1.2.2 HUMAN FACTORS

Roads are built for use by people. Naturally, human traits must influence design. First, there are certain human endowments that determine how far we can see, how quickly we react and how information is perceived and processed. It is important to remember that these traits vary from person to person and from condition to condition. For example, a value such as reaction time should not be thought of as a single physical constant, even though a value must be assumed for design purposes. Second, drivers adapt to perceived and anticipated conditions.

There is a close link between how roads are built and how people use them. However, as with all human abilities, neither perception nor anticipation are perfect. If the perceptual clues are clear and consistent, the task of adaptation is made easier and the response of drivers will be more appropriate and uniform. For roadway design this translates into some useful principles:

- it is important to design a roadway so that it conforms to what drivers expect from such a roadway based on previous experience
- it is important to provide drivers with clear clues about what is expected of them on a particular roadway

Driver expectancy and reaction, and an appropriate design response, have been summarized[17] as follows:

1.2.2.1 Expectancy

Prior driver experiences are critical in reducing reaction time and engendering an appropriate response when a new driving task is imposed. These experiences develop, over time, into a set of expectancies which allow for anticipation and forward planning, and which enable drivers to respond to common situations in predictable and successful ways. If these expectancies are violated, problems are likely to occur, either as a result of a wrong decision or of an inordinately long reaction time.

Two types of driver expectancies have been identified[11]. The first type is long term expectancies, that drivers have developed based on past experience, upbringing, culture and learning. The second type is short term expectancies that drivers formulate from site-specific practices and situations encountered in transit. The combined effects of these expectancies are:

- drivers tend to anticipate upcoming situations and events that are common to the road they are travelling
- the more predictable the road feature, the less likely will be the chance for errors
- drivers experience difficulty when they are confronted with the unexpected
- drivers, in the absence of counter evidence, assume that they will only have to react to standard situations
- the road and its environment upstream of a site create an expectation of downstream conditions; drivers are more likely to experience problems in transition areas and locations with inconsistent design or operation
- expectancies are associated with all levels of driving performance and all aspects of the driving situation. This includes expectancies relative to speed, path, direction, the roadway, the environment, geometric design, traffic operations and traffic control devices.

1.2.2.2 Reaction

It takes time to process information. The term perception and reaction time is used to describe the period between the occurrence or appearance of a ‘signal’ (usually a visual stimulus) and the driver’s physical reaction to it. A complex or unexpected decision with several alternatives takes considerably longer than a simple, anticipated decision. Long processing times also decrease the time available to attend to other information and thus compound the chances for error.

Perception and reaction time is considered to comprise four elements:

1. Perception: the use of vision capabilities to see a visual signal.

2. Identification: the driver identifies the signal and thus understands the stimulus.

3. Decision: the driver decides what action to take in response to the stimulus (e.g. to apply the brakes, turn the steering wheel, etc.)

4. Volition: during which the driver initiates the action decided upon. The time to complete the chosen action (e.g. stopping the vehicle) is not included.

It has been noted[18] that meaningful research on perception and response time in the context of motor vehicle operation is difficult to carry out. Attempts have been made to measure separately the four elements listed above, but there is doubt about the validity of the results because they do not account for any degree of overlap between the elements. Field tests designed to measure perception and reaction time are often suspect because the drivers involved are in a heightened state of anticipation under test conditions, and may exhibit artificially shortened perception and reaction times. The results of various tests have been summarized[18] and are reflected in Table 1.2.2.1.

Table 1.2.2.1 Perception and Reaction Time Design Domain

Perception and Reaction Time(s)	Applicability
0.5 - 2.0	Reaction of alerted drivers to simple stimulus.
2.5	Typically used as being representative of the 90th percentile of drivers and situations.
3.0 - 4.5	Reaction of unalerted drivers to complex or inconspicuous stimuli.

The value of 2.5 s has been used for many years as being representative of most drivers in most situations. The designer should consider whether use of a longer or shorter time is appropriate for an untypical driver population (e.g. a predominance of older people) or for an unusually simple or complex situation.

1.2.2.3 Design Response

A driver's performance is likely to be error-free provided that the driver receives information in the expected form and events occur in accordance with that information. However, when the information does not match the driver's expectations, the driver's reaction may be inappropriate and errors resulting in incidents and collisions are much more likely to occur.

Expectancies, as described in Subsection 1.2.2.1, reduce perception and reaction times because a driver responds through familiarity and habit. However, different drivers will have different perception and reaction times, because of individual characteristics, such as experience, skill, age, degree of alertness, motivation, risk-taking behaviour, etc. These are not under the control of the road designer, but the designer must recognise that these variations exist, and design for as wide a range of driver abilities as possible.

It is very important, therefore, for the designer to realise that driver behaviour is largely governed by habit, experience, expectation and reaction, and that any design or operation which violates these considerations is likely to be less safe. Designers should therefore strive to satisfy the following criteria[17]:

- driver's expectations are recognized, and unexpected, unusual or inconsistent design or operational situations avoided or minimized (e.g. avoid situations where a freeway exit is provided on the left side, because this is unusual and calls for unfamiliar behaviour)

- predictable behaviour is encouraged through familiarity and habit (e.g. there should be a limited range of intersection design formats, each appropriate to a given situation, and similar designs should be used in similar situations)

1.3.4 CHARACTERISTICS OF CLASSIFICATIONS

The principal characteristics of each of the six groups of road classifications are described by the following figure and tables. Figure 1.3.4.1 illustrates the desirable interrelationship of the urban road classification groups. Tables 1.3.4.1 and 1.3.4.2 provide summaries of the typical characteristics of the various groups and sub-groups, for rural and urban roads respectively.

