PEDESTRIAN CIRCULATION SYSTEMS IN CANADA

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This paper is concerned with delineating the conceptual aspects of planning for pedestrians and documenting the nature and extent of pedestrian circulation systems in Montreal, Toronto, and Calgary. Conceptual aspects are discussed within the planning framework and the Canadian context. The developments in Montreal, Toronto, and Calgary are discussed in detail. System characteristics, configurations, concepts, and linkages are described. Canadian experience appears to indicate that the theoretical concepts of pedestrian-vehicle segregation advocated for many years are being incorporated as planning principles. It would also appear that the state of pedestrian circulation planning and design in Canada is still a very empiric art. It seems apparent that no attempt has been made to evolve methods of benefit-cost analysis or determine optimum user-cost criteria. Although the surface road and sidewalk systems are built at public expense, it is assumed that private developers must pay for all or part of the segregated pedestrian systems. In all the three cities discussed, adequate linkages with the public transport system are being included. Although the general tendency seems to be to design underground pedestrian systems, above-ground systems are also being tried.

•PLANNING for the safety of pedestrians and pedestrian facilities has been a longstanding and worldwide problem. Urban traffic congestion is not peculiar to any specific geographical location or historical period; it appears in a variety of forms, and its universality suggests underlying factors that are only partially related to modes of transportation. The basic causes of urban traffic congestion appear to be excessive crowding of population and economic activity into small areas of land and a disorderly arrangement of land uses that has maximized transport requirements. The great bulk and density of urban buildings and the concentration of employment in the central business district have created a volume of passenger and freight movement that has become increasingly difficult to accommodate effectively regardless of transportation methods. The congestion of people, horses, and streetcars before the appearance of motor cars, the rush-hour madness of New York subways, and the lines of automobiles inching their way through traffic arteries are all manifestations of a continuing imbalance between transport demand and available transport capacity (1).

Today, the central business district by its very nature presents a challenging pedestrian pattern. The densities, diversification, and variety of physical development and economic activity provide a mixture of movements, both by foot and wheel, that makes the downtown configuration a composite of interrelated and interwoven patterns of activity. A pedestrian trip may be a terminal trip (the final leg of the trip in origin to destination), or it could be a separate pedestrian trip only. It may be for work, for pleasure, or for shopping. The pedestrian may be using the same streets, sidewalks, and routes for different types of trips during different times of the day or night, during different seasons, or under different circumstances of weather. The increasing densities of urban development and the increasing tempo of economic activity within the central business districts, combined with this tapestry of pedestrian movements, provides a challenge for planners and urban developers.

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Concern for pedestrian safety and the demand for higher environmental quality within the central business district emphasize the need to reexamine concepts of planning for the pedestrian and methods of urban design in major urban centers. The concept of a safe, separate, and exciting environment for walking is not new. Rudofsky points out that the problem of designing for pedestrian safety is of ancient origin. The covered street for pedestrian use only dates back to the Roman Empire and has survived in European cities to the present day (2). Ritter points out that vehicles were prohibited in the Forum at Pompeii, rebuilt 1900 years ago. It was designed as a super-block with seven culs-de-sac closed by bollard-like slabs. The size, speed, and scale of chariots and horses were already incompatible with certain pedestrian needs and functions related to social gatherings in the open. Segregation of pedestrians and vehicles was decreed by Julius Caesar in 46 B.C. in his Lex Julia Municipalis, which forbade heavy wagons within the limits of continuous habitation from dawn to dusk (3, 4). It is interesting to note that the design concepts used in Pompeii centuries ago are very similar to those used most recently in the new town of Stevenage in England. The architectural sketches developed in the 15th century showing vertical segregation of vehicles and pedestrians by Leonardo da Vinci were used in Adelphi by the Adams brothers.

Ritter and Rudofsky have both documented the significance of the concepts underlying the design of European city centers that have catered to vehicle-pedestrian segregation and coordination. To a large degree this has enhanced the environmental quality of older European cities compared to the drab, vehicle-clogged North American urban environments. The central business districts of most major cities in Canada and the United States are jam-packed with cars that are capable of speeds of more than 70 mph but actually move, on the average, at the approximate rate of a horse-drawn carriage used 100 years ago. Utterly inefficient as transport under present circumstances in city centers, these vehicles have at the same time become barriers to pedestrian circulation and divide the urban landscape with a continuum of metallic appendage.

Cumbernauld, near Glasgow, was the first of the new towns to apply the Radburn principle to segregate vehicles from pedestrians. Victor Gruen's plan for Fort Worth, Texas, visualized a square mile of traffic-free pedestrian precinct in the central business district. The town center of Stevenage includes a completely segregated pedestrian plaza in the city center. One of the largest and boldest examples of trying to achieve pedestrian-vehicle segregation is in the postwar reconstruction of Stockholm, Sweden. The Hotorget, the commercial center of downtown Stockholm, and the Sergels Torg areas provide extensive and well-designed pedestrian piazzas and precincts, completely segregated from all vehicles. West Berlin provides several examples of safe and continuous pleasant environments for pedestrian activity.

PLANNING STRATEGY

Planning Framework

Until 1962, pedestrian planning in Canada's downtown areas was simply a matter of providing adequate sidewalks and some traffic control at intersections. Very little consideration had been given to the dominant influence of major pedestrian trip generators (office blocks and department stores) and the major transport nodes (transit stations, transit stops, terminii, and parking areas). The pedestrian systems had generally followed fixed routes imposed by block and building layouts on streets primarily serving vehicles. Pedestrian systems had been secondary in importance to vehicular traffic systems.

