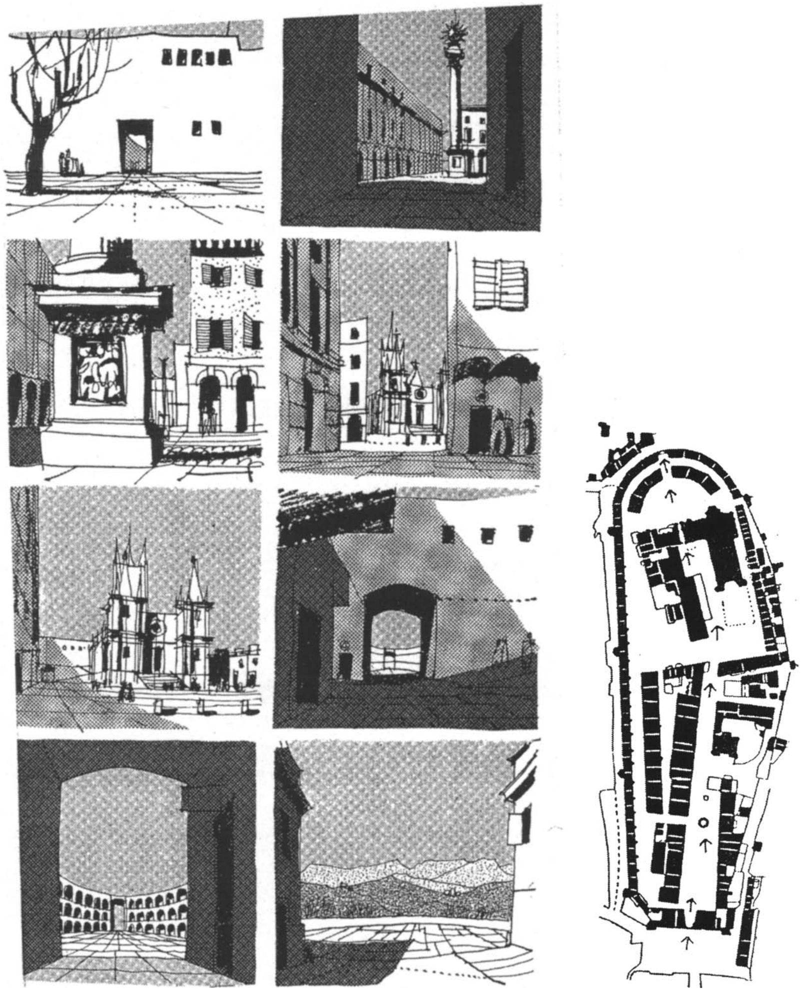


Fig. 5. City walks can be designed to provide exciting sequence of revelations (reprinted from *The Concise Townscape*, Gordon Cullen 1971, p. 17, with permission from Elsevier)

an increasingly closed and hidden world, as processes of production and marketing are hidden from view. Big box shopping, introverted shopping malls and office parks, vast parking lots and reliance on electronic communications have all contributed to urban landscapes that are difficult to read. A transparent environment allows one to sense the social and natural life of a place through first hand observation. Such qualities are impossible to deal with at the macroscale of most transportation analysis and planning, but require detail design and attention to the special qualities of places (Owens 1993). In most large developments of mass produced housing repetitive architecture and uniform street design standards devoted to the automobile have produced neighborhoods with little pedestrian appeal.

Urban design has a long history of theory and approaches to spatial design for path systems, beginning with the Baroque in the 16th century and continuing to the present time. Unfortunately, this thinking has rarely been an integral part of transportation planning. In the late 19th century, the Picturesque movement emphasized the aesthetic experience of walking and riding in the design of new residential suburbs. John Nash's Park Village and Raymond Unwin's Hampstead Garden Suburb in London, England and Frederick Law Olmsted's Riverside in Chicago, Ill. offered a richly rewarding landscape of complex built and natural form that would engage travelers as they strolled, bicycled, or rode through on horseback or carriage. Olmsted and Vaux's Eastern Parkway and Ocean Parkway, built in Brooklyn, N.Y. in the 1870s, are remarkable in the way they accommodate heavy, fast moving traffic, while still offering livable pedestrian oriented public space flanked by residential buildings. Their skillful application of the multiway boulevard layout used treed pedestrian malls to buffer slow moving pedestrian streets from the traffic and noise (Macdonald 1999).

