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Chapter 16

Pedestrian Zones

Elif Ebru Sisman

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http://dx.doi.org/10.5772/55748

1. Introduction

Walking is the oldest form of human transportation. With the exception of devices to enhance the mobility of the disabled, walking demands no special equipment. Thus, walking is the most affordable and accessible of modes. Walking is clean, easy on the infrastructure, healthy for the individual and integral to community livability. People who walk know their neighbors and their neighborhood. A community that is designed to support walking is livable and attractive.

Every trip begins and ends as a pedestrian action, so everyone is a pedestrian at regular and various times and places in their lives. Pedestrians can be grouped in a similar manner as cyclists, but the classifications have less effect on facility design. Adult commuters walk daily to work or college, and require reasonably direct routes to keep travel time down. General pedestrians include all people who are walking through shopping and service areas, from home to a friend's house, and typically on short, purposeful trips. They require safe access to multiple services. Special pedestrians include children and those with impairments. This group may require special facilities or assistance when traveling, and facility improvements for these travelers are generally helpful to everyone. No matter what type of pedestrian or purpose of trip, however, all pedestrians have basic needs. Safety is the primary need for pedestrians, who are often the most exposed to the dangers of high speed traffic. A safe system includes designated separate space for pedestrians that is free of potentially dangerous obstacles and keeps the pedestrian visible to other traffic. Width and surface of facilities is important depending on setting. Urban areas should have solid surface walks with adequate room for many users at one time. Only an aware and educated individual will act in a safe manner when presented with the numerous decision points along any given pedestrian route. Information and training programs are essential to any community striving for safe walking conditions. Because automobile traffic is the largest threat to pedestrians, both educational and physical improvements should include drivers.

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Population and urban living is increasing globally. We have to learn to build new and regenerated sustainable cities to address global issues at a local level.

Today, people are restrained from walking comfortably around especially in the city centre due to rapid urbanization and increasing vehicle traffic. It is socially, aesthetically and economically important to provide people restrained by the urbanization movements with open spaces that are secure, comfortable, partly or totally cleansed from vehicle traffic. In order to specify the needs and suggestions of people, it is important to incorporate them into the processes of planning and designing pedestrian spaces which target to revitalize the historical urban fabric.

2. History of Pedestrianization

In ancient times, the basic form of transportation was to walk. The relationship between urban design and transportation dates back to ancient times. City design in the ancient cities of Mesopotamia, Egypt, and India stressed the laying out proper roads and triumphal avenues as a key ingredient for good design. Later, Greeks and Roman stressed the importance of laying out adequate roads (Sen, 1999).

Beginning the ancient times, pedestrian zones have been the mark of bustling, prosperous cities. Past civilizations banned vehicular and animal traffic from crowded areas, because of reduce pollution, alleviate congestion in the interests of safety and order, and create aesthetically pleasing urban areas. Until the automobile age, two types of pollution from vehicles were noise and manure (Rosen, 2006).

In the classical age, the order minded Romans used the pedestrian zones to solve design problems throughout their empire. During the middle Ages, Northern Italy was the most heavily urbanized area of Europe, claiming Europe's largest and wealthiest cities (Rosen, 2006). Street design became an integral feature of Roman cities, which had paved streets with elevated sidewalks. Concern for aesthetics of street design resurfaced during the Renaissance in fifteenth century Europe (Sen, 1999). The density of the industrial revolution greatly exacerbated the problems stemming from city life. Some of municipal government prohibited cart and wagons transporting merchandise on selected central streets during most daytime hours (Rosen, 2006).

Since the Second World War, down towns in which automobile access was restricted retained or saw increased activity for more often than downtown areas which were not pedestrianized. The modern pedestrian zone was born in Kassel, Germany, at the close of Second World War. With 80% of the city destroyed, urban planners saw once-in- a-lifetime opportunity.

Over the next few years, most German cities and many in other European countries built pedestrian zones.

The Dutch invented a compromise pedestrian zone for residential areas, known as the woonerf that is popular throughout northern Europe. Cars and pedestrians share the

roadway. Pedestrians are the priority users the area. Automobiles are permitted at all times provided they do not exceed walking speed.

3. Definition of pedestrian zones

Happy and healthy living in towns is related to the extent that town's open green space system is enough for the requirements. Today, pedestrian zones have been achieved to increase rapidly disappearing open space and to provide comfortable and safe circulation for pedestrians.

A pedestrian zone is simply an area where vehicles are restricted and reserved for pedestrians who are free to occupy the entire space. The zone entrances and exits are often designated with signage to make all users of the road aware when they are entering or exiting such an area.

As pointed out by Rubenstein (1992); three types of pedestrian malls have commonly been implemented in the United States. The first type consists of a traditional pedestrian street designed for exclusive pedestrian use (Full mall) (Figure2). The second type is the shared mall that permits limited automobile use such as one lane of one-way traffic (Semi mall) (Figure3). The third type is the transit mall which accommodates both pedestrian and transit use (Figure 4).



Figure 1. Pedestrian Zones (Budapest, Hungary)