Pedestrian activity does not constitute a major portion of the movements of all goods and persons. Especially in downtown areas, however, pedestrian movement is often the final part of a vehicular trip. These pedestrian movements are also the most flexible in terms of route choice and accessibility. Three aspects of pedestrian circulation are (a) the land use function that must be allocated space, (b) the transport linkage function connecting transportation nodes and downtown functions, and (c) a means of observing the urban environment for view and vistas. The system's purpose must be to move people from origin to destination, and it should not be considered as competitive with other transportation modes but rather complementary to them.

Quantitative Aspects

Pedestrian movement patterns are determined primarily by major generators such as large office-retail complexes and transportation nodes. The keys to the planning and development of the system are the distance and accessibility of these major trip determinants and their impact on the total volumes. These will determine the design capacity of pedestrian facilities, whether they are sidewalks, plazas, or separated systems.

Pedestrian planning to date has been largely on an ad hoc basis, and little work has been done to determine the demand characteristics, the impact of generators, and the development of analytical tools for analysis. Morris and Zisman argue that planning for pedestrians generally depends more on intuition than facts. The yardsticks and gages that have proved quite useful in determining highway needs are generally useless in making comparable analyses for planning for pedestrians (5).

A number of recent studies have dealt with pedestrian flows much in the same way as traffic studies, using origin-destination (OD) surveys, gravity models, and consideration of socioeconomic characteristics. Morris, for example, uses four categories of trip purposes—terminal, business, shopping, and miscellaneous—and proceeds to apply the gravity model techniques to data collected by regular OD techniques (6). Navin and Wheeler studied pedestrian flow characteristics on sidewalks to find patterns of capacity and use in relation to demand (7). Eyles and Spiller have discussed modal choice as it relates to the pedestrian (8).

To make quantitative analysis more meaningful, Stuart (9) suggests a number of questions that these kinds of data could be directed to answer:

1. How well are the pedestrian route locations aligned with the directions of heaviest travel demand? Can the need for any new routes be identified?
2. Which pedestrian routes require further development to resolve pedestrian circulation shortcomings?
3. Which sites within the existing pedestrian networks are preferred locations for the development of additional activities that generate pedestrian movements?
4. What will be the amount and directions of pedestrian travel resulting from the development of new generators at alternative locations? Will any adjustments in the pedestrian network be necessary?
5. What will be the volumes and circulation patterns of pedestrian movement expected from alternative land use arrangements? What types of networks will be appropriate?

Methods of data collection may parallel those of OD surveys used in metropolitan traffic studies. The major concern, however, must be centered on compatible location generators within a given network rather than developing networks for high-capacity, peak-hour operations. In general, the following kinds of information should be sought by pedestrian OD studies:

1. The location, scale, and character of major generators and their relationship to change-of-mode transportation nodes;
2. The scale, character, and purpose of pedestrian trips; and
3. Identification of route preference, choice, and flexibility.

Design Aspects

Before attempting to resolve vehicle-pedestrian conflicts, the preceding information should be gathered and analyzed; unfortunately, the reverse has occurred. The great mall movement was the fad from mid-1955 to 1963 (10). Wolfe has stated that there is a great emphasis on the panacea of the pedestrian mall, and one would hardly be caught with any plans that did not include this element (11).

Vehicle-Pedestrian Coordination—The two obvious solutions to the problem of pedestrian-vehicle conflict are coordination and segregation of vehicles and pedestrians. Most of the efforts in major cities in North American in recent years have been attempts to coordinate vehicle-pedestrian circulations within the same precincts. The techniques of

traffic control currently in vogue represent responses to perhaps the most immediate problem concerning downtown circulation patterns, and the most significant attempts in quality and quantity have been at potential points of conflict between pedestrians and vehicles, particularly at route intersections.

Vehicle-Pedestrian Separation—Blachnicki and Browne argue that segregation of pedestrians and vehicles has now become essential. They state that we have now reached the stage where the extant road, which has changed very little since Roman times, will no longer do the job in the central business district (12). There are three basic ways of separating vehicles from pedestrians: (a) horizontal separation (the Radburn principle and the precinct); (b) vertical separation with the pedestrian underground; and (c) vertical separation with the pedestrian above ground.

The Radburn principle is basically an interlocking system of roads and footpaths that provides the best solution yet devised for residential areas. The precinct, or pedestrian island, method—a solution to the problem in central business districts—gives protection to the pedestrian but requires a great deal of space. Vertical separation has been tried in many cities by means of underground tunnels as well as above-ground skywalks. Blachnicki and Browne have documented several major recent developments that have used segregation as the basic method of design.

Segregation by Time—Segregation by time gives scope in areas where segregation in space is not possible either because of costs or other circumstances. Planning and design in this case are basically a matter of selecting the most suitable streets for this purpose. The grid system of streets used in most North American cities lends itself to segregation by time because parallel streets could accommodate the traffic while some of the streets are closed to vehicles. The selection of the right times for closing the streets depends on the shopping habits and the opening and closing hours of major generators along the pedestrian network. The key to success in this method is the ability to provide reasonable periods for service delivery in the mornings and the evenings. Where this has been possible, the idea of segregation by time is likely to be supported by the pedestrian as well as the owners of businesses along the street. Examples of the success of this method are Gotenburg in Sweden and Picadilly in London.

Environmental Elements

The environmental elements that influenced the planning and design of pedestrian circulation systems can be grouped into five categories, even though these five categories broadly represent only two elements, (a) the relationship of the pedestrian trip generators to the pedestrian network and (b) the details of urban design along the network and the imageability. These two basic elements are substantially interrelated. The physical location and the interrelationships of the generators influence the orientation and the dimensions of pedestrian networks and, to a large degree, determine the essential nature of design details. On the other hand, the planning and location of the pedestrian network itself will influence further opportunities for location and relocation of important pedestrian trip generators.

