MODULE 1: INTRODUCTION TO TRANSPORTATION ENGINEERING

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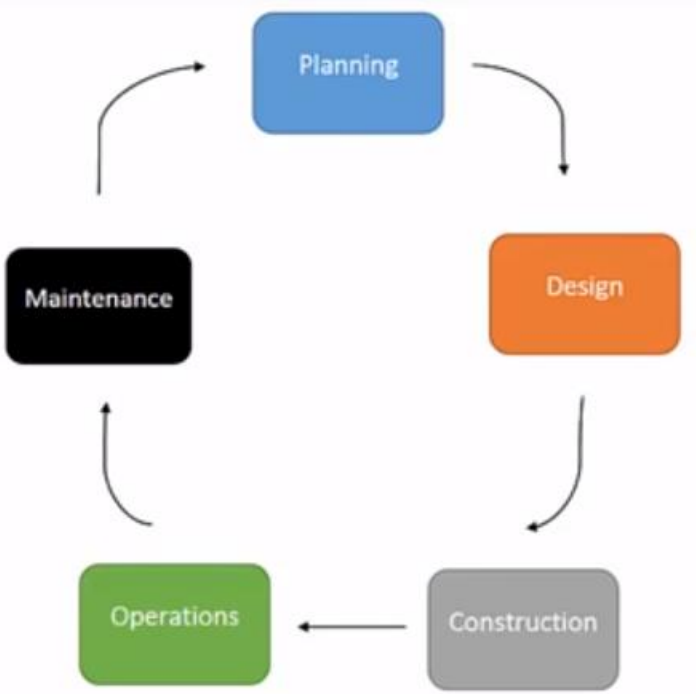
INTRODUCTION

Transportation Engineering defined by the Institute of Transportation Engineers (ITE) as:

"The application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation in order to provide for the safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods."



INTRODUCTION (CONT.)

- Transportation is essential for a nation's development and growth.
- Opportunities for engineering careers in transportation are exciting and rewarding, in both the public and private sector.
- Highway, rail, airport, and mass transit systems,
- New techniques are being applied for operating and maintaining the systems safely and economically.
- Many organizations and agencies exist to *plan*, *design*, *build*, *operate*, and *maintain* the nation's transportation system.

PROFESSION OF TRANSPORTATION

- For as long as the human race has existed, transportation has played a ***significant role*** by facilitating:
  - trade,
  - conquest, and
  - social interaction.
- The primary need for transportation has been ***economic***, involving personal travel in search of
  - food or work,
  - travel for the exchange of goods,
  - exploration,
  - personal fulfilment, and
  - the improvement of a society or a nation.

PROFESSION OF TRANSPORTATION (CONT.)

- The movements of people and goods, which is the basis of transportation, always has been undertaken to accomplish those basic objectives or tasks that require transfer from one location to another.

- For example:

- farmer must transport produce to market,
- doctor must see a patient in the office or in the hospital, and
- salesman must visit clients located throughout a territory.

PROFESSION OF TRANSPORTATION (CONT.)

➢ Every day, millions of people leave their homes and travel to a workplace, which could be:

- factory,
- office,
- classroom, or
- distant city.

IMPORTANCE OF TRANSPORTATION

- The quality of transportation system has a substantial control on markets and maintaining a competitive edge over other regions and nations.
- The speed, cost, and capacity of available transportation have a significant impact on the ***economic vitality*** of an area and the ability to make maximum use of its natural resources.
- Countries or nations with advanced transportation systems are leaders in industry and commerce.

IMPORTANCE OF TRANSPORTATION (CONT.)

➢ Transportation and Economic Growth:

- If a society expects to develop and grow, it must have a strong internal transportation system consisting of good roads, rail systems, as well as excellent linkages to the rest of the world by sea and air.
- The availability of good transportation facilities can strongly influence the growth and development of a region or nation.
- Good transportation permits the specialization of industry or commerce, reduces costs for raw materials or manufactured goods, and increases competition between regions, thus resulting in reduced prices and greater choices for the consumer.

IMPORTANCE OF TRANSPORTATION (CONT.)

➢ Transportation and Economic Growth:

- Transportation is also a necessary element of government services, such as defence, and assisting territories.
- Throughout history, transportation systems were developed and built to ensure economic development and efficient mobilization in the event of national emergencies.