Figure 1.3.4.1 Relationship of Urban Road Classifications

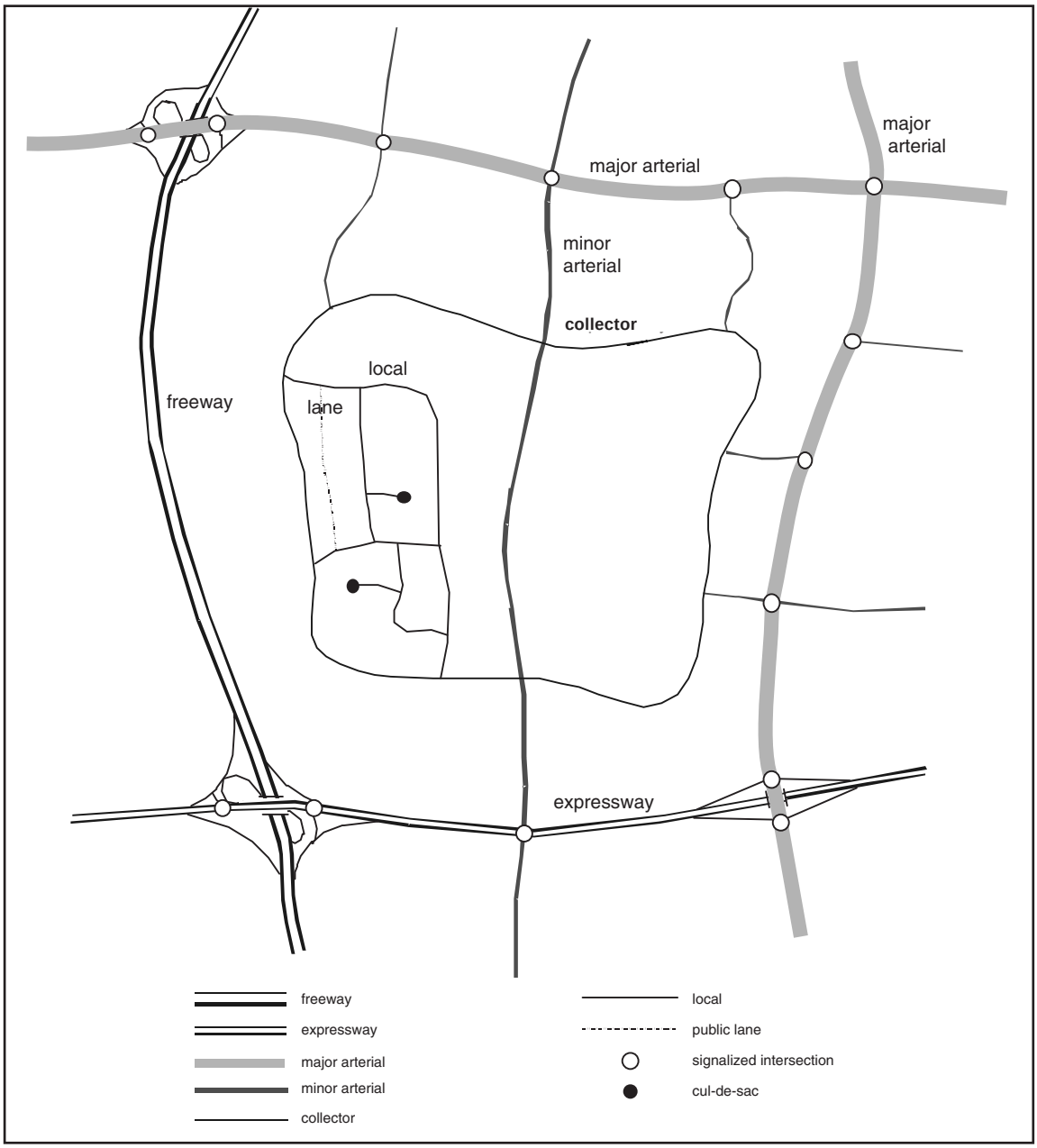

Table 1.3.4.1 Characteristics of Rural Roads

	Rural Locals	Rural Collectors	Rural Arterials	Rural Freeways
service function	traffic movement secondary consideration	traffic movement and land access of equal importance	traffic movement primary consideration	optimum mobility
land service	land access primary consideration	traffic movement and land access of equal importance	land access secondary consideration	no access
traffic volume vehicles per day (typically)	<1000 AADT	<5000 AADT	<12 000 AADT	>8000 AADT
flow characteristics	interrupted flow	interrupted flow	uninterrupted flow except at signals	freeflow (grade separated) major intersections
design speed (km/h)	50 - 110	60 - 110	80 - 130	100 - 130
average running speed (km/h) (free flow conditions)	50 - 90	50 - 90	60 - 100	70 - 110
vehicle type	predominantly passenger cars, light to medium trucks and occasional heavy trucks	all types, up to 30% trucks in the 3 t to 5 t range	all types, up to 20% trucks	all types, up to 20% heavy trucks
normal connections	locals collectors	locals collectors arterials	collectors arterials freeways	arterials freeways