In the past century a few notable exceptions to the general trend of postwar development have sought ways of maintaining pedestrian access, while accommodating the automobile. In a sense, they are adaptations of Picturesque theory to new conditions. In the 1920s and 1930s, Clarence Stein structured his designs for new garden suburbs such as Greendale, Wis. and Radburn in Fairlawn, N.J. around a continuous green core with pedestrian and bicycle paths that connected homes with school, local shops, and transit. In Britain in the 1960s, Gordon Cullen and others developed plans to restore or reinvent the traditional townscape as an engaging "sequence of revelations" for the pedestrian (Cullen 1961) (Fig. 5). The idea is still alive, although not commonly seen, in places like Village Homes in Davis, Calif. and Reston, Va. Many New Urbanist developments emphasize walkability, as well (Audirac 1999). In The Kentlands in Gaithersburg, Md. particular design attention was given to creating pedestrian scaled streets with varied architecture and landscape. Small-scale detail along the streets, as well as changing vistas and

Fig. 6. Kentlands has explorable pedestrian scaled streets with varied architecture and landscape (Michael Southworth; with permission)

focal points from neighborhood to neighborhood make it an enjoyable place to go for a walk. Every district has numerous alternate pathways. It has been so successful in this regard that people drive to it from other suburbs just to take a walk (Southworth 1996) (Fig. 6). In all of these cases walkability has been an important feature, but regrettably each of the developments is a rather small, auto dependent island stranded in motopia.

Several environment/behavior studies have examined the design aspects of the pedestrian environment in depth and provide clues to how design might encourage walking behavior (Appleyard 1981; Bosselmann et al. 1999; Pushkarev and Zupan 1971, 1975). One of the earliest formal studies of pedestrian experience of the urban setting found that spatial form of the street and quality of city floor were the dominant factors in pedestrians' images of Back Bay in Boston, Mass. Traffic was a major distraction and was disliked because of the noise and threats to safety. Natural elements were particularly valued, especially open spaces like the Public Garden that offered trees, quiet, and a contrast with the highly urban surroundings (Lynch and Rivkin 1959).

More recently, an important study examined urban walkability in four neighborhoods in the East Bay of San Francisco, Calif. that had equal access to transit, but that varied in quality of the path network: Albany–North Berkeley, Rockridge, Walnut Creek, and Fremont. Drawing on a large sample, a variety of research methods were used, both qualitative and quantitative, including field analysis of pedestrian friendliness, a questionnaire, travel diaries, and observation of walking behavior. Data were analyzed using univariate, bivariate, and multiple regression analysis. Walking activity was found to correlate with the quality of the pedestrian environment.

Residents of the Rockridge neighborhood in Oakland, Calif. were found to use transit the most. The neighborhood is characterized by walkable, tree lined, small scaled streets with a Main Street type commercial spine of small shops, cafes, and services that is well connected with a transit station. Some have speculated that walkers tend to live in walkable neighborhoods and that neighborhood form itself does not generate walking. However, in this study self selection does not explain the frequent walking trips of Rockridge residents. People who did not value walkability in their neighborhood chose to walk just as much as those who did.

In contrast to Rockridge, Fremont's Mowry Ave. district is a transit village without walkability. It lacks most of the qualities of a walkable neighborhood, and it also had the lowest walking and transit use. Although sidewalks are present everywhere, streets are too wide, and traffic is too fast for comfortable walking. There is little transparency and buildings are large and introverted. Landscaping and street furniture are minimal and there are few pedestrian crossings.

The research offers support for some, but not all, New Urbanist theories: "First, that density does matter, as indicated—in this research—by the high influence of distance on walking frequency. Second, that the level of pedestrianization does matter; the existence of convivial public spaces, social destinations, more intimately scaled streetscapes, and good pedestrian amenities truly geared toward placing the pedestrian first, improve the perceived (and actual) walkability of an area, as shown by the success (on the local level) of the Walnut Creek downtown core" (Lamont 2001).

