ITE has decided to publish an Urban Geometric Design Handbook sometime in 2005 or 2006. The handbook will contain 10 chapters, dealing with local, collector, arterial streets, intersections, access management, special issues... It seeks to provide practical advice on geometric issues, just as the Traffic Engineering Handbook (THE), the Traffic Control Devices Handbook (TCDH) and the Transportation Planning Handbook (TPH) do in their respective fields.

The Handbook comes at a time when new demands are being placed on street design. The health profession is placing renewed emphasis on health promotion through community design, with a growing problem of physical inactivity contributing to obesity problems and the associated diabetic and cardiac malfunctions. This view has been taken up by the U.S. Department of Transportation (DOT) (see the TPH, p. 599): “increased levels of bicycling and walking transportation would result in significant benefits in terms of health and physical fitness, the environment and transportation-related effects. The U.S. DOT set the following goals as a result of this study:

- To double the percentage of total trips made by bicycling and walking in the United States – from 7.9 to 15.8 percent of all travel trips.
- To simultaneously reduce by ten percent the number of bicyclists and pedestrians killed or injured in traffic crashes.” (U.S. DOT, FHWA, The National Bicycling and Walking Study – Final Report, Washington 1994, pp VI)

In contrast, the evolution of the vehicle fleet to light trucks and vans is increasing the injury risk to pedestrians.

ITE has recently published, both in 2003, Smart Growth: Transportation Guidelines – an ITE Proposed Recommended Practice and Neighborhood Street Design Guidelines – A Proposed Recommended Practice of ITE. The Congress for New Urbanism is also cooperating with ITE in the preparation of a Manual. The need for coordination amongst all these efforts has created additional delays.

My work will focus on the collector street chapter. In conventional terms, collectors are a category that fits uneasily between locals and arterials. The presentation will give a report on the approach that could be proposed to deal with this, taking into account the contextual issues. This is a preliminary report, since research and writing have only just begun.

Characterization: Urban or rural

The Green Book divides categories in two: urban or rural. “Urban areas are those places within boundaries set by the responsible State and local officials having a population of 5,000 or more.” (Green Book, 2001, p. 8) Images are conjured: urban is the bustle of large cities and rural is
bucolic farm land, either hilly forest-encased fields (as is the case in Vermont) or endless Prairie vistas. We want to be aware that small towns, with a dense core, do not easily fit these definitions.

The ambiguous nature of collector streets

Most transportation engineers are comfortable with the straightforward categorizations of local streets, whose primary function is access to abutting properties, and arterials which exist to serve traffic flow. For example, some guidebooks have allowed local streets to be built with minimal widths, on the assumption that traffic flow is a negligible factor. On arterials, most of the attention is focused on the efficiency of vehicle movement, trying to avoid congestion.

Collectors comprise that ambiguous in-between category, where the two functions are supposedly access and traffic flow, about as equally important. A lot of guidance that appears elsewhere in guidebooks does not really apply well here. For example, a useful strategy to improve capacity and safety on arterials is to restrict access. But on collector streets, one of whose two main functions is access, that strategy is not generally called for.

Distinguishing residential, commercial and industrial collectors

One collector street may change the service it provides abutting properties, if it passes along residential areas, commercial areas, institutional areas and industrial areas. It then becomes appropriate to differentiate their design. The most fundamental difference that needs to be taken into account is the design vehicle that has to be accommodated.

Collectors frequently have multiple land uses. The traffic level they generate is sufficient to attract certain types of businesses and zoning bylaws will frequently attempt to steer non-residential land uses away from local streets towards collectors. Collectors are also interesting streets on which to place higher density housing, which could create problems on local streets.

Typical traffic flows

The Urban Supplement to the Geometric Design Guide for Canadian Roads indicates that traffic levels would typically be the following:

<table>
<thead>
<tr>
<th>Residential local</th>
<th>Industrial/comm. local</th>
<th>Residential collector</th>
<th>Industrial/comm. Collector</th>
<th>Minor Arterial</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1000</td>
<td>&lt; 3000</td>
<td>&lt; 8000</td>
<td>1000 – 1200</td>
<td>5000 - 20000</td>
</tr>
</tbody>
</table>

These traffic volumes for collector streets imply that, in normal circumstances, a single travel lane in each direction between intersections would be sufficient.
Implications of the roles of collector streets

Access for multiple users

One of the conventional functions of collector streets is to provide access. Traditional thinking has focused on access by motorized vehicles, but in fact collector streets, because of their traffic levels, direct routing and the often large number of destinations they serve, are the ideal street for pedestrians, cyclists and transit.

