Urban Transportation Planning

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Lecture No. # 02

Introduction Contd.

This is lecture number 2 on urban transportation planning. We will continue with the introduction for the course, in this lecture 2. You may recall in lecture 1, we first discussed about the basic aspects related to transportation planning process, then discussed in detail about the development in transport technology looking back at a history. Now, before proceeding with the other aspects related to this lecture, we will have a small recap; recapitulation of what we did in the previous lecture. We will do this recap in question answer mode, we will post some questions and try to answer, so that we are able to check, whether we have captured the right points in the previous lecture.

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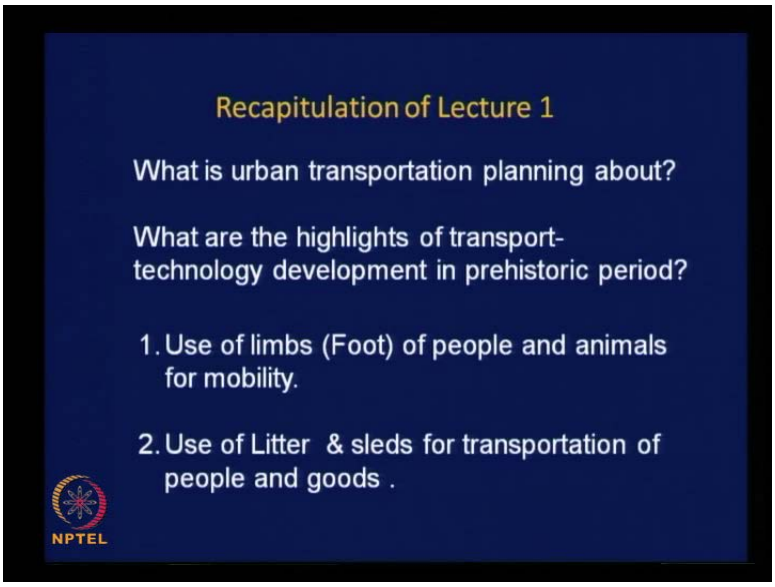

Let me start with the first question to you, recapitulation of lecture 1. The first question is, what is urban transportation planning about? I will answer this question myself, so that you get encouraged to answer subsequent questions on your own. Urban transportation planning is about 5 important points; number 1, understanding of the

travel pattern in an urban area; number 2, understanding of the causal factors that influence the demand for travel and intern the travel pattern; number 3, development of relationship between the travel pattern and the causal factors; number 4, application or use of these relationships to predict the future demand for travel and finally, to predict the future travel pattern. Number 5 and the last prediction of the transport infrastructure requirement, based on the predicted travel demand; so that we are able to plan for the future requirement of transportation infrastructure. This is what we saw to start with in the previous lecture.

Let me pose the second question to you and you can feel free to answer. The second question is what are the highlights of transport technology development in prehistoric period? Any answers? Yes, he would like to answer pass on the mike to him, highlights of transport-technology development in prehistoric period.

You had mentioned sir that transportation really came into being with the invention of the wheel; that was one major step in transportation. And, you mentioned also the role of the Romans.

Yes.

In the development of roads and you highlighted the saying that all roads lead to Rome.

Yes, thanks I appreciate. And, these development took place a bit latter, the first 2 important developments in prehistoric period are; number 1, use of limbs namely foot of people and animals for mobility, that is where we started and then use of litter and sleds for transportation of people and goods. These were the 2 important developments in prehistoric time.

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Then, what were the developments in historic period B.C? The first important development was, as was mentioned by him; invention of the wheel. There was another important development during the same period, anybody? Understanding of construction of roads or development of road construction technology, mainly by Romans; is not it? Let us post this question to our self, developments in historic period A.D up to 10th century. Any suggestion? Any response? Yes, please; give the micro phone to her.

Invention of horse shoe, you mentioned something about that.

Yes, you mean to say that invention of horse collar and horse shoe was the only invention during this time period.

Let us see whether you are right or wrong.

Ships.

Let me, yes please.

(( ))

Yeah, that comes bit later; I will just show you the developments during this period. This is what happened as she was mentioned mentioning fall of Roman Empire, happen during this period. And, this is termed as dark ages in the history of transport technology

development itself. And, the only invention done during this time period was invention of rigid horse collar and iron horse shoes.