The five basic environmental elements can be grouped as follows:

1. Movement patterns—safety, comfort, and continuity of the pedestrian network and available alternative route choices;
2. Location of major trip generators—interconnections between the major trip generators themselves and their relationship to the pedestrian network;
3. Nodal elements—change of node points, such as parking areas, transit stations, and transit stops, and recreational areas, such as squares and parks;
4. Historical elements—unique landmarks and distinctive assets of history, architecture, and even topography; and
5. Imageability—urban design facade, view of and from the network, and vista.

These evironmental factors relate to the scale sensitivity and subtleness of those who are to move along the pedestrian networks at a flexible speed with a number of route choices open to them. Physical and biological detail of the urban scene comes into its own for the pedestrian as he moves along his path. The basic structure of the

formation of pedestrian spaces contributes significantly to visual diversity. Major elements, either man-made or natural, within the pedestrian system make possible a differentiation among subareas of the environment (13). This is an important determinant of the environmental character of the network itself.

There is no strong evidence to support the view that totally segregated systems are completely preferred. The choice between separation and coordination appears to be relatively open. However, in urban areas where intensity of pedestrian activity is very high and coordination with existing street patterns cannot effectively be made, the segregated systems appear to have provided a measure of success.

Economic Aspects

The costs, benefits, and community consequences of providing viable and aesthetic pedestrian circulation systems must be evaluated within the framework of the total transportation system. The cost-benefit criteria must also be based on systems alternatives, not on the evaluation of single elements of the system. For example, the segregation of vehicles and pedestrians will obviously result either in higher motor-vehicle handling capacity in the existing streets or in higher comfort and safety both to motor vehicle users and pedestrians. In downtown areas a large percentage of the pedestrians would also be users of other vehicular systems. The traditional tools of cost-benefit analysis applied to highway and street planning have not been used at all in planning for pedestrians, and in fact they may not be relevant.

To date many of the major segregated pedestrian circulation systems in Canada and the United States have been developed in conjunction with major private urban developments. The private-public interaction has been limited to design standards and, to a small degree, attempts to make possible the development part of an overall pedestrian system. Most arrangements for cost sharing between private and public enterprise have been ad hoc and based on circumstantial expediency in which the approval or disapproval of the proposed major urban development (office buildings, shopping centers, department store complexes, etc.) has been the prime objective. It is necessary therefore to evolve methods of cost-benefit analysis that would include an analysis of socio-economic and environmental consequences within the overall framework of the total transportation system. In a sense, civic governments must take the initiative in developing and evolving plans for a total transportation system.

Segregation often involves substantial additional costs, and the questions of who benefits and who should pay are difficult ones to resolve. The system users and the planners can easily see the benefits and change in comfort, safety, aesthetics, and perhaps traffic efficiency in the central business district. These are the factors that encourage and justify the development of pedestrian systems in conjunction with major urban developments. However, it is argued that pecuniary benefits do accrue to commercial establishments, whether existing or proposed, due to greater pedestrian access that results in increased patronage. The cost-sharing arrangements followed hitherto in Canadian cities reflects some realization on the part of civic governments and private entrepreneurs that benefits accrue to both sides and are not mutually exclusive.

To make it possible to develop a total pedestrian circulation system, some control must be exercised over the location and development of major pedestrian trip generators that in turn affect route choices, patterns, and linkages and to a large degree determine pedestrian volumes. The planners should coordinate these developments to the extent that the proposed pedestrian system and the locational characteristics of the major developments are mutually compatible and enhance environmental quality. The provision of related environmental amenities such as mini-parks, plazas, and nodal points must obviously be a civic responsibility.

Choice Limitations

Whether the pedestrian is going to be below or above the level of the motor vehicles is going to be influenced not only by cost-benefit analyses but also by other limiting factors such as topography, existing building design, geology, excavation costs, cost

of relocation of facilities, groundwater levels, aesthetic surroundings, pedestrian psychology, and accessibility levels. Climate and the surrounding vista play very important roles in determining the type of segration that is desirable. For example, in Montreal the initial pedestrian systems utilized below-grade connections, influenced primarily by desire for climate control and subway access. In Calgary, however, the high water table completely rules out any underground pedestrian systems. The view of the mountains and the sea, providing an enviable vista in Vancouver, may rule out underground systems there. All of these choice elements must be a part of the systems analysis that precedes the design and development of a pedestrian network.

THE CANADIAN CONTEXT

Some of the major Canadian cities have been developing segregated pedestrian systems in recent years. The more notable ones are in Montreal, Toronto, and Calgary. It is significant to point out that approximately a fourth of the total population of Canada lives in these three major cities. All of these cities have opted for some type of segregated pedestrian system. This study is an endeavor to document major downtown pedestrian circulation systems in these Canadian cities.

The Montreal System

The Montreal system (Fig. 1) began in 1962 with the construction of Place Ville Marie. Initially it provided a linkage between the below-grade shopping mall and its associated 42-story office tower with the Canadian National Railway Station concourse and the Queen Elizabeth Hotel.