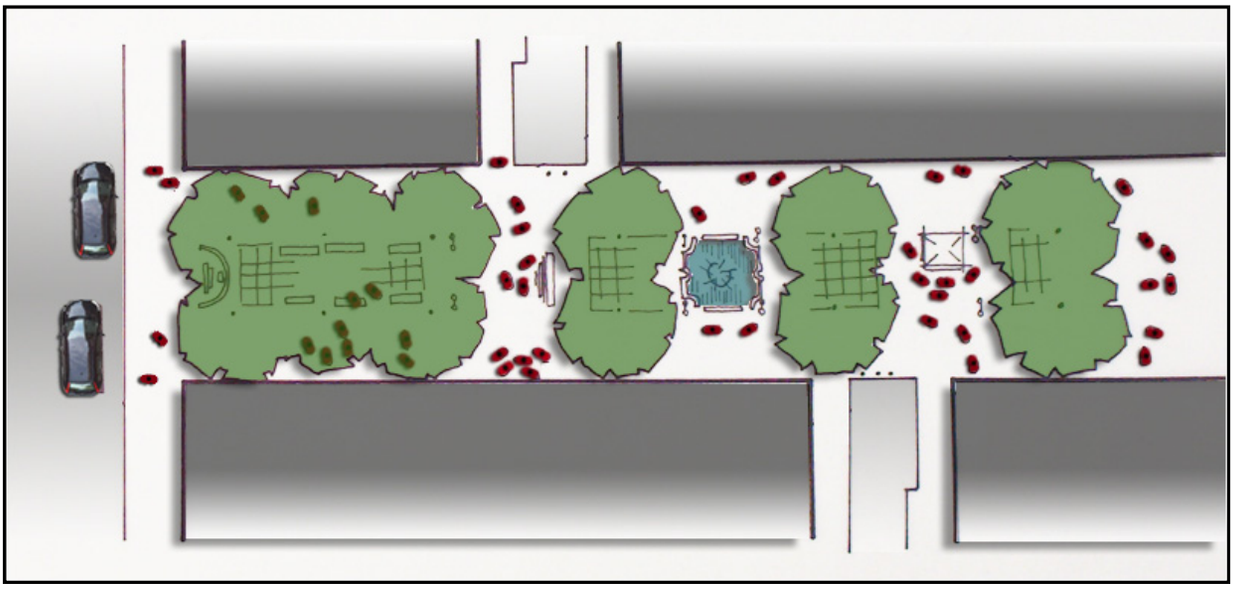


Figure 2. Full mall

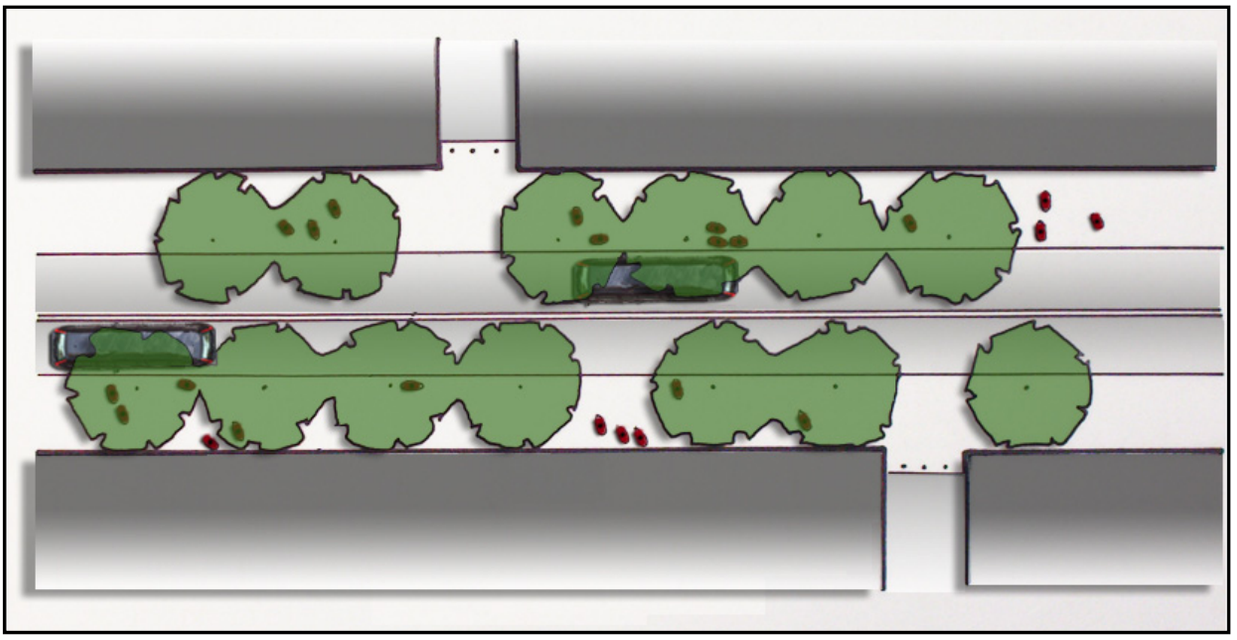


Figure 3. Transit mall

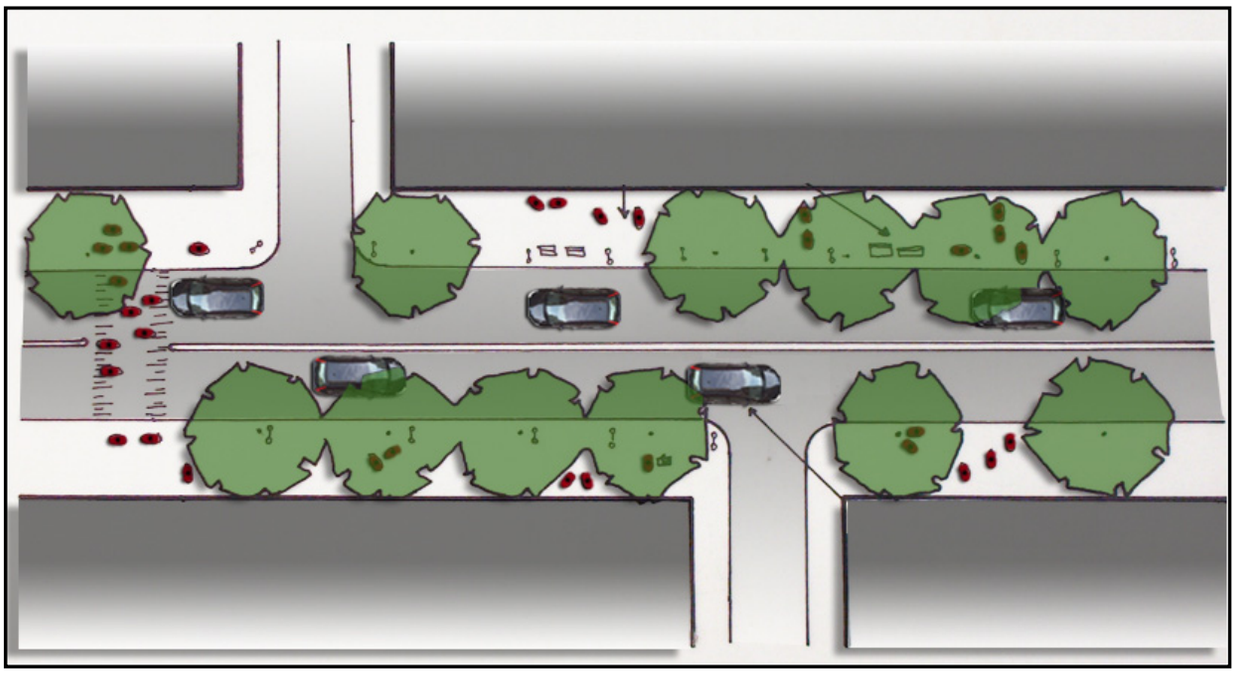


Figure 4. Semi-mall

Research shows that pedestrian zones have some of characteristics (Melia et al, 2010; Ornetzeder et al, 2008).

Characteristics to the development of pedestrian zones were:

- high rates of walking and cycling.
- more independent movement and active play amongst children
- less land taken for parking and roads - more available green or social space
- very low levels of car use, resulting in much less traffic on surrounding roads

The main benefits found for pedestrian zone developments:

- Low atmospheric emissions.
- Low road accident rates.
- Better built environment conditions.
- Discouragement of private car and other motorized vehicles (measure of travel demand management).
- Encouragement of active modes.

The main problem of pedestrian zones is related to parking management. Where parking is not controlled in the surrounding area, this often results in complaints from neighbors about overspill parking.

4. Principles for pedestrian facility design

Landscaping can add value to the aesthetics of the walking environment but they must be placed carefully since high shrubs and trees might also obscure from view (of drivers) the

presence of vulnerable road users such as children (O'Flaherty, 1997; IHT, 1997). However, strategically located trees and greenery can be used instead of bollards to act as a marking for the entrance to the pedestrian area. Innovative design concepts can be used to hide roadside utilities from view to form a seating area for pedestrians (KonSULT).

The following design principles represent a set of ideals which should be incorporated, to some degree, into every pedestrian improvement. They are ordered roughly in terms of relative importance (Portland Transportation Office, 1998)

1. The pedestrian system should be safe. Sidewalks, walkways and crossing should be designed to minimize conflicts with motorized and non motorized vehicle traffic, minimize tripping hazards and protruding objects, and promote a reality and perception of personal safety (Figure 5).



Figure 5. Safety in pedestrian zone (Canakkale, Turkey)

