

GDHS



Course Description

- The course covers principal elements for the design of highways, freeways, intersections and interchanges. The primary goal of geometric design is to provide for the safety and comfort of road users with due regard to social, economic and environmental constraints.
- Although there are suggested design standards and controls that must be followed to meet design goals, their application is determined on a case-by-case basis.
- The objective of this course is to illustrate the practical application of scientific knowledge to the planning and designing of highway elements.

Introduction to Geometric Design

- The geometric design of highways refers to the arrangements of the visible dimensions of streets and highways.
- The main purpose is to provide safe, efficient, and economical movement of traffic.
- Significance: A complete functional design system provides a series of distinct travel movements

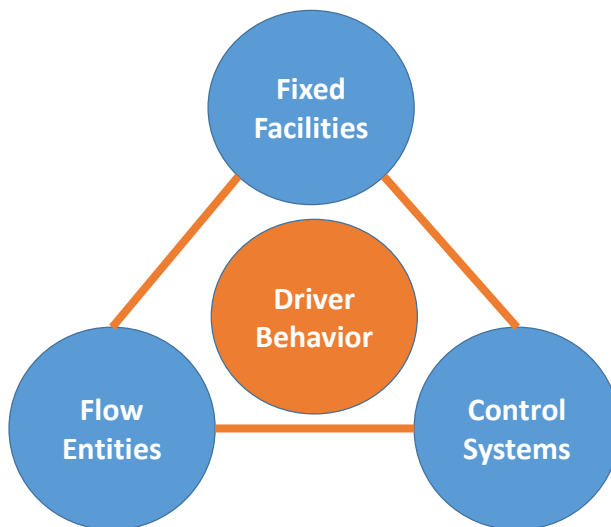
Introduction to Geometric Design

- The emphasis of the geometric design is to address the requirement of the driver and the vehicle such as safety, comfort, efficiency, etc.
- The features normally considered are the cross section elements, sight distance consideration, horizontal curvature, gradients, and intersection.
- The design of these features is to a great extent influenced by driver behavior and psychology, vehicle characteristics, traffic characteristics such as speed and volume.

Introduction to Geometric Design

- Proper geometric design will help in the reduction of accidents and their severity.
- **The objective of geometric design is to provide optimum efficiency in traffic operation and maximum safety at reasonable cost.**
- The planning cannot be done stage wise like that of a pavement, but has to be done well in advance.
- Optimum efficiency and maximum safety can be achieved at reasonable cost through proper geometric design.

Transportation System



Note: Refer to in-class notes and discussion with examples

HIGHWAY FUNCTIONS

- SYSTEMS AND CLASSIFICATIONS
- FUNCTIONAL CLASSIFICATION
- FUNCTIONAL SYSTEM CHARACTERISTICS

Systems and Classifications

- The classification of highways into different operational systems, functional classes, or geometric types is needed for communication among engineers, administrators, and the general public.
- **Classification by design types** based on the major geometric features (e.g., freeways, conventional streets, and highways) is the most helpful approach for highway location and design procedures.
- **Classification by route numbering** (e.g., U.S., State, and County) is the most helpful approach for traffic operations.
- **Classification by administrative hierarchy** (e.g., National Highway System or Non-National Highway System) is used to denote the levels of government responsible for and the method of financing highway facilities.

Systems and Classifications

Importance of functional classification in the context of transportation planning

- **Functional classification** means the grouping of highways by the character of service they provide. It was originally developed for transportation planning purposes
- Comprehensive transportation planning uses functional classification as an important planning tool, and is an essential part of the overall economic and social development