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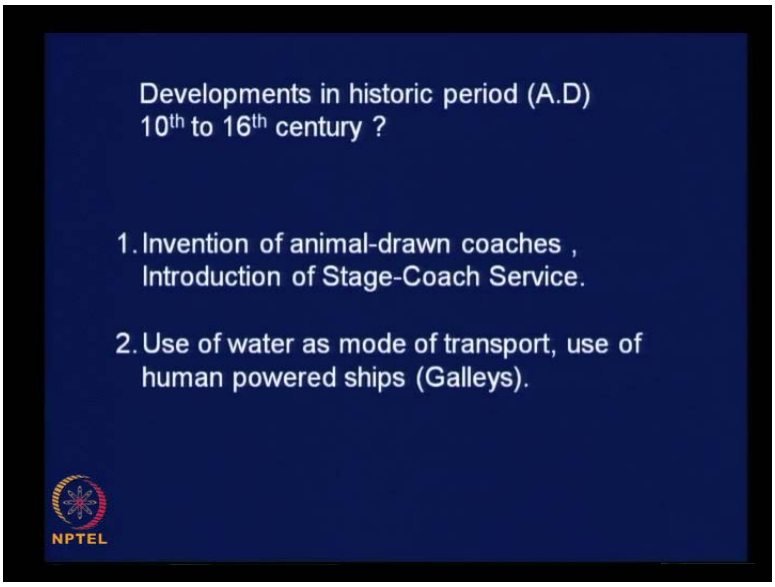

And, development in historic period A.D between tenth and 16th century after invention of wheel and horse collar and horse shoe, what might have happened? Yes, please give the micro phone to him.

Sir, in the invention of the stage coaches.

Invention of stage coaches, you are right. So, invention of animal drawn coaches and then, introduction of stage coach service as a regular public transport service. Stage coaches followed a regular route and stopped at prefixed locations, similar to any public transport service. There was one other important development during the same period, use of water as a mode of transport, was realized during this time period. And in the process, they invented galleys; small ships driven by human muscular power.

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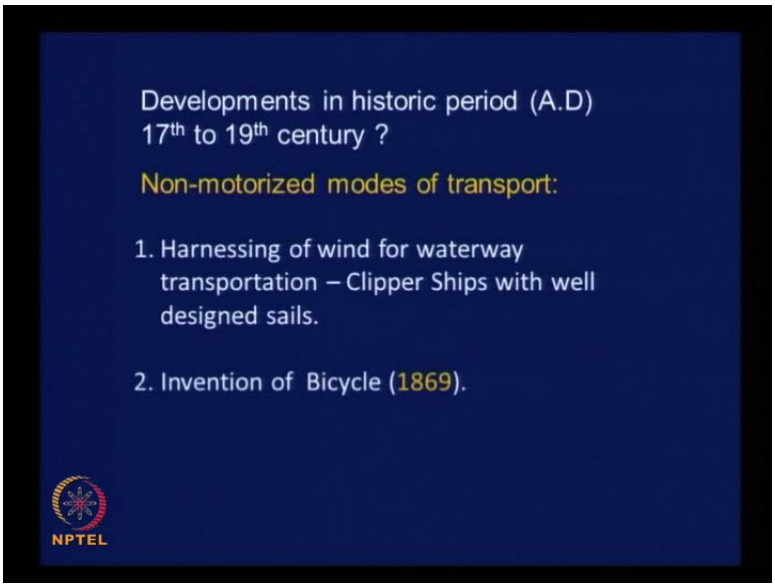

Then the developments during historic period A.D again between 17th and 19th century. Since, there were several developments during this period, let us divide the developments into two categories, first with regard to non-motorized modes of transportation. What was the development, any response? Yes, please.

It was just the speed that Macmillan introduces the bicycle.

Yes.

And, then (( )) improved the bicycles in early tiers were been improved in this period.

Good. Let us see whether the response is right or wrong. And, first Harnessing of wind for waterway transportation was understood clearly. And, Clipper ships with well designed sails were developed. And next invention of bicycle, as she rightly mentioned; please note the year of invention of bicycle 1869. This is the very important because am going to post a question later related to invention of bicycle.