2. The pedestrian system should be accessible to all. Pedestrians of all ages and ability levels need to be able to safely and conveniently travel on foot or with a mobility device.
3. The pedestrian system should provide direct and convenient connections.
4. The pedestrian system should provide comfortable place to walk (Figure 6).
5. The pedestrian system should enhance the public realm of the city. The pedestrian system should be designed not only to serve a transportation function, but also to provide public spaces that enhance community, interaction, economic vitality, and the image of the city. Good design should enhance the look and feel of the pedestrian environment. The pedestrian environment includes open spaces such as plazas, courtyards, and squares, as well as the building facades that give shape to the space of the street (Figure 7). Amenities such as street furniture, banners, art, plantings and special paving, along with historical elements and cultural references, should promote a sense of place.



Figure 6. Comfortable pedestrian zones (Canakkale, Turkey)



Figure 7. The basilica on Szent Istvan Squares (Budapest, Hungary)

6. Pedestrian improvements should be cost-effective and financially sustainable.
7. The pedestrian environment should be used for many things. The pedestrian environment should be a place where public activities are encouraged. Commercial activities such as dining, vending and advertising may be permitted when they do not interfere with safety and accessibility (Figure 8).



Figure 8. Sidewalk (Budapest, Hungary)

Pedestrian safety, accessibility, mobility and comfort are enhanced by:

- Slower traffic speeds
- Fewer traffic lanes
- Narrower traffic lanes
- Shorter street crossing
- Clear visibility between pedestrian and vehicle at intersections
- A buffer from traffic provided by winder sidewalks, curbside bike lanes and street parking
- Tighter corner radii

- Space in the sidewalk corridor for trees planted boulevards, transit shelters, and other street furniture.

5. Pedestrian zone design

The pedestrian zone should be organized into four distinct subzones that maintain an accessible walking path and organize the placement of elements. The four subzones are the; Kerb Zone, The Planting/Street Furniture Zone, the Through Walk Zone, and the Frontage Zone (Figure 9). Minimum subzone dimension is given in below Table 1.