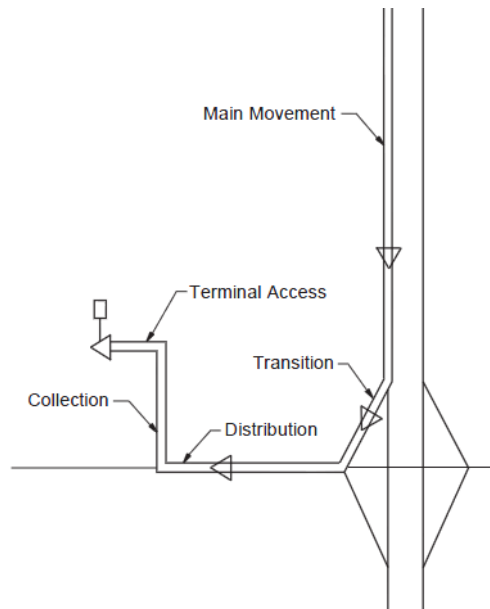
Functional Classification Concept

- Hierarchies of Movements and Components
- Functional Relationships
- Access Needs and Controls

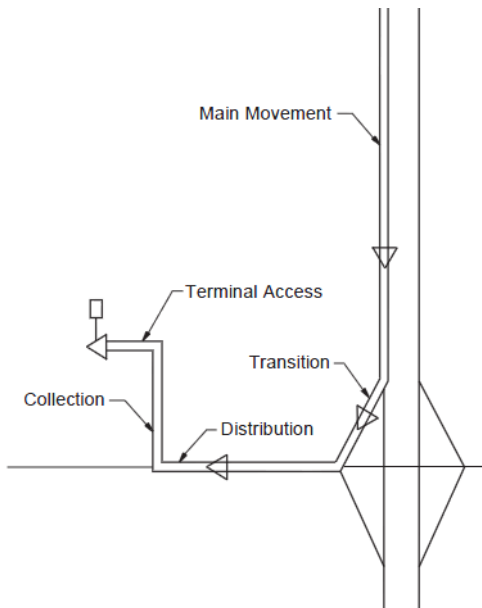
Hierarchies of Movements and Components

Six stages of a typical trip (on a highway system):

1. Main movement
2. Transition
3. Distribution
4. Collection
5. Access
6. Termination



Hierarchy of Movement



Hierarchy of Movement

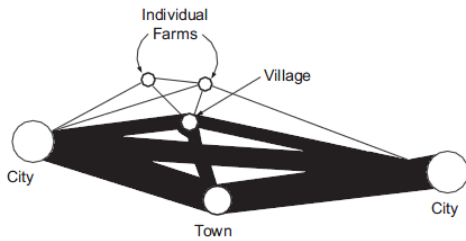
- Each of the six stages of a typical trip is handled by a separate facility designed specifically for its function.
- The inadequacy of parts of the hierarchy to accommodate each trip movement is one of the reasons that system fail or become obsolete.
- Achievement of a balanced system of streets is an important goal in order to best serve the varying types and number of trips that occur.

Six Stages of a Typical Trip

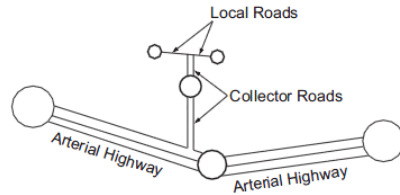
1. **Main Movement:** A highway trip using a freeway, where the main movement of vehicles is uninterrupted and traffic flow is high-speed.
2. **Transition:** When approaching destinations from the freeway, vehicles reduce speed on freeway ramps, which act as transition roadways.
3. **Distribution:** The vehicles then enter moderate-speed arterials (distributor facilities) that bring them nearer to the vicinity of their destination neighborhoods.
4. **Collection:** They next enter collector roads that penetrate neighborhoods.
5. **Access:** The vehicles finally enter local access roads that provide direct approaches to individual residences or other terminations.
6. **Termination:** At their destinations, the vehicles are parked at an appropriate terminal facility.

Functional Relationships

- Functional classification is applied to group streets and highways according to the character of service they are intended to provide.
- This classification recognizes that individual roads and streets do not serve travel independently.
- Rather, most travel involves movement through road networks and can be classified by its relationship to such networks in logical and consistent categories. Thus, functional classification of roads and streets is also consistent with categorization of travel.