Subsequent large developments in downtown Montreal have incorporated below-grade shopping concourses and provide pedestrian linkages to hotels, offices, and transportation nodes. The existing system is continuous and connects Place Ville Marie, Queen Elizabeth Hotel, Canadian National and Canadian Pacific Railway Stations, Place Bonaventure, Place du Canada, and Hotel Champlain and has connections to Metro Station at Bonaventure. The developers of another adjacent system, Place de la Bourse, Place Victoria, Metro Station Victoria, and the Stock Exchange, are negotiating a connection to the Bonaventure-Place Ville Marie system. Similar schemes, not connected directly but with access via Metro, are at the Morgan's and Eaton's Department Stores, Atwater, Berri de Montiguy, and peripheral Metro stations.

The Montreal system is essentially a below-grade climate-controlled system of enclosed malls and connecting passageways, now totaling approximately 2 miles of passageways and giving direct access to some 40 acres of prime office, hotel, and shopping developments, including 300 underground shops, 50 restaurants, and 2,500 hotel rooms (14). The system is not yet complete, and future developments are proposed connecting Cité Concordia (Marathon Realty's proposed Windsor Station scheme) and other major generators. Some concern is expressed by planners and engineers that the system may develop to be too large and therefore lose its pedestrian-scale characteristics (15).

The 1964 Downtown Report noted that there were interesting possibilities in the Place Ville Marie developments, the subway mezzanines, and the proposed Place Bonaventure complex (16). It was further suggested that Metro stations, integrated with public squares that figure prominently in Montreal development history, might play a polarizing role in the downtown area (16).

The Montreal system was "unplanned"; each developer has initiated his own scheme, including connections under city streets. The original scheme (Place Ville Marie) proponents were Vince Ponte, a project architect, and M. Gariepy, Planning Department Architect; subsequently, many more planners, architects, and developers became involved. The total scheme, though, appears to suffer from its original lack of planning and at many points can hardly be called a system at all. It also suffers greatly from a lack of visual relationship between all the movement systems of the new core (17). Considerable developments have taken place, confirming the ideas of the 1964 Report. The system has always developed on an ad hoc basis, without developmental guidelines or even standards. Recently, however, the City Planning Department has initiated studies

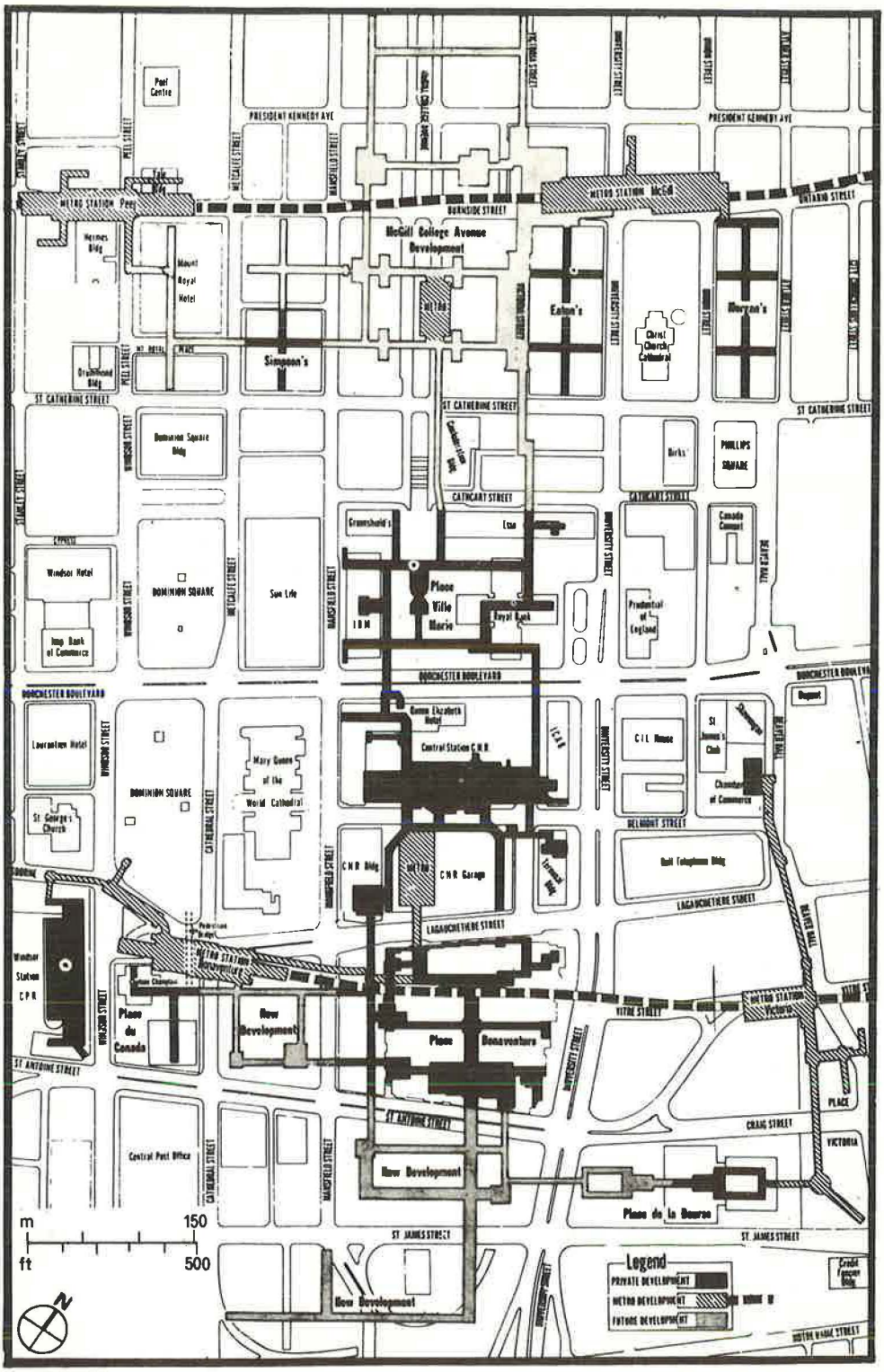

Figure 1. Montreal: segregated pedestrian system.

and developed a concept for the future system. As long as developers are willing to build these systems, the city will permit them.