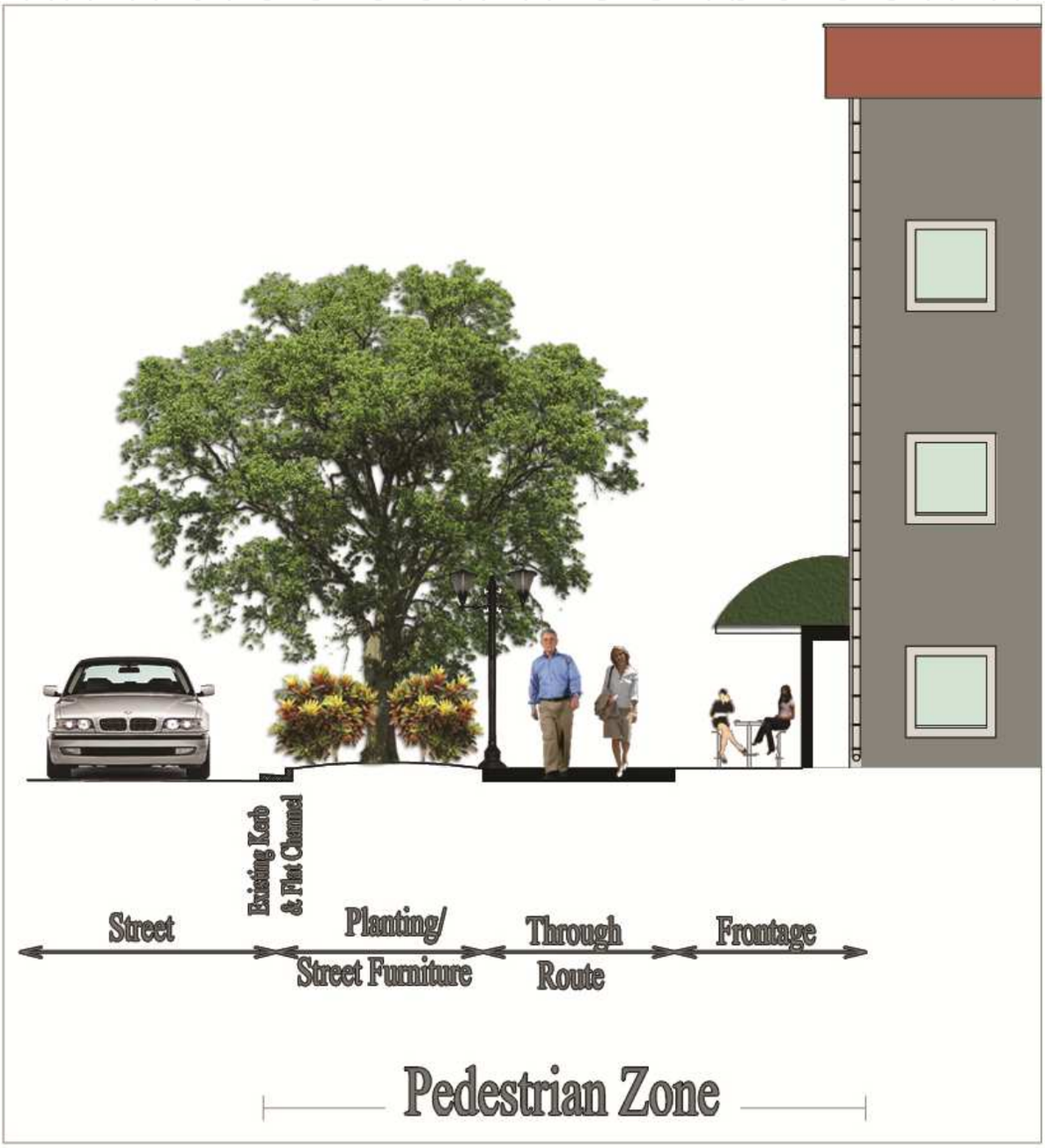


Figure 9. Subzone of Pedestrian Zone

Location	Max. Pedestrian flow	Zone				Total
		Kerb	Planting/Street furniture[#]	Through route	Frontage	
Arterial roads in pedestrian district	80 p/min	0.15m	1.2 m	2.4m+	0.75 m	4.5m
CBD						
Alongside parks, schools and other major						
Local roads in pedestrian district	60 p/min	0.15 m	1.2 m	1.8 m	0.45 m	3.6 m
Commercial/industrial areas outside the CBD						
Collector roads	60 p/min	0.15 m	0.9 m	1.8 m	0.15 m	3.0 m
Local roads in residential areas	50 p/min	0.15 m	0.9 m	1.5 m	0.15 m	2.7 m
Absoulute minimum*		0.15 m	0.0m	1.5 m	0.0 m	1.65 m
[#] Consider increasing this distance where vehicle speeds are higer than 55 km/h						
*Only acceptable in existing constrained conditions and where it is not possible to reallocate road space						

Table 1. Minimum Subzone dimensions (NZ Transport Agency, 2009)

6. Kerb zone

The zone is comprised of the top of kerb adjacent to the side walk. The kerb used primarily for drainage and discourage motorists from driving onto the pedestrian zone. The zone prevents roadway water run-off entering the footpath. The zone defines the limit of the pedestrian environment.

7. The planting/Street furniture zone

The zone creates a psychological buffer between motorized vehicles and pedestrians. The zone contains trees, signs, street lights, seats and parking meters, bicycle parking and other furniture. Trees benefit from as much space as possible. The minimum width required for tree planting is 4 feet; yet this is not desirable for long term tree health and vitality.

8. Through route (or clear width)

This area should be kept free of obstructions at all times. The area contains the basic sidewalk width or clear area for pedestrian travel and is sized to provide for two directions of pedestrian travel. The area should have a safe and accessible walking surface and free of vertical obstructions and protruding objects (Figure 10,11).

The width of the footpath is dependent on the location, purpose and expected demand. The operating space for pedestrians with impairments or mobility devices needs to be considered. The minimum and desired width for the pedestrian through-route zones in various situations are summarized below. Wider path widths should be provided where possible, rather than simply designing for the minimum through-route width (Department of Transport, 2012).

- 1.2 m is the absolute minimum through-route width allowing passage for a single wheelchair (this minimum width should only be used for a short distance in constrained environments).
- 1.8 m is the desired minimum path width (1.5 m absolute minimum) to allow for two wheelchairs to comfortably pass, widened to 2 m near schools and small local shops.
- 1.54 m wide clearance should be maintained between a bus shelter and the kerb, as specified in the Public Transport Bus Stop Layout Guidelines, where insufficient space is available the absolute minimum through route width is 1.2 m.
- 2.4 m desirable minimum through-route width(or higher based on demand) for commercial or shopping environments
- In busy alfresco dining areas such as the central city area, a minimum through-route of 3 m - 4 m should be provided, reduced to 2.5 m in areas with less pedestrian traffic.