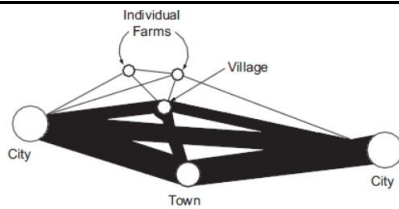


(A) Desire Lines of Travel

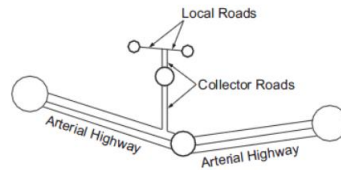


(B) Road Network Provided

Channelization of Trips



(A) Desire Lines of Travel

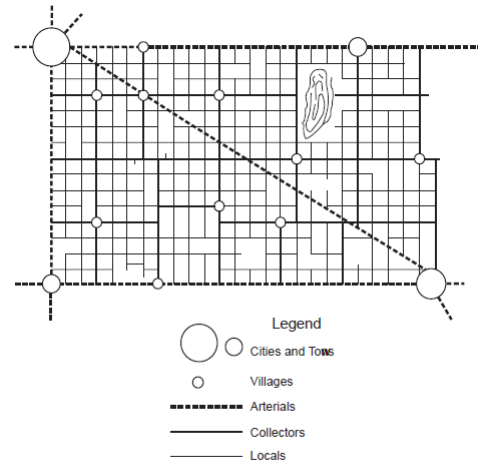


(B) Road Network Provided

- In Fig Part A, lines of travel desire are straight lines connecting trip origins and destinations (circles).
- The widths of the lines indicate the relative amounts of travel desire. The sizes of the circles indicate the relative trip-generating and attracting power of the places shown.
- As it is not practical to give direct-line connections for every desire line, trips should be channelized on a limited road network as shown in Fig Part B.
- Heavy travel movements are served directly or nearly so, and the smaller movements are channeled into somewhat indirectly.
- The facilities labeled local access, collector, and arterial describe their functional relationships.
- In this scheme, the functional hierarchy is also seen to be related to the hierarchy of trip distances served by the network.

Rural Highway Network

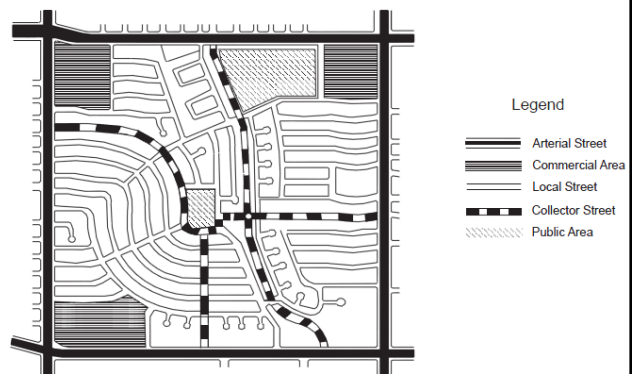
- A more complete (though still schematic) illustration of a functionally classified rural network is shown here.
- Since the cities and larger towns generate and attract a large proportion of the relatively longer trips, the arterial highways generally provide direct service for such travel.
- The intermediate functional category, the collectors, serves small towns directly, connects them to the arterial network, and collects traffic from the bottom-level system of local roads, which serves individual farms and other rural land uses.



Schematic Illustration of a Functionally Classified Rural Highway Network

Suburban Street Network

- Although the previous examples have a rural setting, the same basic concepts apply in urban areas as well.
- A similar hierarchy of systems can be defined; however, because of the high intensity of land use and travel throughout an urban area, specific travel generation centers are more difficult to identify.
- In urban areas additional considerations, such as spacing, become more important in defining a logical and efficient network.