The apparent success of the existing system, including the Metro system, determines in part that other developers will follow suit. Future plans call for a development, with pedestrian systems, between Place Bonaventure and Place du Canada (Chateau Champlain), with a possible connection east to Place Victoria and Place de le Bourse and extensions north from Place Ville Marie to Sherbrooke, connecting with Peel and McGill Metro Stations. Recently, Canadian Pacific Railway announced plans for a $250-million complex at Windsor Station and the Laurentian Hotel site, with at least three 60-story skyscrapers that would incorporate pedestrian mall systems.

Some thought has been given to development of the system to the south, although again no formal documents or policy exist. The present schemes are all in the newly developing center of the city. Montreal recognizes another axis of downtown life, centering on Place Victoria and the financial center. This is partly "old Montreal" that has been refurbished. It also includes the city administrative center, the new Quebec Palais de Justice, l'Hotel de Ville, and other civic buildings. The proposals for this area call for an elevated pedestrian system to conform more closely with the levels of the newer downtown.

The elevated system is rather controversial. Any advantages of conforming to the present system levels and being oriented through visual connection appear to be outweighed by the aesthetic unpleasantness of skywalks. On the other hand, an elevated system seems to be favored, especially if the pedestrian circulation system can be carried through buildings, over alleyways, and across streets in broad skywalks such as the one from Place du Canada to Dominion Square, rather than underground walks no more than 8 ft wide.

In this financial-administrative area, the city and the Province of Quebec are major landowners and users. Therefore any pedestrian system built here would have to be paid for by the city and the province. The scheme is as yet only being talked about, with no formal commitment from the city (18).

Whether the system is underground or above ground two basic principles remain. First, a climate-controlled environment is important because of the rigorous winters experienced in Montreal. Climate control is not only extended to the shopping concourses and connections but to the entire system. Access to the system is "enclosed" through subway connections and the Autoroute Bonaventure, which gives direct access to major parking garages. Some problems with excessive wind from Metro and the tunnel nature of the system have been experienced. Heating and air conditioning costs are offset by lower maintenance costs for cleaning (especially winter snow and slush). The second principle that is the basis for involvement of the city is the acceptance of segregation of vehicular and pedestrian traffic. It has been noted that the vehicular congestion and accidents involving pedestrians on downtown streets have been reduced because of the underground pedestrian system (19).

The Toronto System

Toronto's underground pedestrian circulation system is less developed than Montreal's. It contains shopping malls in the Toronto-Dominion Center and the Richmond-Adelaide Building (Fig. 2) and various smaller parts, including a below-grade pedestrian link from the Union Station (C. N. R. and C. P. R.) to the Royal York Hotel and connections from the subway system to Eaton's and Simpson's Department Stores. Segregated pedestrian linkages are planned at proposed shopping concourses at Commerce Court with connection to the subway. The proposed Sheraton Hotel plan has a segregated pedestrian link with the new City Hall and the Richmond-Adelaide Center. All these developments appear to be part of a plan to develop a segregated underground pedestrian circulation system in downtown Toronto by 1980.

The Toronto system is being developed by individual developers, with active participation and some funding by the city. City planners have been closely involved in planning the overall system and do exert some control over it.