IMPORTANCE OF TRANSPORTATION (CONT.)

➢ Social Costs and Benefits of Transportation:

- Building vast transportation systems requires enormous resources of energy, material, and land.
- In major cities, transportation can consume as much as half of all the land area.
- Transportation has other negative effects as well. Travel is not without danger; every mode of transportation brings to mind some major disaster.
- In addition, transportation can create noise, spoil the natural beauty of an area, change the environment, pollute air and water, and consume energy resources.

IMPORTANCE OF TRANSPORTATION (CONT.)

➢ Social Costs and Benefits of Transportation:

- Society has indicated a willingness to accept some risk and changes to the natural environment in order to gain the advantages that result from constructing new transportation systems.
- Society also values many social benefits brought about by good transportation; such as providing medical and other services to rural areas and enabling people to socialize who live some distance apart.
- A major task for the modern transportation engineer is to balance society's need for fast and efficient transportation with the costs involved.

DISCUSSION

- Is transportation very important?
- Why should you study the subject and perhaps consider transportation as a professional career?
- How transportation impacts people's daily lives?
- What is the amount of land consumed for transportation facilities? Can exceed 50% of the land area?

STATISTICS

- About 18% of U.S. household expenditure is related to transportation.
- Transportation accounts for about 28% of total energy consumption.
- Almost 100% of the energy utilized for propelling transport vehicles is derived from petroleum resources.
- Over 50% of all petroleum products consumed in the U.S. are for transportation purposes.
- Over 80% of eligible drivers are licensed to operate a motor vehicle.

STATISTICS (CONT.)

- Each person in the Unites States travels an average of 12,000 miles (19,200 KM) each year.
- Over 10% of the work force is employed in a transportation-related activity.
- There are:

- about 4,000,000 miles (6,400,000 KM) of paved roadway,
- of which 1,200,000 KM are used for intercity travel and
- 75,000 KM are for interstate highways.

STATISTICS (CONT.)

- There are approximately:

- 140,300 miles (224,500 KM) of freight railroads,
- 5300 public use airports,
- 26,000 miles (41,600 KM) of navigable channels and
- 359,000 miles (574,400 KM) of oil and gas pipelines.

TASKS

- ***Task1***: Any student how can provide an answer for Basrah city (amount of land) or any other city in Iraq will get 2 degree bonus.

- ***Task2***: Any student how can make comparison on transportation facilities statistics between the USA, UK, China, Iraq and any other Arabian country will get 2 degree bonus.

HISTORY OF TRANSPORTATION

- The oldest mode of transportation was on footpaths; animals were also used to transport men and material.
- after the invention of wheel; simple animal drawn vehicles were developed and these become a common and popular mode of transportation for a very long period.
- Some of the major uses of roads in ancient society were to provide local access to food and shelter and to provide pathways for religious pilgrimages.
- For construction of major/long roads, the military motivations were behind opened up most of the major roads.

ANCIENT ROADS

➢ ***Mesopotamia roads:***

- Mesopotamia (the land between the rivers) is the mother of civilization. The Mesopotamia is the origin of science, medicine, law, and business; one might even say religion (Jacobson, 1940).
- One of the most important achievements of the Mesopotamia is the invention of the wheel in 5000 B.C.
- After the invention of the wheel, animal-drawn vehicles were then first developed in Babylonia, and still later in Egypt.
- Then, need for hard surface road for the animal-drawn wagon was emerged.

ANCIENT ROADS (CONT.)

- ***Mesopotamia roads:***

Sumerian's animal-drawn wagon 2500 B.C.

ANCIENT ROADS (CONT.)

➢ ***Mesopotamia roads:***

- The first manufactured roads were the stone-paved streets of Ur in the Mesopotamia in 4000 B.C. (O'Flaherty, 1997).
- The oldest constructed roads discovered to date are in former Mesopotamia, now known as Iraq. These stone paved streets date back to about 4000 B.C. in the Mesopotamia cities of Ur and Babylon, Federal Highway Administration of America (FHWA).
- The Sumerians built their roads by using mud bricks laid in and covered with bitumen.
- They used painstaking brick-making skills, forming identical mud bricks.

ANCIENT ROADS (CONT.)