9. Frontage zone

The zone is the space at the edge of walkway adjacent to property line. The area that pedestrians naturally tend not to enter, as it may contain retaining walls, fences, pedestrians emerging from buildings, 'window shoppers' or overhanging vegetation.

The Frontage Zone may also be used as a secondary area for plantings, street furniture and social activities.



Figure 10. Without a Through Pedestrian Zone, the sidewalk corridor loses its essential function (Tekirdag,Turkey)



Figure 11. The Through Pedestrian Zone is the area of the sidewalk corridor intended for pedestrian travel (Canakkale, Turkey)

10. Planting of pedestrian zone

Plantings in the pedestrian zone should create desirable microclimates and should contribute to the psychological and visual comfort of users.

Planting design and plant choices for areas surrounding pedestrian areas play a big role in the overall appearance and environmental impact of the pedestrian area installation or new development. Trees and other landscaped areas near streets, sidewalks, and parking lots can reduce storm water runoff and adverse impacts to water resources. Trees and vegetation intercept rainfall, and the exposed soils associated with plants absorb water that will be returned to ground water systems or used by plants.

Use of native plants and shrubs help restore our natural ecosystems and help insure the survival of the full range of wildlife native to the area.

Planting trees in the strip of land between sidewalk and the edge of the road can be attractive and provide a security buffer between pedestrians and automobiles. But this strip of land is referred to by professional arborists as "the death zone" because it is so hostile to trees.

The absolute minimum width of the planting strip should be fully 1.2 m. A planting strip of 3 m in width is much more reasonable. This gives enough mass and strength to the trunk to shrug off snow loads, and should be tall enough to be upbranched to provide clearance for pedestrians and vehicles.

Evergreen plants are not suitable for sidewalk planting except in very rare circumstances, such as behind a sidewalk for a buffer hedge. They tend to be low branched, causing

clearance problems, they cast shade in winter, causing icing problems, and most are very salt intolerant (Figure 12).



Figure 12. Evergreen plants are not suitable for planting (Tekirdag,Turkey)

The tree stock in any one area should not exceed more than 10% of any one species. Monocultures can lead to widespread tree loss when the population is attached by an alien invasive insect or disease.

Trees and vegetation help cool urban climates through shading and evapotranspiration. Trees will provide shade and, if placed between the sidewalk and the road, an additional level of pedestrian protection (US Environmental Protection Agency).

Planting materials should be chosen which provide visual interest, support the local ecology, require little or no watering or maintenance, and make the pedestrian experience more pleasant. Care should be taken to choose plants whose growth will not create obstructions for the pedestrian nor damage the sidewalk (as certain tree roots may do).

Grass is generally the easiest and least expensive to install but may be harder to maintain over time where mowing is difficult, such as on slopes or near walls. Alternatives should be considered, especially when caretakers can be identified who can provide plants and/or who will care for the area until plants are established (i.e. the property owner or a neighborhood group).

A mix of native, low-growing ground covers will provide an alternative to grass that will not need mowing or frequent watering to survive and remain attractive. Flowers and leaves from native plants will also provide food and habitat for insects that contribute to the natural life cycle of butterflies, birds, and bees, and therefore play indispensable roles in the health of our environment.

The nature of the planting materials should be in keeping with the site. Mown grass or compact shrubs may be more in keeping with a commercial district or town center. Wildflowers and grasses may be suitable for certain residential areas and more open landscapes. Larger shrubs can be placed to block undesirable views while not obstructing important sight lines or snow clearing.

Street trees are a significant component of the green areas, and deliver (social, economic and environmental) benefits to the city. Studies of urban trees benefits tend to categorize them as either: social (including both human health and well-being, deeper spiritual and psychological significance); economic and environmental (including ecological benefits) (Sommer and Sommer, 1989; Tarran, 2006; Flannigan, 2005). Street trees have aesthetic value and attractiveness. Tree size is an important variable within this with the general preference for large, spreading, globular or round trees. Height has also been found to be an important variable (Kalmbach and Kielbaso, 1979; Williams, 2002).

11. Social benefits

The planting of street trees can provide an opportunity to promote the importance of preserving remnant vegetation and the need to plant more trees in the urban environment. Trees can improve the aesthetic of a streetscape thus encouraging walking and increasing the chance of social encounters and providing health benefits. A well designed and connected road and path network will optimize walking trips and all abilities access. Planting in the nature strip delineates the pedestrian space from the vehicular space which improves the sense of safety.

Furthermore, tree canopies engender a human scale to the street helping to slow vehicles and create a more pleasant street environment. Trees form a significant component of the cultural and historical value of an area. Protection of existing trees will ensure a legacy for future generations. Trees soften the harsh angularities of urban structures, aid healing and help satisfy the need to recognize seasonal differences. Street trees can enhance historical areas with plantings that are appropriate to the particular historical period and reflective of local residential garden and park plantings. A sense of place and local identity can be created by trees for local residents and visitors to the City. Direction and movement can be emphasized by trees. By manipulating planting arrangement and spacing to provide a continuous visual experience, trees can emphasis direction and movement.

12. Environmental benefits

Trees can improve local microclimate, and reduce the “urban heat island effect” where the air and surface temperature of urban areas are much higher than these of surrounding rural or forest areas. Trees naturally purify the air by diluting and absorbing pollution and collecting airborne particles on their leaves. Trees also reduce carbon dioxide gas in the atmosphere by direct absorption and oxygen gas production. Furthermore, the provision of pleasant street environments will encourage more walking, potentially reducing the number

car trips taken and pollution produced. Trees can provide seasonal shade for pedestrians, cyclists and motorists and reduce the light reflection or glare from buildings and other surfaces. Trees assist in reducing the extreme temperatures by trapping heat in winter and by filtering heat and increasing the humidity during summer. Trees are ideal for reducing wind velocity in streets. The porous structure of trees allows them to temper turbulence and reduce wind tunnel effects without creating eddy currents that can occur against solid structures. Linear plantings of appropriate native trees act as valuable flight paths and habitat corridors for birds and small native mammals and provides shelter, food and nesting hollows (Moonee Valley City Council 2007).