Pedestrian – sidewalks, children’s safety


Zegeer et al. indicate that:

- “Sidewalks on both sides are required for Urban Collector (residential) and All Commercial Urban Streets.
- On All Streets in Industrial Areas, sidewalks on both sides preferred. Minimum of 1.5 m (5-ft) shoulders required.” (p. 32)

This is probably an oversimplification. In residential and commercial areas, a sidewalk on at least one side of street should be provided. In industrial areas, the designer needs to look at the potential for pedestrian use. Many industrial areas are far removed from homes, so that bicycle access is of greater importance in design.

Curb extensions are an effective tool to reduce pedestrian crossing distances and provide pedestrians and motorists with a more visibility to one another.

Schools

In chapter 12 of the TCD Handbook, Jim Gattis provides the following guidance: “When a new elementary or middle school is sited very close to what is or will become a busy through street, traffic problems will result. By definition, through streets often carry higher volumes of traffic at higher speeds that are not compatible with the pedestrian skills of younger children. The speeds and volumes on the through street are also incompatible with the slow speeds of the mass (of) vehicles trying to access the school during school hours.” He advocates placing elementary schools on collector streets (p. 424): in one case he cites, he concludes that “from the perspective of both motorists and pedestrians, a site at two collector streets would have been much better”. (p. 425) It is also advisable to avoid locating schools on local streets because of the peak traffic volume and short term parking they generate.
Cyclists

Considering the traffic levels and speeds (see below), cyclists should generally be able to be accommodated without special treatments (i.e. bike lanes or off-street bike paths). Their needs must, however, be recognized especially in selecting street widths.

Transit

Large commercial establishments are not appropriate for collector streets because of the high traffic volumes they generate; typically, they are surrounded by a large expanse of parking, which makes access by transit patrons unattractive. By contrast, because of their reduced dimensions, commercial establishments on collectors are often closer to the transit stop. So businesses and transit can be mutually supportive on collector streets.

Choosing the optimal operating speed

The first step a designer must consider is what is the appropriate operating speed for the road. The operating speed is the key variable in determining if access in safe conditions can be provided for vulnerable users.

This is a change from the practice of choosing the design speed. As has been observed over and over, there exists considerable discrepancy between the two speeds. The operating speed is the final result, it is the one that counts in terms of traffic safety. This change in outlook is demonstrated in the development of the IHSDM (Interactive Highway Safety Design Model): for example, “The major difference between the ISD (Intersection Sight Distance) model as it is applied in geometric design practice and the ISD model as it is applied in IDR (Intersection Diagnostic Review Model) is that, in IDR, the initial speed, \( V \), is set equal to the actual 85\(^{th} \) percentile speed of traffic in the roadway, \( V_{\text{act}} \), or the best available estimate of \( V_{\text{act}} \), rather than being set equal to a particular design speed.” (IHSDM Intersection Diagnostic Review Model Knowledge Base Report, FHWA, McLean 2002, p. 18)

The type of land use the collector street serves gives some indication in the choice of operating speeds. For example, in industrial areas where pedestrian activity is limited, operating speeds of 35 to 40 mph would be acceptable. In residential areas, lower operating speeds are important. In elementary school zones, even lower operating speeds, typically 20 mph would be appropriate.

A recent study looked at the justification of a standard 30 mph speed limit in urban areas. By reconstructing accidents that occurred at higher speeds, they were able to report that “there would have been a decrease of 44% in the number of collisions, including a 83\% decrease in frontal collisions, 33\% decrease in side collisions and a 23\% decrease in collisions with pedestrians. The results also show that the relative risk of being involved in a collision with fatal or severe injuries is greatly increased at speeds exceeding the legal limit, with a multiplicative factor of 81 at traveling speeds above 80 kp/h ( ). Globally, the data show quite clearly that the legal speed limit of 50 kph in an urban environment constitutes a valid reference in terms of collision injury reduction and overall road safety.” (M. Gou, O. Bellavigna-Ladoux, M. Gougam, Incidence de la vitesse sur le risqué d’être impliqué dans une collision grave or mortelle en
Designing the street to obtain an operating speed