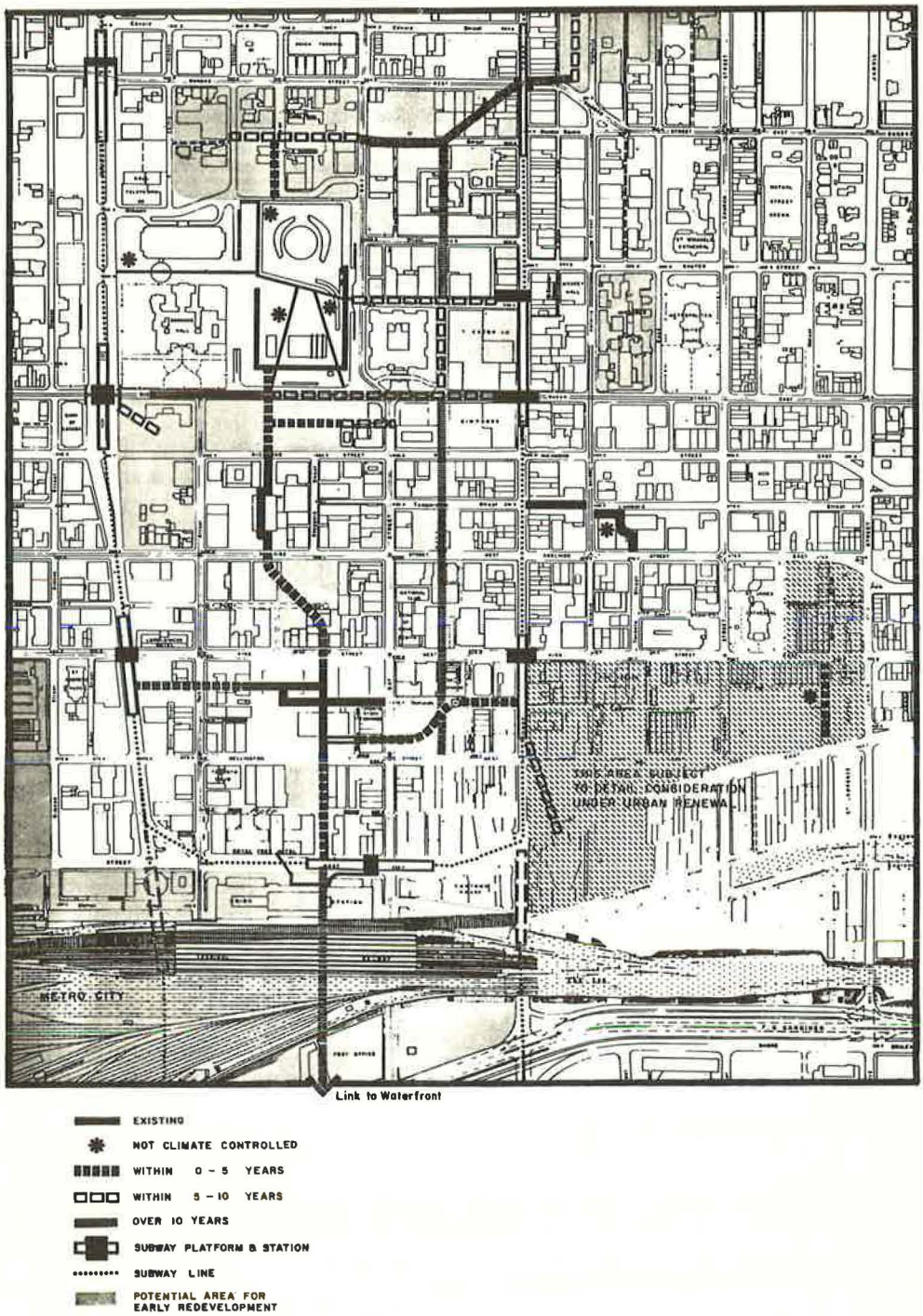

Figure 2. Toronto: separated pedestrian system.

The Toronto concept is similar to Montreal's. In general the major generators such as shopping concourses and hotels are linked with change-of-mode transport nodes. The Montreal system stresses climate control, segregation, and linkages in a subterranean environment, whereas the Toronto concept stresses similar elements in a below- and at-grade open environment (20).

The pedestrian system at present has over ½ mile of nonconnected passageways and concourses, with another ¼ mile under construction. As can be seen from Figure 2, the system envisages a north-south spine with two or more extending arms and the Toronto-Dominion Center at the hub. A connector is being constructed between the City Hall and the Richmond-Adelaide Center, along with two active proposals providing links south to the Toronto-Dominion center in the near future. These are all below street level and serve as passageways (21).

The Toronto Transit Commission, an agency of the municipality that owns and operates the subway system, takes an active part in the development of the segregated pedestrian circulation network. The commission has proposed and worked toward developing direct linkages to subway stations and entrances from all possible major trip generators.

As in Montreal, the Toronto system gradually jelled, but with more preplanning by civic officials and active encouragement and financial assistance by civic governments. The systems guidelines for development and concepts of the scheme have been formalized. Toronto realizes that the total image of the city and its ability to attract investment "... depends a good deal on the ease, the freedom, and the pleasure with which people can move about on foot" (22).

The concept of segregation of pedestrians from vehicles is paramount to relieve traffic congestion, both vehicular and pedestrian, improve traffic flows, and provide safer movement. The segregated system affords an opportunity for some measure of climate control. It is also a useful means of improving the quality of the downtown area through provision of plazas and green space, and it can provide a better place to stroll than can an unsegregated sidewalk (22).

One of the major principles is that the system is an "open" system, not enclosed, and the system should not be excluded from the street-level downtown environment. This negates overall climatic control but should provide a more pleasant human experience. Design guidelines indicate this and emphasize the concern for variety of experiences, open space, quality of service, street furniture, and continuity of the system (22). The open system and the development concepts are exemplified by the Metro Center development proposals. In describing the connections from the GO trains (Government of Ontario Commuter Trains) to downtown, Metro Center proposals indicate that connections should become an orientation place where the user can see the outdoor courtyards, shopping ways, and foyer areas all at once. In this respect it is one step further than the light wells of Place Ville Marie that, although they do bring the vision of outdoor space into shopping malls, do not orient the user into the total organization of the scheme (23).

Three portions of the existing system were developed independently, and these form the nucleus for the projected pedestrian circulation system. The first is the subway station at Queen and Yonge, with its connections into Eaton's and Simpson's. Metro Transit is also responsible for many other smaller links and is actively planning more to integrate into the proposed system.

The second segment is the link from the Canadian Pacific-Canadian National Union Station under Front Street to the Royal York Hotel. This link is little used, however, being old, narrow, and slightly unpleasant, and is expected to be replaced in the future either by the city or by Metro Center developers.

The third component is the underground concourse of the Toronto-Dominion Center. Although a pedestrian system had been proposed in various forms since the subway system was opened, the Toronto-Dominion Center made possible the development of an overall scheme. The Center is a twin-tower office complex with a below-grade shopping concourse containing approximately 50 shops. At present no cross-street connections exist, although provisions were made during design and construction and connections are bulkheaded at lot boundaries (24).

The proposed system is outlined in a City of Toronto publication that describes the rationale, connections, legal arrangements, and civic participation (22). It takes the form of an elongated cross, the north-south axis from the City Hall to Union Station, and an east-west axis at King Street, with the Toronto-Dominion Center at the cross (Fig. 2). Various smaller side shoots are planned, especially east of City Hall in an area scheduled for redevelopment by Eaton's. This Eaton's development area has been the subject of many proposals, the majority of which contain segregated pedestrian systems. The current proposal is to link Eaton's and associated shopping malls to the subway, Simpson's, and City Hall at below-grade and above-grade levels (25). Civic officials appear to be discouraging skywalk proposals.