The visual and aesthetic benefits of street trees as usually classified under social benefits, but appear to have received less attention in recent years with the focus on quantifying the measurable social, economic and environmental services provided by the urban forest. These somewhat "intangible" benefits may be less well understood, and less easily measured by researchers from the biological or social science with little research published by landscape architects and urban designer (Ely, 2010).

13. Economic benefits

Improved amenity and connectivity of the street network, (particularly walking routes between public transport and major activity centers) can support and improve the viability of commercial activities within the City. Street trees and in particular avenue plantings are known to markedly increase property values and to attract industry and new residents to the City. Appropriate street tree planting along commercial strips can improve the economic viability of the strip by improving customer comfort and therefore business diversity.

Street trees can reduce energy expenditure by providing shade to houses and cars and reducing energy consumption. Other aspects of street trees which have been considered in the development of this Strategy include litter drop, lifting footpaths and other property damage, obstruction of sight lines for traffic (especially when trees are young), blocking views and light, competition with other vegetation such as grass or garden plants, and potential to exacerbate allergies (Moonee Valley City Council 2007).

Acorrding to O'Brien (1993) identifies a number of functional and aesthetic contributions to urban streetscapes. Street trees; (Ely, 2010)

- Creating or reinforcing identity in a street (Figure 13)
- Complementing historic or culturally significant buildings or streetscape (Figure 14)
- Enhancing pedestrian or vehicular orientation legibility and way finding. Street trees can emphasize direction and directional change by accentuating road lines (Figure 15). They can emphasize a sense of movement, and their spacing can be manipulated to create a desired ambience, with closer spacing emphasizing a sense of speed. Trees can also be used to emphasize road junctions and focal points, and to reinforce the hierarchy of streets within the city.

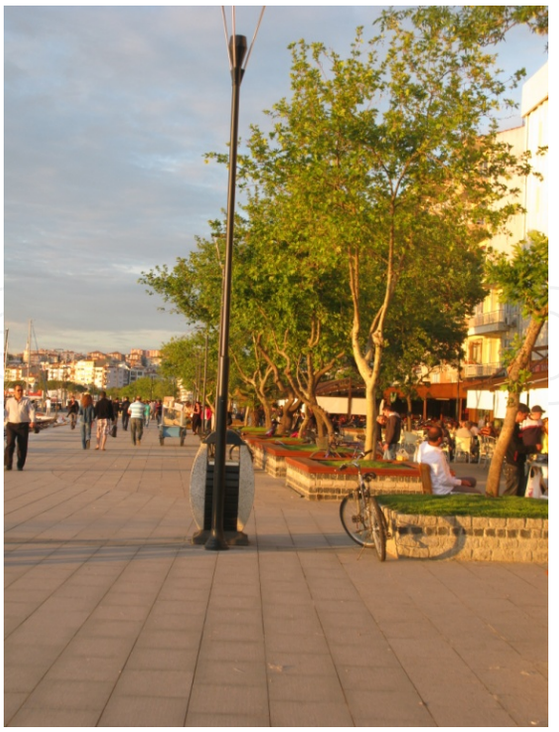


Figure 13. Trees reinforcing identity in a street (Canakkale, Turkey)

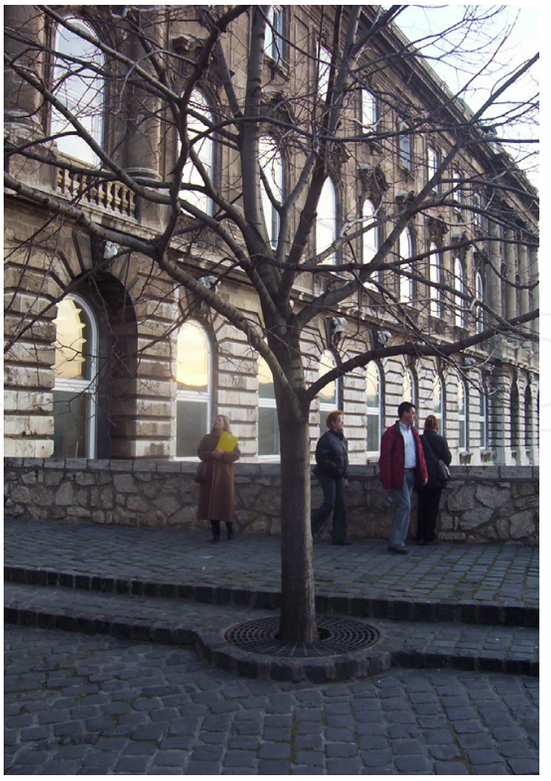


Figure 14. (Budapest, Hungary)



Figure 15. Street trees can emphasize direction and directional change (Tekirdag,Turkey)

- Trees can play a symbolic or monumental role, for example in major boulevards and city gateway (Figure 16).



Figure 16. Tree's Symbolic or monumental role (Burgaz, Bulgaria)

- Enhancing visual amenity through screening unsightly views, softening the mass of large buildings, and reducing the apparent width of streets (especially if trees are planted adjacent to the kerb) (Figure 17).



Figure 17. Enhancing visual amenity through screening unsightly views (Burgaz, Bulgaria)

- Providing visual interest, color and a sense of movement in urban setting (Figure 18).



Figure 18. Providing visual interest (Burgaz, Bulgaria)

- Providing awareness of seasonal change
- Providing a ***sense*** of human scale by creating smaller space within the wider streetscape, both vertically (by creating "walls" of tree trunks), and horizontally (by creating "roofs" of tree canopies) (Figure 19, 20).