The challenge then is to combine the street elements in such a way as to achieve the target operating speed. It is important to look at the street characteristics that impact speed. Two recent articles appearing in the ITE Journal have attempted to explore this issue. In the December 2002 issue, there is an article (A.J. Ballard and D.M. Haldeman, Low Speed Design Criteria for Residential Streets, pp. 44-46) on a study undertaken by the City of San Antonio to determine street characteristics that discourage speeding. The aim was to define geometric criteria to give operating speeds that do not exceed 30 mph:

- new streets where the estimated traffic is less that 500 vehicles per day must have a maximum unimpeded street length of 1,200 feet. The unimpeded length is the length of the street segment between speed impediments, i.e. stop signs, traffic signals, sharp turns, cul-de-sacs, etc.;
- new streets where the estimated traffic is greater than 500 vehicles per day require a maximum unimpeded street length of 900 feet; moreover, the maximum length is shortened to 700 feet for streets with predicted volumes of more than 1,000 vehicles per day that have one of the following characteristics: intersect an arterial street, function as a neighborhood entrance street, are likely a cut-through street or have widths of 40 feet or more.

Gwinnett County has applied the following rule to encourage 85th percentile operating speeds between 25 and 30 mph: the maximum distance between speed control points should be 500 feet. Control points include designs that require a complete stop, such as the intersection of a local residential street with a collector or arterial road or a T intersection between local streets, or a horizontal curve with a specified radius and delta angle or an approved traffic calming device. (J. E. Womble and W. M. Bretherton jr., Traffic Calming Design Standards for New Residential Streets: A Proactive Approach, March 2003, pp. 50-54) A subsequent letter to the editor noted that curvilinear streets may diminish sight distance. (W. Lieberman, May 2003)

The use of maximum unimpeded street length or stops as speed control points can applied to local streets, but their use on collector streets militates against traffic flow (the horizontal curve design is appropriate, though, for collectors). The Quebec Manual for Setting Speed Limits on Municipal Road Networks identifies a series of street characteristics that play a role in the selection by drivers of their operating speed, a good many of which are design related:

- number of traffic lanes (as we have seen, collectors should generally be 2 x 1 lanes);
- width of paved surface;
- longitudinal sight distance;
- length of the homogeneous zone;
- traffic flow;
- roadway hierarchy;
- number of access points;
- lateral sight clearance.
and a few street features, that change often:
- Parking, which the Manual divides into two categories; with parking allowed or with no parking allowed
- Presence of pedestrians (p. 30)

For collector streets, width of the paved surface, longitudinal sight distance (related to horizontal curvature) and lateral sight clearance appear to be the most promising design elements to consider.

**Traffic flow**

In accordance with the function of collector streets to facilitate traffic flow, there are a number of considerations that come to mind. There should preferably be uninterrupted movement on collector streets between intersecting collectors or arterials. In other words, it would be better to avoid placing stops on collectors when they intersect local streets. The design of the collector street should be such that operating speeds are in reality according to the prescribed limit.

In the absence of special considerations, the normal number of lanes at the intersection should be the same as it is between intersections, that is one in each direction. If there should be a need for a turn lane (normally left-turn), consideration should be given to installing a refuge island to facilitate pedestrian crossings.

At intersections, considering the traffic level of collectors, single lane roundabouts have sufficient capacity. At intersections where collectors cross arterials, the traffic level of the arterial will play a large role in determining which, of roundabouts or signals, is the best solution.

**Cross-section**

**Street width**

Collector streets are often built to accommodate on-street parking on both sides of the road. Insufficient consideration is given to an analysis of parking demand. The designer needs to understand what the parking generation rates are in his jurisdiction and how many off-street parking stalls are required by zoning by-laws. If zoning by-laws require a high number of stalls off-street, on-street parking may be restricted to infrequent use. In such cases, street width that provided for on-street parking everywhere would generally be excessive, inducing higher vehicle operating speeds. If zoning by-laws require fewer stalls than are typically used in the jurisdiction, there could be high rates of usage of on-street parking spaces.

With good indications of parking demand and zoning by-law requirements, the designer can select appropriate street widths. Curb extensions are particularly useful in guaranteeing that road space provided for parking does not get transformed into traffic lanes. Typically, one assumes a homogeneous street width, but such homogeneity is not necessarily advisable.
Lane widths – bike facilities, texture

On-street parking usage will also be an important consideration in the design of bike lanes, if they are required. In areas of high parking use, the preferred position of the bike lane will be between the parking lane and the traffic lane. In areas of low parking use, it may be more advisable to locate the bike lane between the curb and the parking lane. If there are few cars parked on the street, the cyclist is more exposed to risks by being near the traffic lane than by the possibility of passenger side doors opening without warning.