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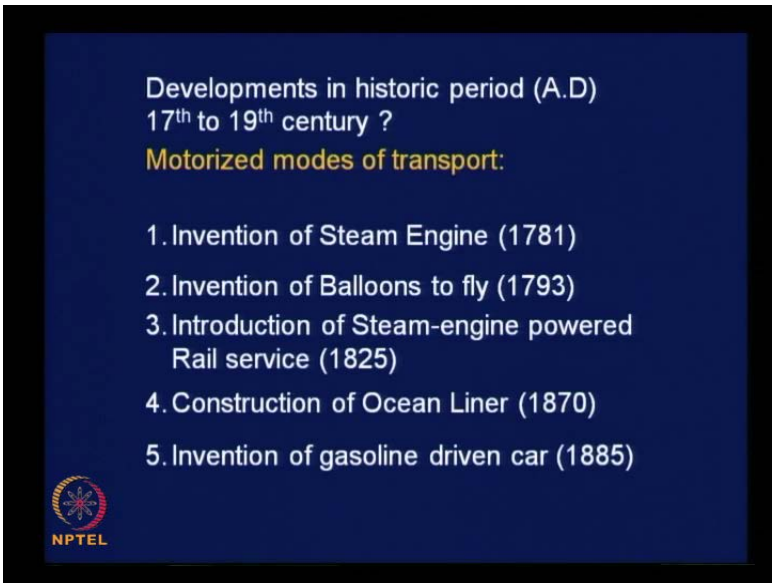

Then, in respect of motorized modes of transportation during the same period of 17th to 19th century, there were several inventions; starting from the invention of steam engine by James watt in 1781. Next, invention of balloons by French brothers in the year 1793 and then, introduction of train service; using steam powered engine in the year 1825 in England. And, subsequently construction of ocean liners, huge ocean liners for national, international as well as intercontinental travel; also, invention of gasoline driven cars during the same period of time. There were 5 important developments in transport technology during this time period.

Now, my question related to invention of bicycle is this. You remember the year of invention of bicycle; it is 1869. You may find from the developments listed here, that the bicycles have been invented at the time, when the construction of ocean liners was taken up. And, well after the invention of steam engine, introduction of train service and so on; is it not, invention of steam engine, of course this is a very complicated process compared to invention of bicycle. Bicycle is a very simple machine used for the transportation. Why it has taken so much of time to invent a bicycle? Why people have been struggling to invent a bicycle and finally, did it after the invention of steam engine? What could be the reason? Yes, please give the micro phone to him.

The pavements of surfaces which were existing probably were not conducive for the riding a bicycles; I mean it was not, it was unthinkable that you could ride on the unpaved services or the basically (( )).

It is fine, but it may not be true because they have already invented wheel and the wheel coaches were running. And, the pavement surface and path ways were more or less conducive. Any other response? Yes, please; take the micro phone, it is there.

I think it is more related with the balance.

Yes.

Because the real engine is balanced completely on 4 wheels and may be more than that. Plus the even the ocean liners, they are also completed supported from by the water but the bicycle is it is more of the balance.

Excellent; excellent answer. Bicycle is statically unstable vehicle; you cannot just hold the bicycle stable in its static position. Whereas dynamically, it is a stable vehicle, it has taken quite some time for people to understand the possible dynamic stability of a two wheeled vehicle. It is really a complicated mechanism which needed lot of third process before they invented bicycle. So, that could be the reason in my opinion that bicycle was invented only after the invention of several motorized modes of transportation.

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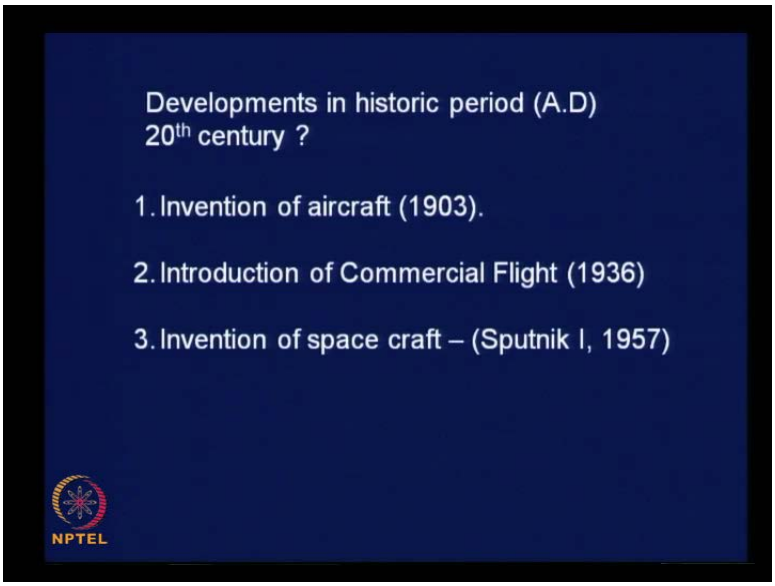

Let us pass on to the next question, developments in historic period A.D in 20th century. The most important development was the invention of aircraft in 1903 by Wright brothers and then introduction of commercial flight in 1936. And, another important mile stone in transport technology also took place in the same century. Any response? Invention of space craft; Sputnik 1, was invented in the year 1957 itself, from then on there were several developments in space craft technology.