In another study, field research in Dresden, Germany tested pedestrians' responses to several different walking environments with varied design qualities: one was Modernist, while the others were traditional including one rather complex, semiorganic pattern. Walkers much preferred the traditional environments to the Modernist walk (Pragerstrasse) which was judged least pleasant and least delightful, most tiring, annoying and boring. The street was very wide (110–155 ft), lined by block towers, and had no visual terminus. People commented on its overwhelming scale and monotony, and called it a "no man's land." Hauptstrasse, on the other hand, was admired for its trees, flowers, benches, fountains, sculpture, and street lamps. Although this street was straight and wide (122–180 ft), two rows of trees divided it into three narrower sections. Continuous four to six story buildings defined its edges and a plaza with focal statue terminated it (Fig. 7). Subjects appreciated Rahnitzgasse for its plaza, narrow winding streets, sequence of spaces, and the small scale of shops and cafes. Spatial qualities were not the only factors that determined preference; the social environment was also important. For example, subjects valued seeing people sitting at cafes and couples on benches. The streets were criticized for lack of spatial definition, too much traffic, poor maintenance, lack of street life, and large and monotonous design of newer buildings and shops. Contrary to Picturesque theory, which advocates winding paths because they are more unfolding and more intriguing, walkers preferred the straight, wide street because it was comfortable and pleasant, allowing freedom of movement, while the narrow, winding picturesque street was sometimes judged as too constricted. The research concludes that strong aesthetic experience alone will not necessarily support increased pedestrian activity; the environment must also be sociable and useful (Isaacs 2000).

Another part of the study explored time sense in walking. Paths of greater complexity were sensed to take longer to walk than paths of simple design, despite being the same actual length. The paths with longer time estimates had smaller spatial dimensions (width of street buildings), more variation in dimensions along the path, shorter blocks with more intersections, and more changes in direction. The "experienced distance" was greater than the actual distance (Isaacs 2001). Jan Gehl hypothesized the opposite: that long straight streets, being more boring, would seem to take longer to walk than interesting streets (Gehl 1987). This raises several questions: Could visually complex environments discourage use because they would seem to take longer to traverse? Would living in a complex district discourage transit use because walks would be perceived as longer? Or is a walk in a complex environment more therapeutic and relaxing because it seems to be longer than it really is? (Isaacs 2001).