Two key links in the north-south axis are now actively being pursued. South of City Hall, the Four Seasons Sheraton Hotel and Thompson Office Building are providing links to Nathan Phillips Square and the Richmond-Adelaide Center as a condition of sale of this city-owned property. Between the Richmond-Adelaide Center and the Toronto-Dominion Center another major office development by Imperial-York will incorporate a segregated pedestrian system connecting north and south.

One of the more useful connections would be north of the proposed Metro Center. This complex, built on air space over the Canadian National-Canadian Pacific Union Station, would have 20,000 residents and 40,000 daytime office workers and act as a transportation terminus and linkage for regular Canadian National-Canadian Pacific trains, GO trains, Greyhound Bus Depot, Airporter Bus, and Metro Transit subway. A segregated pedestrian system is an integral part of the packaged scheme, connecting under Front Street to the downtown. Metro Center is reluctant to provide this link, believing it to be a city responsibility (26). An interrelated transportation system will only operate effectively if pedestrian facilities provide quick, convenient connections with the various elements. Also, to encourage desirable development these pedestrian connections must link the Metro Center with the downtown and waterfront (27).

One part of an east-west link is under construction at Commerce Court opposite the Toronto-Dominion Center, on Bay Street, with connections to the subway system and tentatively to the Stock Exchange. Negotiations are under way to link these two developments.

Further links are proposed for the 1970-1980 period from the cross spine within the confines of the densely built-up downtown. The City Planning Department has outlined a series of segregated pedestrian systems in the uptown area of Bloor Street connected to the subway stations. One development at Bloor and Yonge, a twin 30-story office-hotel-shopping complex with 1.5 million sq ft of floor space that will connect into the subway and form the nucleus of the proposed uptown system, is segregated from vehicular traffic and will operate above, below, and at grade (28).

The Calgary +15 System

Calgary's pedestrian system is less developed than either Montreal's or Toronto's. Its uniqueness is that it is the only elevated system in Canada. As in Toronto, the city planners feel that some direct relationship with the downtown environment is essential (29).

Underlying the +15 concept are a series of elevated and ground-level plazas and walkways with skywalks that utilize existing interior building layouts and mid-block connections to serve the downtown core area (Fig. 3).

In contrast to the Montreal and Toronto systems, where private developers initiated construction and connection points were later introduced, the Calgary system was conceived by the City Planning Department. Some developers are still reluctant to integrate into the system (30). Montreal and Toronto feature total climate control, whereas Calgary does not—even though segregation is a major objective. To date 31 buildings and other developments have the +15 features, but few interconnections have been proposed. Because the system has not yet been officially approved by the city council, all +15 features incorporated into developments have come through negotiation and persuasion.

Calgary's +15 concept originated from three major studies (29, 31, 32). The 1967 Master Plan proposing a strong downtown emphasizes the need to (a) create a good pe-

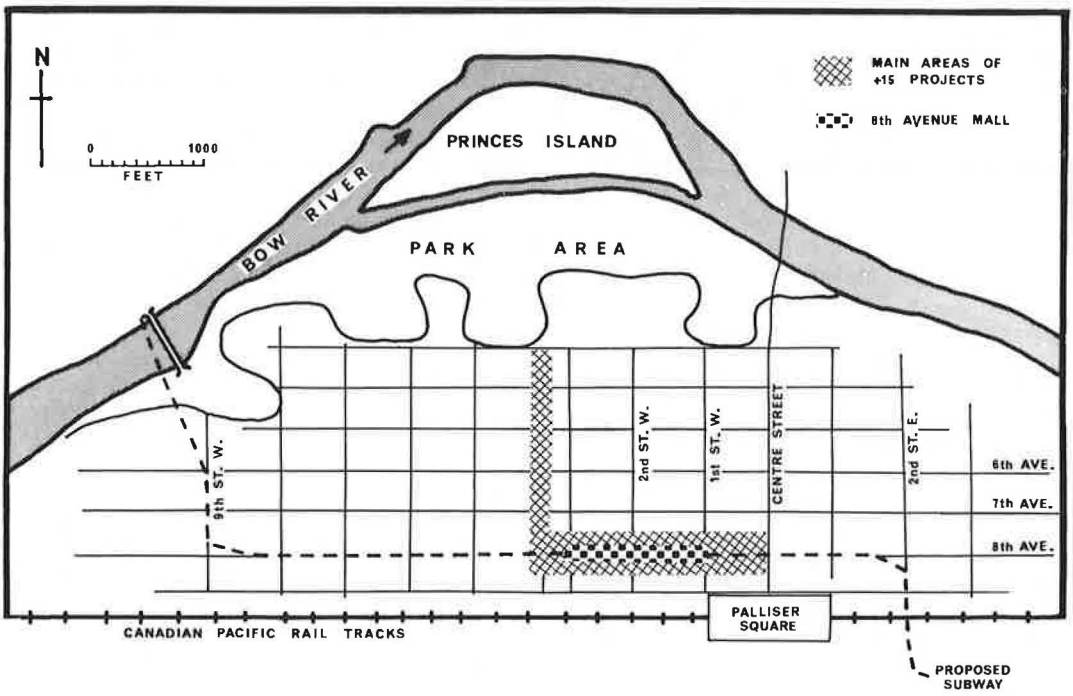

Figure 3. Calgary: downtown area to be served by +15 system.

destrian environment, (b) improve pedestrian and vehicular circulation, (c) connect major buildings and places of interest, and (d) create good pedestrian access.