So, this completes our recap on lecture 1, let us proceed further to understand different aspects related to transportation system and its characteristics. As you may appreciate understanding of transport system and its characteristics is very important to understand the travel pattern as well as travel behavior of people in an urban area. In this context, let us look at the characteristics of different modes of transportation and before getting into the specific characteristic aspects, let us take a over view of the transportation system itself. What are the different modes of transportation system or how many modes of transportation are available in the system as a whole? Just number, how many? 4, one response is 4, any other number? Fine. Let us list all the modes available for transportation in the system as a whole.

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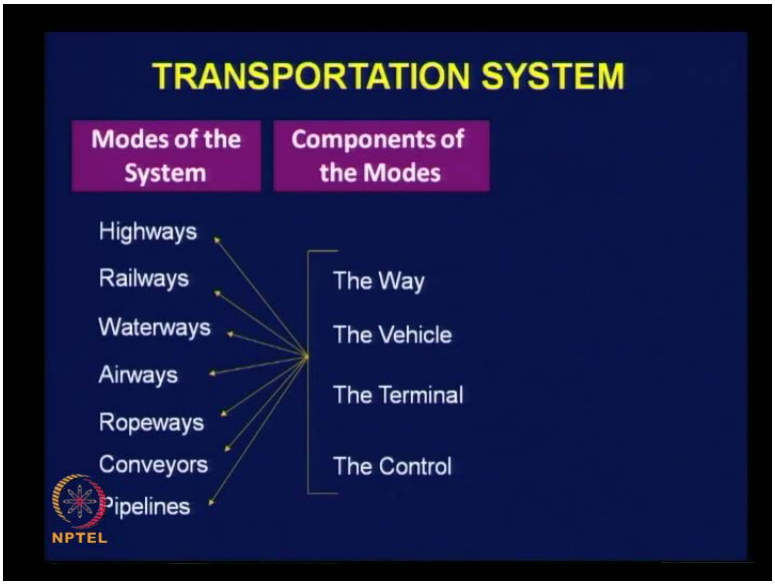

Starting from modes of the system, starting from highways, railways, waterways and airways; these are the very well known 4 major modes of transportation. This is not the end; there are several other modes within the system like ropeways; even though usage is

limited, it is a mode of transportation available for both goods as well as passenger transportation. Then, conveyors as a mode of transport is quite popular in different context, any other mode? Last but not least, pipelines; so, we have totally 7 modes of transportation in the system, 4 major modes and 3 minor modes. Now, let us try to identify some major components for these modes. Can you identify a set of major components in general, which is applicable for any of these modes? You may realize that there is a path way needed for mobility for transportation. So, you can understand the way to be one of the major components of any mode.

And, then to carry the goods and people on the way, we need a vehicle; so, vehicle is another important component. Then, we need to load and unload people and goods at prefixed locations, these locations are nothing but transport terminals; the terminal is another important component of a mode. And, then when you operate number of vehicles in a mode, there needs to be some kind of control and guidance. So finally, we can say that the control is also the important component of any mode of transportation. Now, we understand that there are 4 important components that are applicable for each of these 7 modes that we have already identified.

Let us go further and try to understand the characteristics of each of these components in respect of each of these modes. Let us start with the way, way concerned with highways. The road way system which is constructed to a said specification and standard, it is a way for the mode highways. Highways facilitate simultaneous longitudinal and lateral movement of the vehicles. There is some flexibility possible in respect of highways when you think of mobility of vehicles on the way.

Where as in the case of railways, the way is nothing but the railway track or the rails resting on sleepers and then on ballast; this is a very rigid system, which does not permit simultaneous longitudinal, and lateral movement of vehicles. It facilitates only longitudinal movement of vehicle. You must have some other system to facilitate lateral movement of vehicles in a rail system. You think of a way in respect of waterways. Do we construct the way, path way for water way, vessels, boats or ships? It just the identified water surface, the body of water; so, we can term it as the route rather than a way. There is no actual construction taking place in formulating the way for water way mode of transportation. In respect of airways, it is almost similar to waterways; we do not construct the path way for airway transportation, we just identify the route.