There is no general theory of spatial design for the pedestrian

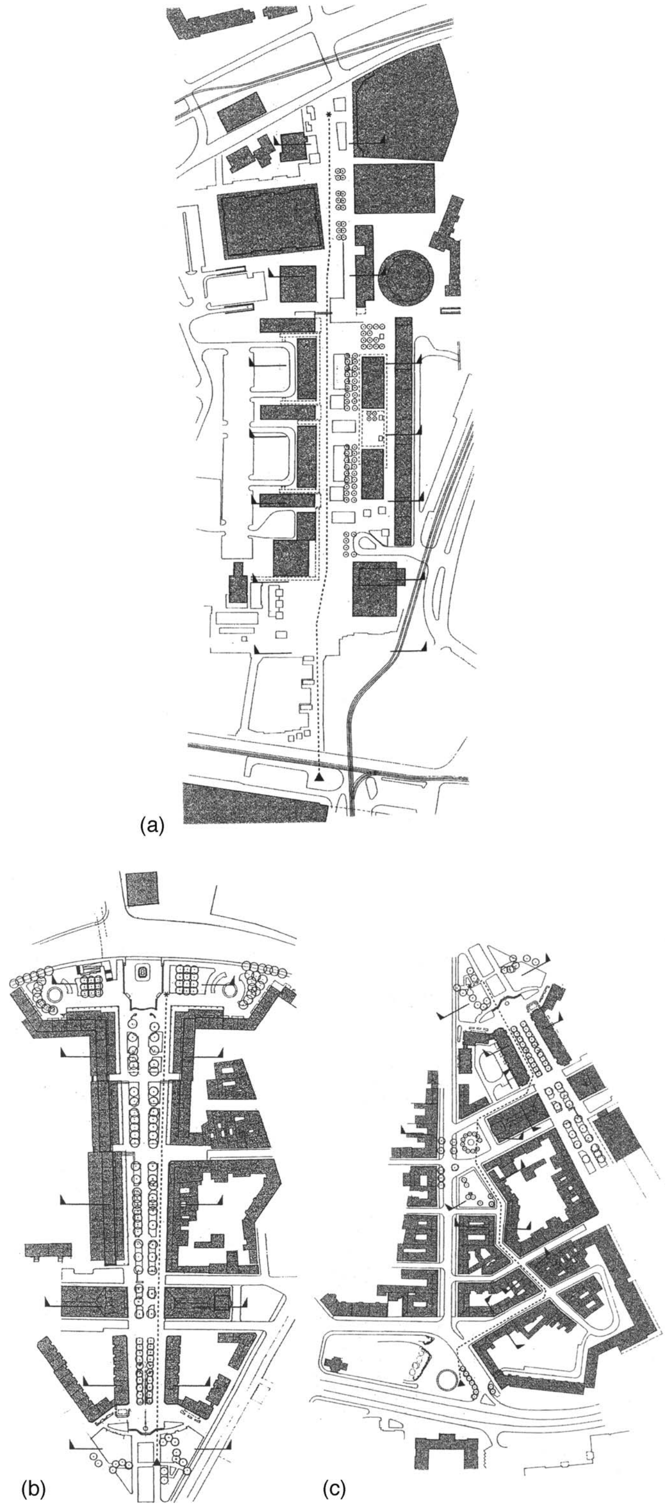


Fig. 7. Pedestrians in Dresden much preferred the traditional (b) Hauptstrasse and the more intimate and complex (c) Rahnitzgasse to the Modernist (a) Pragerstrasse (Raymond Isaacs; with permission)

environment that applies everywhere. Given the variety of context situations, it is difficult, if not impossible to specify a simple set of standards. Although many urban designers have attempted to develop formulas for street width, setbacks, or ratios of enclosure height to street width, for every rule that is made, examples of successful streets can be found that break the rule. The canyon streets of Manhattan, N.Y. are often perceived as attractive and walkable, as are the small 17th century lanes of Marblehead, Mass. or the broad tree canopied boulevards of the Country Club district of Kansas City, Mo. Street trees and other vegetation almost always enhance walkability, but several European examples immediately come to mind that break the rule such as the treeless, arcaded streets of Bologna or the stone streets of Venice, Florence, or Sienna, Italy. Here the architecture, street space, and street life provide the interest and engage the pedestrian in exploration. Many United States neighborhoods are rather nondescript architecturally, but still have a high degree of walkability. For example, streetcar suburbs built from the 1880s to 1920s such as Rockridge, Elmwood, and Piedmont in San Francisco's East Bay or Crocus Hill and Summit Hill in St. Paul, Minn. are known for the comfortable scale of the streets and blocks, the canopy of street trees, the variety of architectural expressions, and the connection of buildings to the street.

Successful approaches will vary by culture, place, and city size. Nevertheless, a few attributes are likely to contribute to the quality of path context in most urban and suburban settings: scale of street space, presence of street trees and other landscape elements, views, visible activity and transparency, scale, and coherence of built form. The important thing is to engage the pedestrian's interest along the route.

Conclusion

It will not be easy to achieve walkable cities in the United States, especially since more than half of the typical American metropolis has been built according to automobile dominated standards. There may be resistance to improving things for the pedestrian or bicyclist, fearing space will have to be taken away from the car (Federal Highway Administration 2003). It is more difficult to retrofit built-up areas because the patterns are already established. While it is not impossible to modify existing street networks to serve pedestrians and to insert some density and mixed uses into low density cities, it will require imagination and persistence.

Several actions will be necessary if we are to improve walkability in the American city:

First, cities and suburbs need to assess current walkability conditions for every district of the city, and then develop policies and plans for the total pedestrian environment (Southworth 2003). At the present time several cities and 11 states have developed pedestrian plans with assistance from ISTEA and TEA-21 including Ann Arbor, Mich., Boulder, Colo., Cambridge, Mass., Oakland, Calif., Phoenix, Ariz., Portland, Ore., St. Louis, Mo., Vermont, Wisconsin, and New Hampshire (City of Boulder 2003; City of Cambridge 2000; City of Oakland 2002; City of Portland 1998a,b; Greenway Collaborative 2003; Maricopa Association of Governments 1999; New Hampshire Department of Transportation 2000; State of Vermont Agency of Transportation 1998, 2002; Wisconsin Department of Transportation 2002). *The Portland Pedestrian Master Plan* states that "providing for pedestrians should be a primary mode of transportation throughout the City." It is a good example of pedestrian planning that is based on citywide analysis of a range of factors that affect walkability, including path quality, and some context variables. A Pedestrian Potential Index was developed to evaluate each street segment in the city based on policy factors, proximity factors (access to schools, parks, transit, neighborhood shopping), and pedestrian environment variables (land use mix, number of destinations, street connectivity, pedestrian scaled development, and topogra-