The +15 concept is primarily concentrated in the core of downtown. This is a 180-acre area of high-density development that is considered adequate for strengthening the core without making it too large for normal walking distances. The principle of segregated pedestrian walkways, shopping malls, plazas, and closed streets was adopted as being more desirable than street widening or restricting future development densities. With the enormous capital already involved in servicing buildings by vehicles at street level, future vehicular traffic would remain at grade. A vertical and horizontal separation was called for.

Relying on preliminary experience with systems in Montreal, Toronto, and U.S. cities, the planning department opted for an at-grade and above-grade system that would segregate vehicles from pedestrians, provide protection from the harsh winter climate, and create environmental interest. An upper-level pedestrian system was preferred to an underground system because it could (a) create a more acceptable walking environment, (b) avoid the expense of combatting a high water table, (c) eliminate the costly relocation of underground utilities, (d) improve accessibility to and within buildings, (e) avoid the high cost of excavation, and (f) provide direct access over rail and road and reduce the poor visual and economic impact of railways (33).

The system is similar to Toronto's, where climate control was considered desirable but not essential and where open space was to be provided in the form of plazas and ground-level malls. The design term +15 refers to approximate development height, 15 ft being the minimum clearance required over streets and lanes.

Development of the downtown area to incorporate +15 features depends on the use of development control techniques rather than zoning control. As an incentive, floor-space ratio bonuses are given to those developers adhering to the +15 system. Four major arteries constitute the framework within which the system is to be developed. Bow Trail, circling downtown on the north, is a major traffic distributor. Seventh Avenue will be a major bus transit artery, with Center Street as the rapid transit artery. Eighth

Avenue is designated as a major pedestrian artery and is now a pedestrian mall. To date two blocks of this artery have been developed and are well used. Seventh and Eighth Avenues link with downtown parking facilities, high-rise residential and office buildings, the retail core, and civic and institutional areas.

Walkways and plazas are proposed to be integrated into future developments without conflicting with existing amenities. The concept's comprehensive design standards, incentives, and guidelines have been well documented and are available as guidelines to developers (33). Despite the general enthusiasm from citizens and developers, the concept has not been officially adopted by the city council. Development to date has been achieved through the use of selective development control techniques and through the voluntary intent of developers, the council having endorsed projects individually. Since the inception of the scheme there have been 31 developments constructed or approved for construction, with a total value of approximately a half billion dollars and providing 2 miles of walkways and plazas (30). Few parts are interconnected, beyond store to promenade walkways and a walkway at Calgary Place to Calgary Inn on Fourth Avenue, and the more intensive development is in the retail core and toward the Palliser Center and Husky Tower.

Despite the lack of formal approval, without which the city cannot develop its share of mini-parks and plazas except on a piecemeal basis, the scheme is off the ground and appears to be a success. Most developers have been enthusiastic about the scheme and consider it well thought out, imaginative, and, above all, economically viable. The developers seem to realize that returns from two-level shopping are greater, and they appear to benefit from floor-space ratio bonuses.

The main thrust of the planning department, in addition to the development incentives and bonuses, is that some projects have already been constructed with the necessary facilities so that the +15 proposals can be incorporated. This makes future developers more disposed toward the system on the grounds that the existing buildings and shops will be obsolete and ready for redevelopment when the system is more fully under way. The most important projects have been the C. P. R. Palliser Square (complex of hotels, transportation, shopping, and observation tower) and Calgary Place (office and retail complex). Another incentive has been the closing of two blocks on Eighth Avenue to vehicular traffic. This is now a pedestrian mall, an experiment that took 2 years to be fully acceptable.

CONCLUSIONS

Canadian experience discussed in this paper would support the following conclusions:

1. Theoretical concepts of pedestrian-vehicle segregation advocated by Ritter and Rudofsky (2, 3) are being incorporated, although not consciously, as planning principles in high-density downtown areas.
2. The state of pedestrian circulation planning and design is still a very empiric art rather than supported by rigorous analytical criteria. Experience and techniques of the highway field seem to be unavailable or not used in determining the characteristics of pedestrian systems, supporting the conclusions of earlier research by Morris (6).
3. A planning framework suggested by Stuart (9) appears to be the overall basis for planning, but the quantitative aspects are treated only superficially.
4. The segregation-by-time concept suggested by Blachnicki and Browne (12) appears not relevant to the Canadian context.
5. Among the environmental elements discussed previously, only the relationships of the system to major trip generators and nodal elements are considered important. Environmental comfort, safety, and imageability are still largely ignored.
6. No attempt has been made to evolve methods of benefit-cost analysis or to determine optimum user-cost criteria. Although the surface road and sidewalk systems are built at public expense, it is assumed that private developers must pay for all or part of the segregated pedestrian systems. The assumption here is that such a system would benefit the developers immensely. A complicated system of floor-space ratio bonuses (indirect subsidies) and cost-sharing arrangements are made in each case.

7. Adequate linkages to subway stations and transit stops are considered essential. These linkages are carefully planned by the city and the transit and are built at public expense.

8. Where there are very high densities and transport nodal linkages are good, private developers are willing to pay for or build the required system components.

9. There appears to be a reduction of accidents on surface streets and noticeable traffic relief due to segregated systems.

10. Although the general tendency is to design underground pedestrian systems, above-ground systems are also being tried. It is too soon to compare and analyze user response patterns to these two methods of vehicle-pedestrian segregation.

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