How about the ropeways? Can you identify the way in ropeway transportation? The rope it selves is a way, constitute the way as for as this particular mode is concerned.

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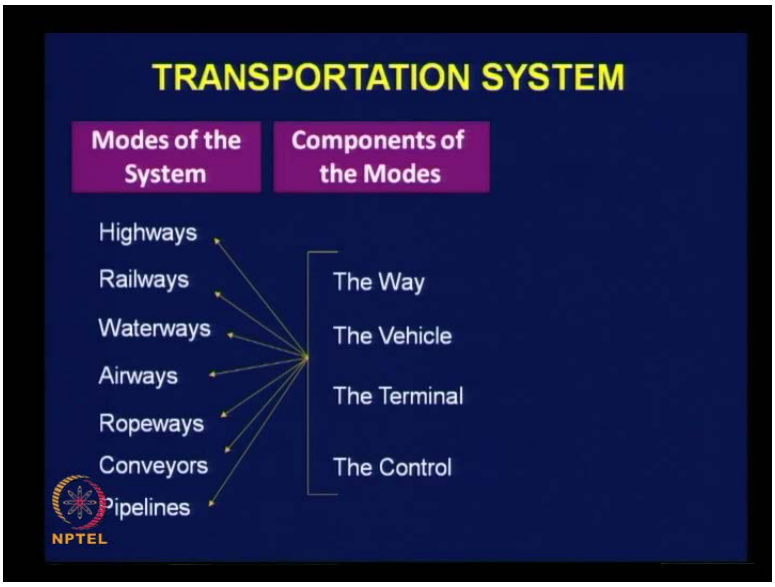

Conveyors could be bell conveyor or sometimes bucket conveyors. Where do we make use of conveyors as mode of transportation? Big factories and mining areas, it is used as a very effective mode of transportation to transport bulk commodities over short distances. Conveyors used for passenger transportation, any example?

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Yes, please.

Ski lifts.

Ski lifts and it is quite common, now a day's conveyors system is used for long distance movement of passengers in international airports; it is quite common now a day's.

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Yes, please walked ways, yeah and so on. So, the conveyor belt or bucket system itself acts as a way in this particular mode of transportation. And, lastly pipeline, the way for this mode or the pipes themselves constitute the way for this particular mode. Let us look at the characteristics of vehicles in each of these modes. If we consider highways, the vehicles have a wide ranging static and dynamic characteristic. We have very large

vehicles like multi axel trucks, articulated buses, and smaller vehicles like cars, motorized three wheelers, motorized two wheelers and so on.

And, this way is capable of accommodating all these categories of vehicles, even though they widely vary in their static and dynamic characteristics. The highway system is able to accommodate all these kinds of vehicles, because of the flexibility available in the highway system. The vehicle in the case of railways is very rigid as fixed configuration and wheel spacing axel spacing and so on, you cannot have varieties as you have in highways in the case of railways. You can have either passenger trains or good trains and the specifications for the coaches as well as for the goods, wagons all are most same; depending upon the gage used for the railway system.

How about the vehicle characteristics for waterway transportation? It provides for wide variation, the shape, size and other dynamic characteristics of vehicle; starting from small boats used in inland waterway transportation to huge vessels used in ocean transportation. And, the mobility in the case of waterway transportation is quite flexible. The vehicles can move simultaneously both longitudinally as well as laterally. And, in the case of submarines, even vertical movements simultaneous longitudinal, lateral, vertical movement is also possible in case of waterways. If we consider airway transportation, the vehicles again can have a wide variety of configuration and dynamic and static characteristics starting from small helicopters to very small planes to huge aircrafts, carrying hundreds of passengers or several thousand tons of cargo.

And, the vehicles in the case of ropeways, can we identify the vehicles in ropeways? In ropeways the cabins that are moved on the rope to transport either goods for example, tea leafs in the case of tea estates or passengers as a recreational mode of transport in place of tourist importance. So, the cabin which moves on the rope is the vehicle in the case of rope ways. Conveyors which is the vehicle in the case of conveyor, we have identified already the way in conveyors.