Boulevard or not

Planted strips provide a greater sense of comfort for pedestrians and allow driveway grades to occur without inconveniencing pedestrians and wheelchair users. In high snowfall areas, though, and in the absence of frequent curb cuts, they can cause drainage problems which result in ice formation. In such cases, it may advisable to site the sidewalk next to the curb.

Curbs and roadside obstructions – speed consistency

Much discussion has occurred about the advisability of trees near streets. In highway literature, where speeds are higher, trees are often seen as roadside obstacles. NCHRP Report 500 takes a nuanced approach to the problem. Its first recommendation is to “develop, revise, and implement planting guidelines to prevent placing trees in hazardous locations…. The guidelines must address wide-ranging issues such as lateral displacement of encroaching vehicles, the purpose of the roadway, community values, environmental issues, and other safety concerns” (pp. V-5-6). If collector streets are designed for the operating speeds suggested above, and the design promotes speed consistency, trees can be accommodated by providing an appropriate setback.

Bus bays or bus bulbs

Bus bays are sporadic street widenings to accommodate buses at bus stops. They are particularly well suited when traffic flow would be seriously interrupted by the dwell times for passenger embarking and disembarking maneuvers. The Urban Supplement to the Geometric Design Guide for Canadian Roads, published in 1995, only describes bus bays. Three locations are described:

- Near-side of an intersection in advance of a cross street;
- Far-side of an intersection beyond the cross street (as illustrated in Exhibit 7-17A in the 2001 Green Book);
- Midblock, distant from any public street intersection (Exhibit 4-28 in the 2001 Green Book).

In contrast, “a bus bulb is a section of sidewalk that extends from the curb of a parking lane to the edge of a through lane (also known as curb extensions, which have been mentioned above in connection with pedestrians and parking). Buses stop in the traffic lane instead of weaving into a parking-lane curbside stop. The extension of the curb into a parking lane creates additional
area for patrons to wait for the bus. The bulb can also provide space for bus patron amenities, such as shelters and benches, and for additional landscaping to improve the visual environment. The replacement of a bus bay in a parking lane with a bus bulb can result in additional parking spaces because the bulb does not require the inclusion of weaving space for a bus to enter the bay. Among the conditions that support the construction of bus bulbs include: …

- Lower operating speeds on the roadway;

These two characteristics generally apply to collector streets. Consideration needs to be given to the number of bus lines and the number of buses at peak periods to ensure that they do not create a high level of congestion.

*streetside*

Sidewalks with curb-cuts or raised crosswalks

The 2001 Green Book describes sidewalk curb ramps. It indicates that “When designing a project that includes curbs and adjacent sidewalks, proper attention should be given to the needs of persons with disabilities whose means of mobility are dependent upon wheelchairs and other devices. The street intersection with steep-faced curbs need not be an obstacle to persons with disabilities. In fact, adequate and reasonable access can be provided for sidewalk curb ramps.” (p. 365ff) AASHTO has a Guide for the Planning, Design, and Operation of Pedestrian Facilities and U.S.D.O.T. has Designing Sidewalks and Trails for Access, Part II: Best Practices Design Guide. The Urban Supplement to the Geometric Design Guide for Canadian Roads discusses ramps and curb-cuts (U.C. 29 – 31) but also platform intersections (or raised intersections) and raised crosswalks (U.D. 47 – 49) which provide better service for the elderly and other mobility-impaired people (but require special consideration for the blind). More design information is provided in the Canadian Guide to Neighbourhood Traffic Calming, (Transportation Association of Canada, Ottawa, 1998)

*Trade-offs*

One distinct feature of this new Handbook is that it should really help the designer understand the impacts of various design features so that they can design a roadway to achieve a desired end product. Restrictions and trade-offs are plentiful in urban areas, so when faced with limited ROW width there are many decisions to be made about assigning that ROW to lanes, curb-gutter, sidewalk, bike lanes, clear zones/setback, utilities, medians, etc. The Handbook should help designers think through those impacts and trade-off process to select the street design that best achieves their goals, whether it be new urbanist oriented or more traditional design.

Paul Mackey
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