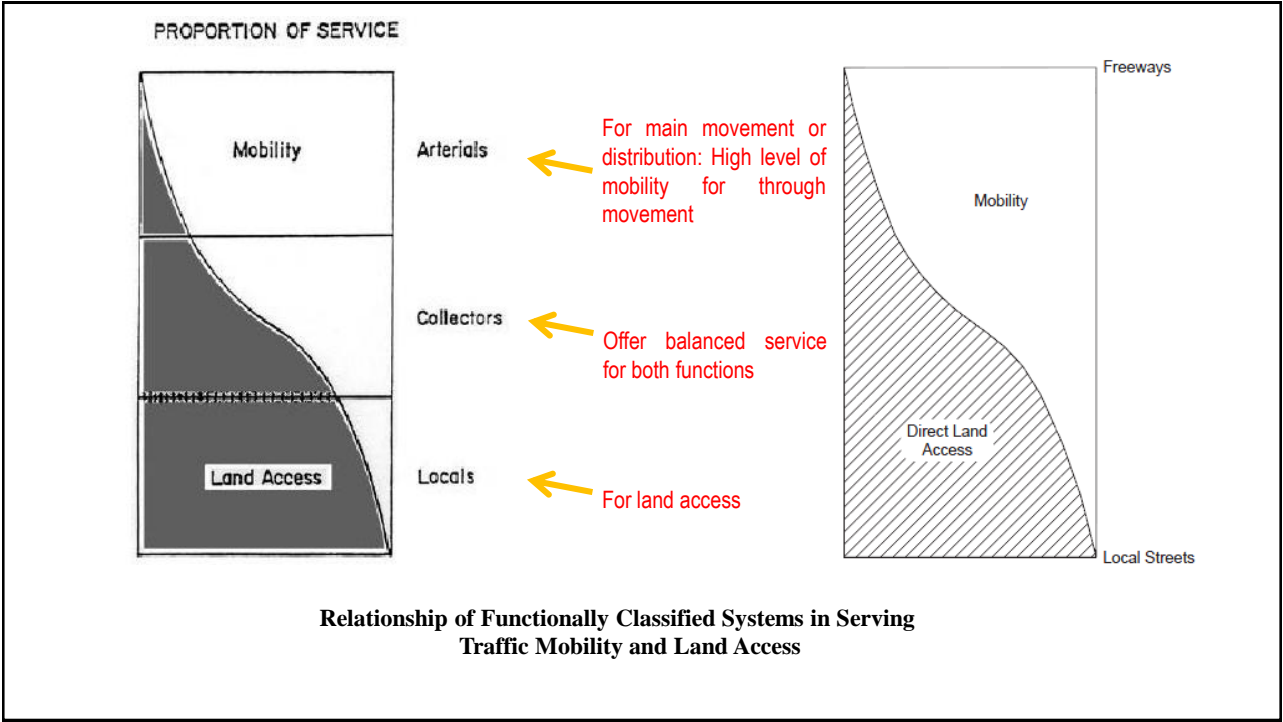
Schematic Illustration of a Portion of a Suburban Street Network

Access vs. Mobility

- The two major considerations in classifying highway and street networks functionally are :
 - Access
 - Mobility
- **Access**: It is a fixed need for every area served by the highway system.
- **Mobility**: It is provided at varying levels of service. Mobility can incorporate several qualitative elements, such as riding comfort and absence of speed changes, but the most basic factor is operating speed or trip travel time.

Access vs. Mobility

- Regulated limitation of access is needed on arterials to enhance their primary function of mobility.
- Conversely, the primary function of local roads and streets is to provide access (implementation of which causes a limitation of mobility).
- Collectors offer a compromise between both functions.
- The extent and degree of access control is thus a significant factor in defining the functional category of a street or highway.



FUNCTIONAL SYSTEM CHARACTERISTICS

- Includes various definitions and characteristics of highway facilities in urban and rural settings based on their functional classifications.

Urban and Rural Areas

- Urban and rural areas have fundamentally different characteristics with regard to:
 - Density of land use
 - Type of land use
 - Density of street and highway networks
 - Nature of travel patterns
 - The way in which these elements are related
- Consequently, urban and rural functional systems are classified separately.