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Yeah shall we say, the way and the vehicle are together? As far as conveyor system is concerned, they are both are as in the same system. And, pipelines again the way and the vehicle are identified as one unit in the case of pipelines. Terminal is another important component; let us quickly see the characteristics or the importance of terminal in respect

of each of these modes. If we consider highways terminal is relatively less expensive and less important compared to the way which is capital intensive, constructed all along the route. How do we identify the terminal in the case of highways? The bus stations truck terminal etc or the terminals, even the way side bus stops or busses also are included under the category of terminal for highways.

In the case of railways, the terminals are very clearly defined; all the railway stations whether big or small, constitute the terminal for railway system. For waterway transportation, ports, sea ports or inland water way ports constitute the terminal; please understand in the case of waterway terminal is a very important component, were we do not spend much or invest much of money in developing the way for waterway transportation. And, the terminal is a very important component in the case of waterway system.

And how about airways? The terminals are nothing but the airports which are again very important cost intensive component compared to its way. And, ropeways, do we have terminal for ropeways? Yes, we have marked fixed locations for the starting and the ending of the rope way operation; can be designated as terminals for the rope way mode. Conveyors, similar to ropeways there will be starting point and an ending point for the conveyors; those two locations can be identified as terminals. And, for the pipelines, similar to the other two systems the starting and end points of the pipeline system could be considered as terminals. And finally, the control, how do you understand the control for highways? Any response, control for highways?

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Yes, please signals.

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Intersections.

Rounder boats.

Rounder boats, great separation and so on. You may recollect your under graduate knowledge about the traffic control devises, signs, signals, markings and traffic islands. All these devises together form the control system for highways, is it not? That is how

we need to understand the control for highways. How about railways? Similar, to highway system mostly signals, signs right and the points in crossings to some extent to regulate the movement of trains. Then, for waterways, how do we control the movement of vehicles in waterway system?

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Mainly by communication for n route regulation of the vessels in the case of waterways for regulation of movement of vessels in the terminal area, in addition to communication you can also make use of light signals; both together are employed to find tune the movement of vessels in the harbor area. In the case of airway transportation, it is similar to waterway transportation; n route regulation is mainly by communication. And, regulation of movement of aircrafts in the terminal area airports is both by communication as well as by light signals to some extent marking on the runways and taxi ways. And, control the respect of ropeways, the driving mechanism itself acts as a control system for ropeways. And, conveyors again the control is nothing but the driving mechanism itself acts as a control. And, in respect of pipelines, the pumping mechanism becomes the control system for pipelines.

Even though most of these aspects that we have discussed are known to us, it is better to look at the characteristics of these modes in the context of studying the characteristics of the transportation system as a whole. Another important aspect to be thought of is the steps that are involved in the development of each of these components; each of these 4 major components of any mode of transportation.

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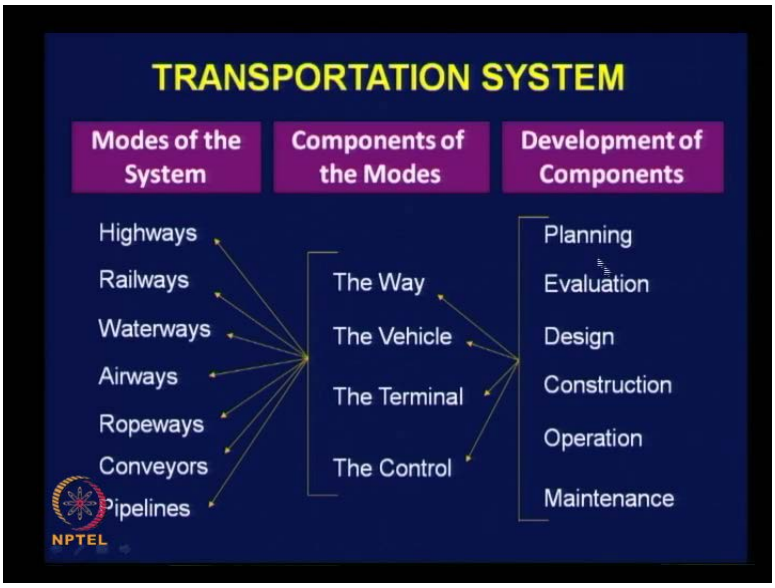

For development of the components, we go through 6 important steps. Starting from planning, evaluation, design, construction operation and maintenance; all these 6 steps are important for each of these components, if we consider way, you need to go through all the 6 steps to develop way completely. It is equally applicable to other components too; the vehicle system, the terminal system as well as the control. Now, if you think of comprehensive study of transportation system as a whole, it implies the study of all the 6 steps, related to all the 4 components in respect of all the 7 modes. That is what is really understood by a comprehensive study of transportation system.