Figure 19. Street plants create a space by trunks and canopies(Tekirdag,Turkey)



Figure 20. Creating "walls" of tree trunks (Balchık, Bulgaria)

- Providing clear spatial definition in streets, for example by separating pedestrian and vehicular zones, both physically and psychologically (Figure 21).



Figure 21. Street trees separating pedestrian and vehicular zones (Tekirdag,Turkey)

- Most significantly, street trees can provide a unifying element in an often visually diverse and sometimes chaotic urban streetscape.

14. Street tree selection

The choice of tree for a particular street or area is guided by a wide range of factors, including the ability of the species to withstand various environmental and physical constraints as well as the type of street environment that is to be created or preserved. These factors include (Moonee Valley City Council 2007):

Existing tree planting

- Species type
- Location (nature/median strip, road, path)
- Planting density (number of gaps)
- Quality (age, form etc)

Street reserve

- Road reserve width
- Presence and width of footpath
- Presence and width of nature strip and median strip
- Overhead or underground services

Other notable features

- Surrounding land use (residential, commercial, industrial, open space)
- Planting limitations (retail strips, narrow reserves)
- Stage of housing development (in new residential areas)
- Connections to nearby public open space
- Parking and traffic limitations
- Site topography and quality of views
- Proportion of recent plantings

Proposed tree species

- Physical characteristics (height, spread, shape, ornamental value, etc)
- Evergreen or deciduous
- Rate of growth and longevity
- Resistance to pests and diseases
- Tolerances to climatic conditions (periods of drought), soil compaction, poor drainage, pollution, tree pruning and damage caused by vandalism
- Degree of limb shed
- Value of tree as a wildlife habitat

Latin name	**Latin name**	**Latin name**
Acer campestre	*Corylus colura*	*Quercus rubra*
Acer negundo	*Ginkgo biloba*	*Quercus cocinea*
Acer platonoides	*Gleditsia triacanthos*	*Tilia tomentosa*
Acer pseudoplatanus	*Ligustrum ovalifolium*	*Robinia pseudoacacia*
Aesculus carnea	*Liriodendron tulipifera*	*Robinia pseudoacacia 'Umbracaulifera*
Alnus cordata	*Morus alba*	*Schinus molle*
Betula pendula	*Platanus orientalis*	*Sorbus araia*
Catalpa bignonioides	*Populus sp.*	*Ulmus glabra*

Table 2. Suggested Sidewalk Plants

15. Maintenance of street tree

Street tree maintenance includes the inspection, pruning, removal and replacement of trees.

Pruning

Street trees are to be pruned using a combination of hazard reduction pruning and maintenance pruning objectives (Figure 22).

Hazard Reduction Pruning

Primary objective is to reduce the danger to a specific target caused by visibly defined hazards in a tree. Hazard pruning consists of the removal of dead, dying, diseased, decayed and obviously weak branches, two inches in diameter or greater.

Maintenance Pruning

Primary objective is to maintain or improve tree health and structure. Maintenance pruning may include one or all of the pruning types, crown cleaning, crown thinning and crown raising.

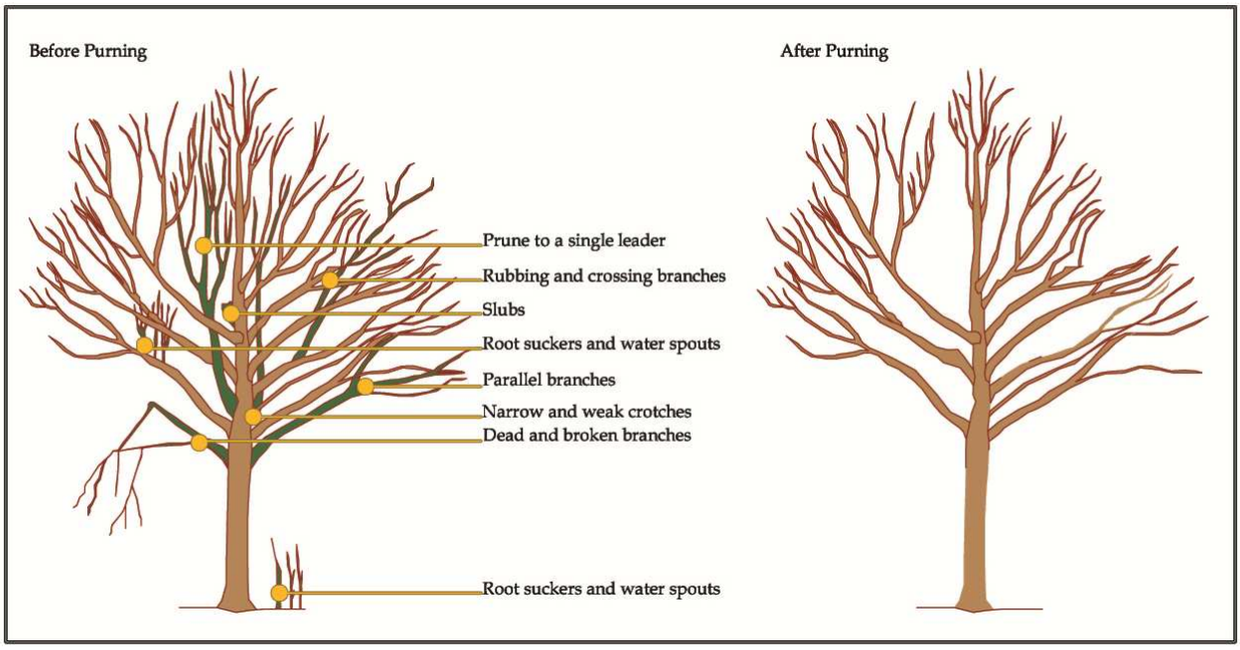


Figure 22. Pruning of trees

16. Types of pruning

Crown Cleaning – Consists of the selective removal of one or more of the following items; dead, dying, diseased, or weak branches and water sprouts from a tree's crown.