Functional highway system in urbanised areas

- **Urban Areas – population 5,000 or more**
 - ❖ Urbanised area – population of 50, 000 and over
 - ❖ Small urban areas – population between 5,000 and 50,000

Hierarchy of the functional system (AASHTO)

- ❖ Urban Principal arterials (main movement)
- ❖ Urban Minor arterial System (distributors)
- ❖ Urban Collector Street System
- ❖ Urban Local Street System

Roads Classification: Some Definitions

- Arterials is a general term denoting a street primarily meant for through traffic usually on a continuous route. They are generally divided highways with fully or partially controlled access.
- Collector streets are intended for collecting and distributing traffic to and from local streets, and also for providing access to arterial streets. Normally full access is provided on these streets.
- Local streets are primarily intended for access to residence, business or adjacent property. It does not normally carry large volume of traffic and also it allows unrestricted parking and pedestrian movements.

Rural and Urban Roads

The roads making up the functional system differ for urban and rural areas.

- ❖ In **urban areas** there are more arterials with further functional subdivisions of the arterial category.
- ❖ In **rural areas**, there are relatively more collectors with further functional subdivision of the collector category.

Rural and Urban Roads

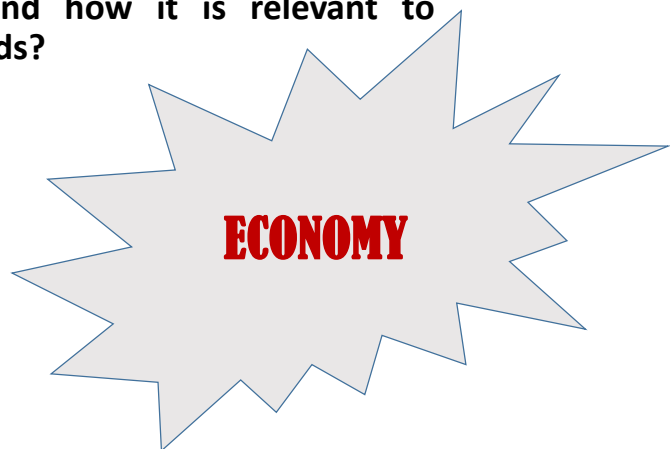
System	Urban		Rural
	Traffic Volume %	Road Length %	Road Length %
Principal arterial system	40-65	5-10	2-4%
Principal arterial plus minor arterial street system	65-80	15-25	6-12%
Collector road	5-10	5-10	20-25%
Local road system	10-30	65-80	65-75%

Typical distribution of urban and rural functional systems

Road Classification

Why is it necessary and how it is relevant to Geometric Design of roads?

- ❖ Volume of traffic
- ❖ Type of traffic
- ❖ Purpose of road
- ❖ Importance/priority

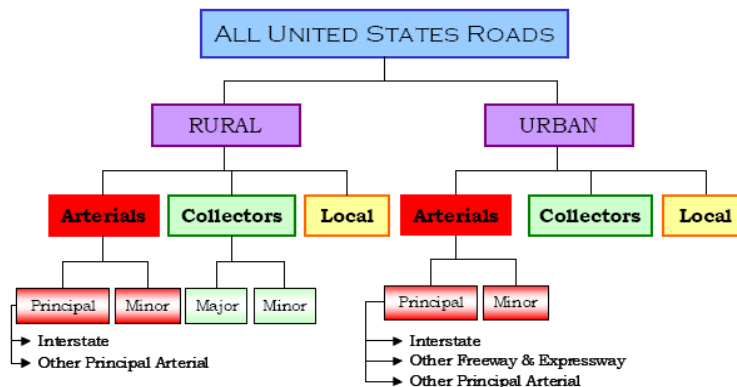


Classification of Highways

Classification	Examples	Suitability
By design type	Based on major geometric features,	For highway location and design procedure
By route numbering	e.g. state, county	For traffic operation
By administrative boundaries	National highway system, non-national highway system	Denote the levels of government responsible for, and the method of financing, highway facilities
By functional type	The grouping of highways by characters of service they provide	For transportation planning process

Highway functional classification system

Highway Functional Classification System



FUNCTIONAL CLASSIFICATION- 1ST Step in Design Process

- The functional concept is important to the designer.
- The first step in design process is to *define the function that the facility is to serve.*
- The LOS needed to fulfil this function for the anticipated volume and composition of traffic provides a rationale and cost-effective basis for the selection of *design speed* and *geometric criteria* within the ranges of values available to the designer.