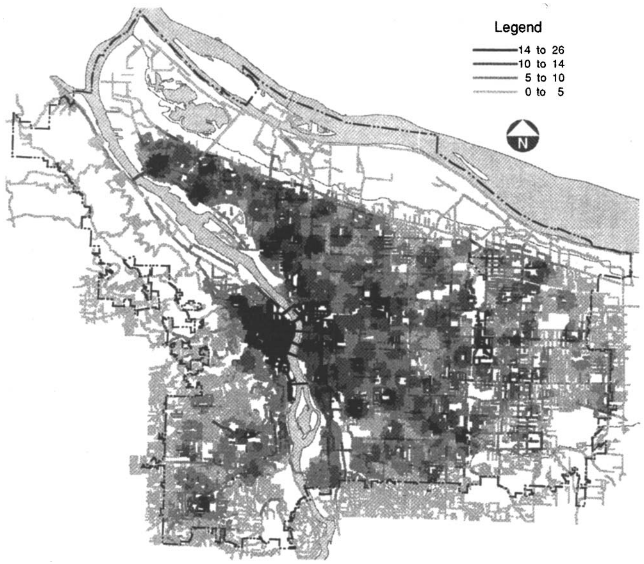


Fig. 8. Map of pedestrian potential index, Portland, Ore. (*Portland Pedestrian Master Plan*; with permission, City of Portland Office of Transportation)

phy (Fig. 8). Another measure, the Deficiency Index, identified problems for pedestrians in each street segment based on missing sidewalks, pedestrian–automobile crash locations, traffic speed, traffic volumes, roadway width, and lack of connectivity based on block length. When applied to each street segment in the city, the indices reveal patterns of potentials and needs. Policies and plans were then based on these analyses.

Second, standards and regulations need to be revised to promote the walkable city including street design standards to support walking, zoning for mixed land use, parking standards, and subdivision standards. Some headway has been made here with traffic calming guidelines and New Urbanist street designs, but they are still far from the norm (Librett et al. 2003; Untermann 1990; Southworth and Ben-Joseph 2003, 2004).

Third, research on walking behavior in varied urban environments and among different social groups is needed to understand which design factors are most effective in promoting walking. Design experiments in which selected variables are manipulated would be particularly informative. Walkability criteria also need to be refined and tested, especially those that deal with quality of the path context.

Fourth, urban designers and transportation planners need to begin to work together in creative and experimental ways to explore a variety of approaches to enhancing walkability. We can learn from the experience of European cities that have done much to make the city walkable over many centuries (Gehl 1987; Beatley 2000).

Fifth, involvement of the public through educational activities and participation in the planning process will be crucial. City events can be organized to focus on the walking experience. For example, the field of psychogeography, which has origins in the Situationist and Lettrist movements, has used experimental city walks for exploring and discovering the city to promote walking and exploration (Hart 2004). New York City has experimented with a pedestrian safety advertising campaign using vivid posters on bus shelters throughout the city to reduce pedestrian accidents (New York City Department of Transportation, *Safety information*). Many European cities have had education and enforcement campaigns to make motorists, as well as pedestrians and bicyclists more aware of their rights and responsibilities. Toward this end, the European Parliament adopted the *Charter of Pedestrian Rights* in 1988 (Tolley 1990).

Finally, a new generation of transportation and urban planners is needed who view pedestrian access as a necessary and integral part of the total transportation environment. In recent years, there has been a striking shift of interests among graduate students in transportation planning, some of whom now focus on questions related to pedestrian and bicycle planning and design as serious transportation research topics. At the same time, academic programs in transportation planning, urban design, city planning, and public health need to promote a dialog between the fields to break down the barriers that have built up between the disciplines. Interdisciplinary and joint degree programs should be encouraged to produce more broadly educated professionals.

To create the walkable city in the automobile age, emphasis will need to shift from almost total auto orientation, to acceptance and promotion of pedestrian and bicycle access at all levels. The regulatory environment will need to shift toward encouragement of walkability, and the design and planning professions will need to work toward creation of integrated pedestrian access at all scales of movement. The tasks are challenging but the benefits for urban life will be substantial. A focus on the walkable city will transform the way we live in fundamental ways, benefiting human health, social relations, and the natural environment.

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