➢ ***Mesopotamia roads:***

- After drying they would take the bricks to the site and set them in place with bitumen.
- Bitumen is the natural sticky black substance in asphalt. Centuries would pass before asphalt was used in Europe and America, (FHWA).
- The most impressive example of road construction of the Mesopotamia which still remains is the Sacred Road or the Procession Street of Babylon.
- This street, which was a continuation of the road from the north, traversed the entire length of Babylon in a straight line from north to south.

ANCIENT ROADS (CONT.)

- ***Mesopotamia roads:***

Procession Street of Babylon

ANCIENT ROADS

➢ ***Egyptian roads:***

- The oldest paved road in Egypt was built by Khufu about 3000 B.C.
- To transport stones from the quarries on the east side of the Nile river to the plateau on the opposite side upon which the pyramid was constructed.
- The road was paved with fine stone, recessed into the rock bed, to prevent the heavy weights of stones from sinking into the surface of soil.
- Around 2,300,000 blocks of stone were used to build the pyramid of Khufu, each stone weighing on the average two and one half tons.
- Teams of oxen and men were assigned to pull the stones over the road by using rollers.

ANCIENT ROADS

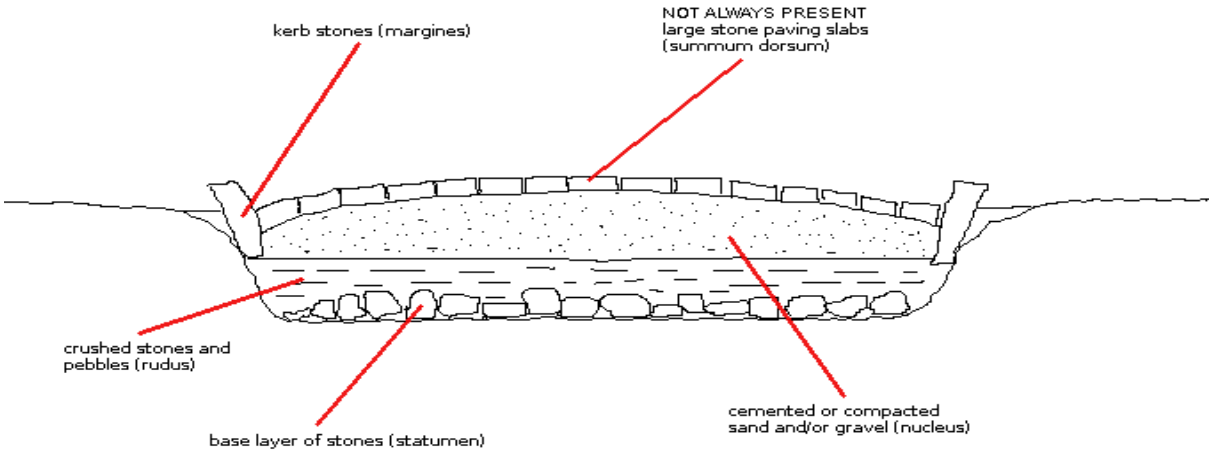
➢ ***Roman roads:***

- The earliest large-scale road construction is attributed to Romans.
- The Roman road system was based on 29 major roads, totalling 78,000 km in length, which radiated from Rome to the outer borders of the Empire.
- Romans recognized that the fundamentals of good road construction were to provide good drainage, material and workmanship.
- Roman roads were constructed long straight sections regardless of gradient to minimise travel time.

ANCIENT ROADS

➢ ***Roman roads:***

- The roads were built by using heavy foundation stones at the bottom and they mixed lime and volcanic puzzolana to make mortar and they added gravel to the mortar to make concrete