And, students taking courses in transportation stream take courses like pavement engineering, which involves study of design construction and maintenance of both highways and airfield pavements. Can you identify the terminologies are related to this particular course in this flow chart? For the course pavement engineering. Yes, please.

No.

No. I am asking you to identify the terms related to the course pavement engineering.

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Yes, highways and airways and their modes. If we come to the next column, it is related to the way; then go to the next column, it is related to the design construction and maintenance. That is how I would like you to understand the contents of different

courses that you take in the specialization of transportation engineering. Traffic engineering, we mainly study road traffic engineering. So, in respect of modes, it is related to highways. Then, if you look at the components it is related to control.

Control.

Then it is related to operation, highways control operation, broadly covers these areas. Transportation planning, we study in general planning of all modes of transportation, it covers the whole system. And, all the 4 components of the system and you can say planning is directly related to this system, planning this system as a whole. Transportation economics, yes, please.

Evaluation.

Evaluation of any component related to any mode, you can say transportation economics is directly related to the system and evaluation process. So, it is possible to identify the relevant terms for any course that a student is taking in the stream of transportation engineering from this flow chart. Let us move on further.

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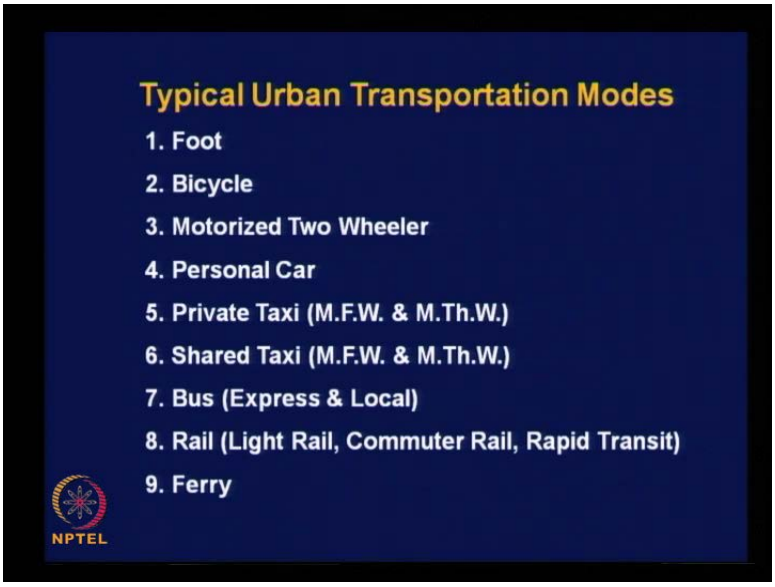

Let us try to list the different modes of transport available for urban transportation. The availability of or the categorization of modes is based on their technical as well as the level of service characteristics. Accordingly, we can classify the modes starting from Foot, Bicycle, Motorized two wheeler, Personal car, Private taxi, Shared taxi, Bus, Rail

and Ferry in some cases like the state of Kerala, the state Assam and so on; they have ferry service available even for urban transportation. Here, in respect of private taxi, I have listed M.F.W; M.F.W stands for Motorized Four Wheeler; M.Th. W stands for Motorized Three Wheeler. By private taxi, it is meant that one can engage the taxi for their own purpose, where as in the case of shared taxi, it is a vehicle operated on a particular route with fixed locations for stoppage.

So, when the route and stopping's are suitable to your requirement, you take a share taxi, otherwise you engage a private taxi. Shared taxi again could be a Motorized Four Wheeler or Motorized Three Wheeler like auto rickshaw. So, this is how we classify the difference modes available for urban transportation.