Crown Thinning – Consists of the selective removal of branches to increase light penetration, air movement and reduce weight.

Crown Raising – Consists of the removal of the lower branches of a tree in order to provide clearance for pedestrians and vehicles. Crown raising should be performed with the intent of providing clearance of eight feet over sidewalks and thirteen and one half feet over streets. A crown to trunk ratio of two thirds to one third should be maintained. Care must be taken to eliminate vision obstructions of oncoming traffic, stop signs, stop lights, street signs, school signs, traffic signs and any other signs or lights that affect public safety.

Crown Reduction – Consists of removing limbs to reduce the height and/or spread of a tree. Crown reduction pruning should only be done in situations where branches interfere with utility lines, where there has been significant crown dieback, or due to storm damage it is appropriate to prune for safety and aesthetic reasons (Figure 23, 24).

Crown Restoration – Improves the structure, form and appearance of trees that have been severely headed, vandalized or storm damaged.

Training Pruning – Pruning a young tree to develop a strong scaffold branch structure. Branches that are crossing, interfering with scaffold branches or have included bark should be removed. Large growing branches with narrow attachments may need removed. Low limbs should be removed to provide clearance over streets and sidewalks. Young trees should receive a training pruning at four years after initial planting. Scaffold branches should be selected with the intent of eventually providing the above mentioned clearances. A crown to trunk ratio of two thirds to one third should be maintained. Care must be taken to eliminate vision obstructions of oncoming traffic, stop signs, stop lights, street signs, school signs, traffic signs and any other signs or lights that affect public safety.

Pruning in late autumn and early winter can lead to winter injury. The pruning wounds may not have time to "harden off" or prepare for winter. This can lead to deeper freezing in the tissues around the wound and in essence a larger wound can be created that the tree will have difficulty dealing with. During the late winter months (February and March), harmful pathogens are at a minimum, mostly inactive; therefore, this is a safe pruning environment from that standpoint. During this season, deciduous trees have hardened off and when the growing season begins the wounds will be sealed and the callusing process will begin.



Figure 23. Incorrect pruning (Burgaz, Bulgaria)



Figure 24. Incorrect pruning (Tekirdag Turkey)

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17. References

Department of Transport, 2012. Planning and Designing for Pedestrians: Guidelines, Western Australia. http://www.transport.wa.gov.au/mediaFiles/AT_WALK_P_plan_design_pedestrians_guidelines.pdf

Design Guidelines for Streets and Sidewalks 2009. Chapter 10: Pedestrian Facility Design Minneapolis. http://www.slideshare.net/Sarah17/chapter-10-pedestrian-facility-design

Ely, M. E., 2010. Integrating Trees Into the Design of the City: Expert Opinions on Developing More Sustainable Practices for Planting Street Trees in Australian Cities, Ph. Thesis, p:483, School of Architecture, landscape Architecture and Urban Design Faculty of the Professions, The University of Adelaide.

Flannigan, J., 2005. An evaluation of residents' attitudes to street trees in southwest England. *Arboricultural Journal* 28, 219–241.

Guidelines for Action Sidewalk Design Transportation Advisory Committee and Town Citizens. http://www.acton-ma.gov/DocumentCenter/Home/View/856

KonSULT, the Knowledgebase on Sustainable Urban Land use and Transport. Institute for Transport Studies, University of Leeds, Leeds LS2 9JT
http://www.konsult.leeds.ac.uk/private/level2/instruments/instrument049/l2_049a.htm

Melia, S., Barton, H. and Parkhurst, G., 2010. Carfree, Low Car - What's the Difference? *World Transport Policy & Practice* 16 (2), 24-32.

Mineapolis Pedestrian Master Plan 2009. Access Mineapolis Ten Year Transportation Action Plan.
http://www.minneapolismn.gov/www/groups/public/@publicworks/documents/webcontent/convert_286149.pdf

Moonee Valley City Council 2007. Street Planting Strategy.
http://www.mvcc.vic.gov.au/forresidents/environmentprograms/~/media/Files/ForResidents/Environment/EW_2008_StreetPlantingStrat_LR.ashx

NZ Transport Agency, 2009. Pedestrian Planning and Design Guide. ISBN 978-0-478-35228-3 (online), New Zealand.

O'Brien, D. 1993. Street Trees for Cities and Towns, Sydney, Imago Press.

Ornetzeder, M., Hertwich, E.G., Hubacek, K., Korytarova, K. and Haas, W., 2008. The environmental effect of car-free housing: A case in Vienna. *Ecological Economics* 65 (3), 516-530.

Portland Transportation Office, 1998. Portland Pedestrian Design Guide City of Portland Office of Transportation Engineering and Development Pedestrian Transportation Program. http://www.portlandoregon.gov/transportation/article/84048

Rosen, S.B., 2006. The success and failure of pedestrian malls in Europe and America. Senior Project, City and Regional Planning Department California Polytechnic State University San Luis Obispo.

Rubenstein, H.M., 1992. Pedestrian Malls, Streetscapes and Urban Spaces. John Wiley&Sons, Inc.

Sen, S., 1999. Toward A Typology of Transportation-Related Urban Design Problems and Solutions: Case Studies of Small And Medium Sized Cities ın The Eastern United States. National Transportation Center Morgan State.

Sommer, R. and Sommer, B., 1989. The factor structure of street tree attributes. *Journal of Arboriculture* 15, 243–246.

US Environmental Protection Agency, Heat Island Effect, See:
http://www.epa.gov/heatisland/mitigation/trees.htm

Tarran, J., 2006. Trees, Urban Ecology and Community Health. TREENET Proceeding of the 7th National Street Tree Symposium: 7th-8th September, Adelaide, TREENET Inc.

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