ANCIENT ROADS

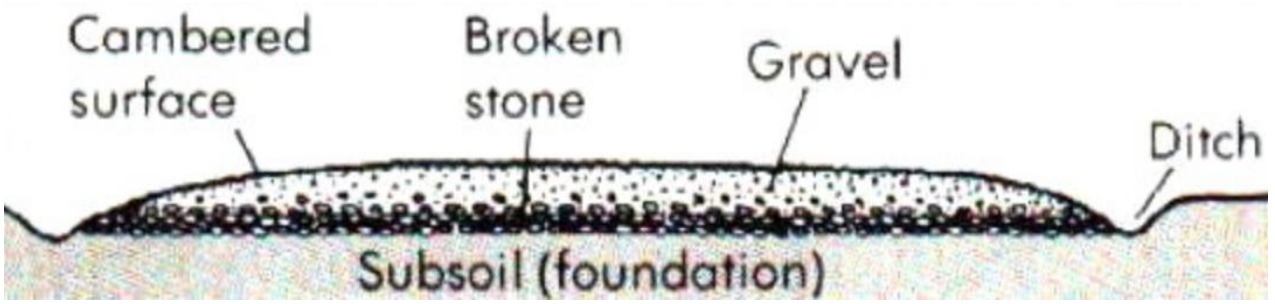
➢ ***English roads:***

- After the collapse of the Roman Empire in about in AD 400, both its road schemes and the associated human skills decayed and then disappeared for over a millennium.
- John Macadam (1756-1836) invented a new process of roads construction with a smooth hard surface that would be more durable and less muddy.
- He discovered that the massive foundation of rock-on-rock was unnecessary.
- He declared that the natural ground should be enough to support the road and traffic weight as long as surface of the road prevents erosion of the underlying.

ANCIENT ROADS

➢ ***English roads:***

- Macadam used crushed stone bound with gravel on a firm base to construct the foundation of the road.
- Then, the road surface was made slightly cambered to make sure that the rainwater rapidly drained off the road and did not penetrate to the foundation.