Functional Classification as a Design Type

Classification	Function	Design Type
Arterials	Provide a high degree of mobility for the longer trip length	some degree of accessibility, high operating speed and LOS
Collectors	Accommodate shorter trip, feed arterials, provide some degree of mobility and serve neighbouring property	Intermediate design speed and LOS
Local roads and streets	Relatively short trip lengths, little need of mobility or high operating speed	Lower design speed and LOS

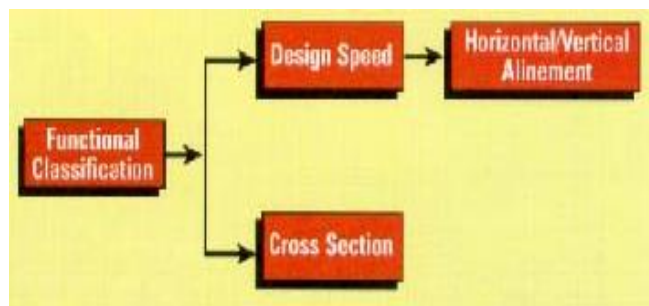
The Role of Functional Classification in the Design Process

- Once the functional classification of a particular roadway has been established, so has the allowable range of design speed.
- With the allowable range of design speed defined, the principal limiting design parameters associated with horizontal and vertical alignment are also defined.
- Similarly, a determination of functional classification establishes the basic roadway cross section in terms of lane width, shoulder width, type and width of median area, and other major design features

The Role of Functional Classification in the Design Process

Determination of functional classification establishes the basic roadway cross section in terms of lane width, shoulder width, type and width of median area, and other major design features

The flexibility available to a highway designer is considerably limited once a particular functional classification has been established

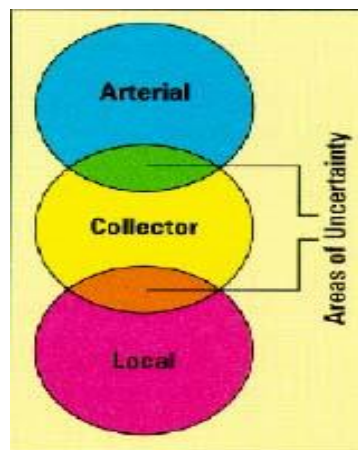


Range of Design Speeds for Various Highway Functional Classes

Functional Classification	20 mph	30 mph	40 mph	50 mph	60 mph	70 mph
Rural Principal Arterial				X	X	X
Rural Minor Arterial				X	X	X
Rural Collector	X	X	X			
Rural Local Road	X	X	X			

Source: Roadway Design Manual, Virginia DOT, 1995.

Classification process is not an exact science





*Representative urban arterial
(Windsor, CT)*



*Representative rural arterial.
(Taconic State Parkway, NY)*



*Representative collector in a residential area.
(Greenbelt, MD)*



*Representative urban collector.
(Lambertville, NJ)*

Functional System in USA

Functional System	Percent of Total Mileage	Percent of Total Travel
Interstate	1.2	22.8
Other Freeway/Expressway	0.2	6.2
Other Principal Arterial	3.8	24.3
Minor Arterial	5.7	18.4
Major Collector	11.1	7.8
Minor Collector	7.2	2.1
Collections	2.2	5.3
Local	68.6	13.1
Total	100	100

Functional System (Rural and Urban) Mileage and Travel in USA

Land Use Changes and Road Functions

- *Road functions can change over time.*