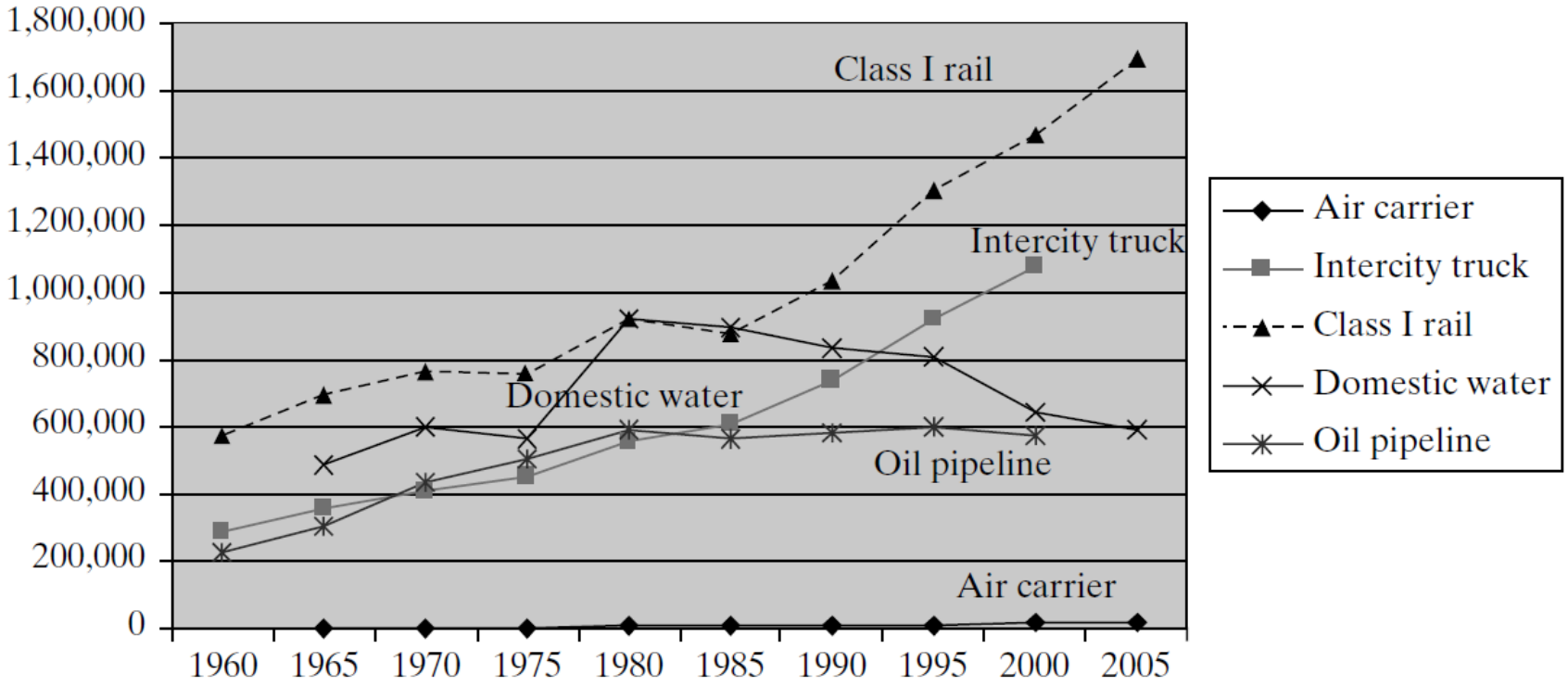
MODES OF TRANSPORTATION

- Freight Transportation
- The principal modes of intercity freight transportation are:

- railroads,
- highways (Trucks)
- waterways, and
- pipelines.
- Air freight is an important carrier for high value goods, but it is insignificant on a ton-mile basis.
- Although, trucks move fewer ton-miles than does rail, the value of the goods moved by truck comprises about 75% of the total value of all goods moved in the USA.

MODES OF TRANSPORTATION (CONT.)

- Freight Transportation.



USA Ton-Miles of Freight (Millions)

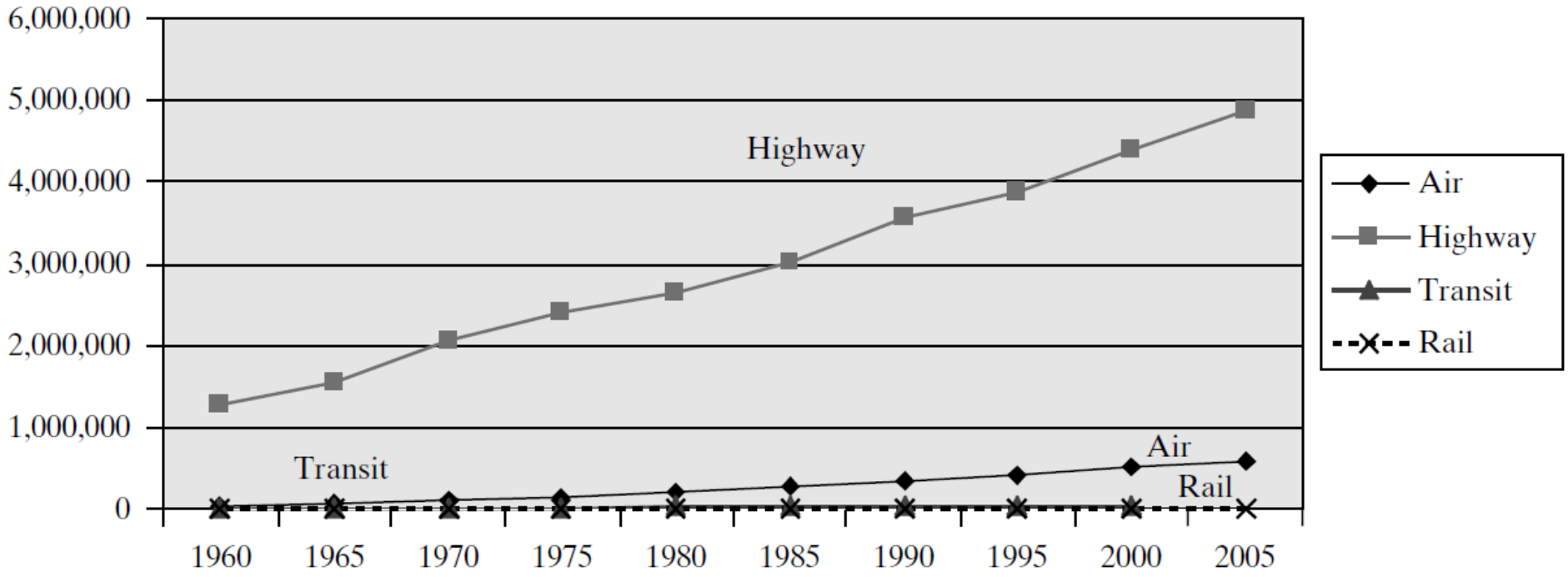
MODES OF TRANSPORTATION

- Passenger Transportation
- The principal modes of intercity Passenger transportation are:

- highways (automobile),
- Air,
- Transit (Bus), and
- Rail.
- Air and automobile are dominant, representing 98% of all intercity passenger miles.
- These statistics were obtained from the USA and could be not valid for other countries such as the UK or China.

MODES OF TRANSPORTATION (CONT.)

- Passenger Transportation.



USA Passenger-Miles (Millions)

PUBLIC TRANSPORTATION

- Transit services available to urban and rural residents.
- Transit Modes:

- Mass transit (buses, light rail (tram) or rapid transit) characterized by fixed routes, published schedules, designated networks, and specified stops.

PUBLIC TRANSPORTATION (CONT.)

- Transit Modes:

- Paratransit (taxi, car rental, and dial-a-ride), is characterized by flexible and personalized service.
- Ridesharing (carpool, vanpool, or shared-ride taxi) is characterized by two or more persons traveling together by prearrangement.

- ***Discussion***: Do you/people prefer to use public transport?

TRANSPORTATION MODES SELECTION

- Each mode has inherent advantages of cost, travel time, convenience, and flexibility.
- The automobile is considered to be a reliable, comfortable, flexible, and ubiquitous form of personal transportation.
- When distances are great and time is at a premium, air transportation will be selected.
- If cost is important and time is not at a premium or if an auto is not available, then intercity bus or rail may be used.
- Selecting a mode to freight follows a similar approach.

TRANSPORTATION MODES SELECTION (CONT.)

- Trucks have the advantages of flexibility and the ability to provide door-to-door service.
- Waterways can ship heavy commodities at low cost, but only at slow speeds and between points on a river or canal.
- Railroads can haul a wide variety of commodities between any two points.
- Both modes usually require truck transportation to deliver the goods to a freight terminal or to their final destination.
- In each instance, a shipper must decide whether the cost and time advantages are such that the goods should be shipped by truck alone or by a combination of truck, waterway, and rail.

TRANSPORTATION MODES SELECTION (CONT.)

➢ ***Example***:- An individual is planning to take a trip between the downtown area of two cities, A and B, which are 400 miles apart. There are three options available:

- **Travel by air**: This trip will involve driving to the airport near city A, parking, waiting at the terminal, flying to airport B, walking to a taxi stand, and taking a taxi to the final destination.
- **Travel by auto**: This trip will involve driving 400 miles through several congested areas, parking in the downtown area, and walking to the final destination.
- **Travel by rail**: This trip will involve taking a cab to the railroad station in city A, a direct rail connection to the downtown area in city B, and a short walk to the final destination.

TRANSPORTATION MODES SELECTION (CONT.)

➢ **Hint:**

- This is a business trip, the person making the trip is willing to pay up to $25 for each hour of travel time reduced by a competing mode. (For example, if one mode is two hours faster than another, the traveller is willing to pay $50 more to use the faster mode.)

➢ After examining all direct costs involved in making the trip by air, auto, or rail (including parking, fuel, fares, tips, and taxi charges) the traveller concludes that the trip by air will cost $250 with a total travel time of 5 hours, the trip by auto will cost $200 with a total travel time of 8 hours and the trip by rail will cost $150 with a total travel time of 12 hours.

TRANSPORTATION MODES SELECTION (CONT.)

- **Determined:**

1) Which mode is selected based on travel time and cost factors alone?

2) What other factors might be considered by the traveller in making a final selection?

- **Solution:** (1)

- Air: 250 + 25(5) = $375 5 hours
- Auto: 200 + 25(8) = $400 8 hours
- Rail: 150 + 25(12) = $450 12 hours

TRANSPORTATION MODES SELECTION (CONT.)

➢ **Solution:** (2)

- The traveller may have other reasons to select another alternative.
- **Safety:** While each of these modes is safe, the traveller may feel "safer" in one mode than another. For example, rail may be preferred because of concerns regarding air safety issues.
- **Reliability:** If it is very important to attend the meeting, the traveller may select the mode that will provide the highest probability of an on-time arrival. If the drive involves travel through work zones and heavily congested areas, rail or air would be preferred.

TRANSPORTATION MODES SELECTION (CONT.)

- **Solution:** (2)

If potential air delays are likely due to congestion, flight cancellations, or inclement weather, another mode may be preferred.

- **Convenience:** The number of departures and arrivals provided by each mode could be a factor. For example, if the railroad provides only two trains/day and the airline has six flights/day, the traveller may prefer to go by air.