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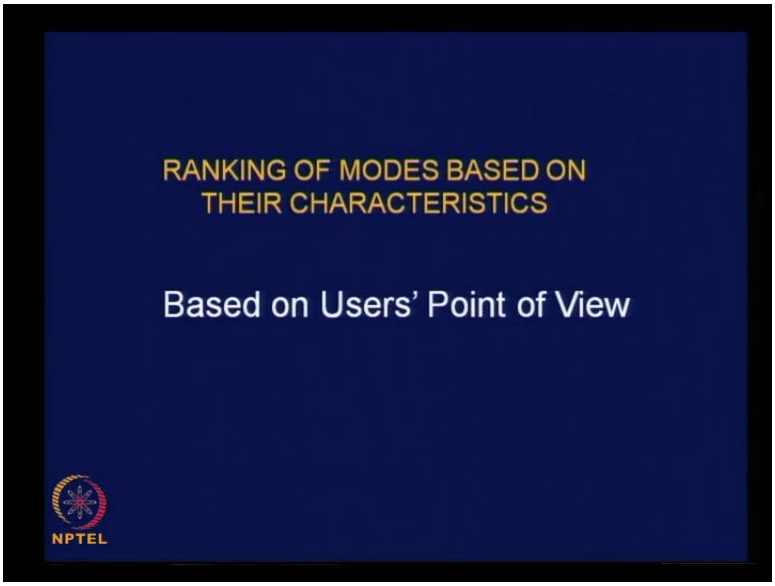

Now, let us try to understand and rank these modes based on their characteristics, first based on the user's point of view. We categorize or we understand the modes based on their level of usage available to us or level of service provided by each of these modes to our requirement, is it not. We look at modes to study or to understand the level of service based on their speed, how fast a particular mode can take us. Then, the accessibility; how easy it is to access that particular mode. If it is a train you may have to go a long way from home to reach the railway station. If it is a bus, again you may have to take another mode to reach the bus stop. If it is your own car it is available at the door step it provides door to door movement.

So, accessibility is another criterion that for the users, keep in mind while judging the level of service of a mode. Then cost implication; how expensive is a particular mode of transportation then probably the level of comfort available in a particular mode. So, these are the facts or the factors which influence the cauterization of different modes by the users.

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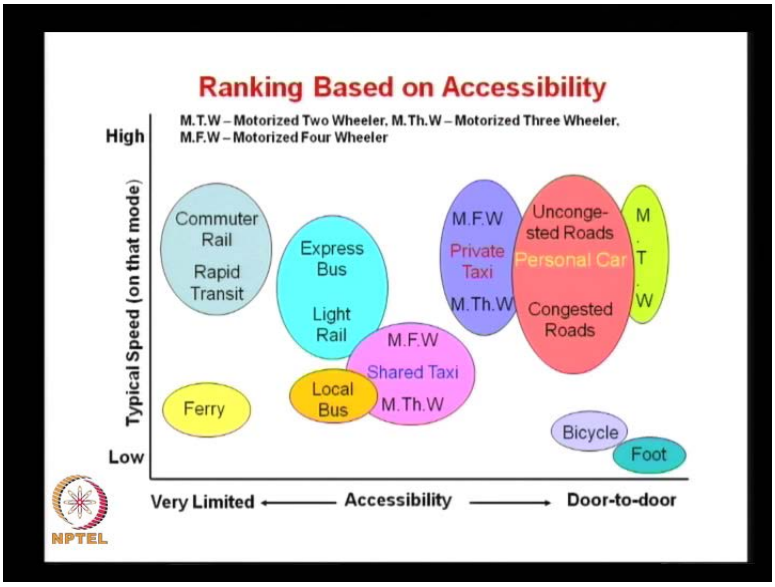

Let us first consider speed of the mode as well as accessibility, both taken simultaneously and rank all the available modes for transport in urban context, which is the mode that has got limited accessibility; very less accessibility. Commuter rail rapid transit generally on the average the railway station may be little far off compared to the other modes of transportation. Next comes may be ferry, depending upon the location. You may just find that I have given these things in balloon kind of presentation, because it has got its own range in respect of speed as well as accessibility; that is why I am not rigidly fixing a particular number for these characteristics.

Then, probably express bus and light rail, which is better accessible compared to the other two. Then, local bus simultaneously can see the speed is indicated in respect of each of these modes, then shared taxi could be a Motorized Four Wheeler or Motorized Two Wheeler. Next comes private taxi which is easily accessible when compared to shared taxi could be motorized four wheeler or three wheeler. Next, personal car which is easily accessible and it is speed could be very high; if the road is uncongested, and

relatively low if the road is congested. Next bicycle easily accessible but of course speed is much less. And, then motorized two wheeler Motorcycles, available to you, provide you door to door service. And then finally, the well known mode of transportation foot; very slow but provides you door to door service. So, this is how the available modes can be ranked based on accessibility and speed simultaneously.

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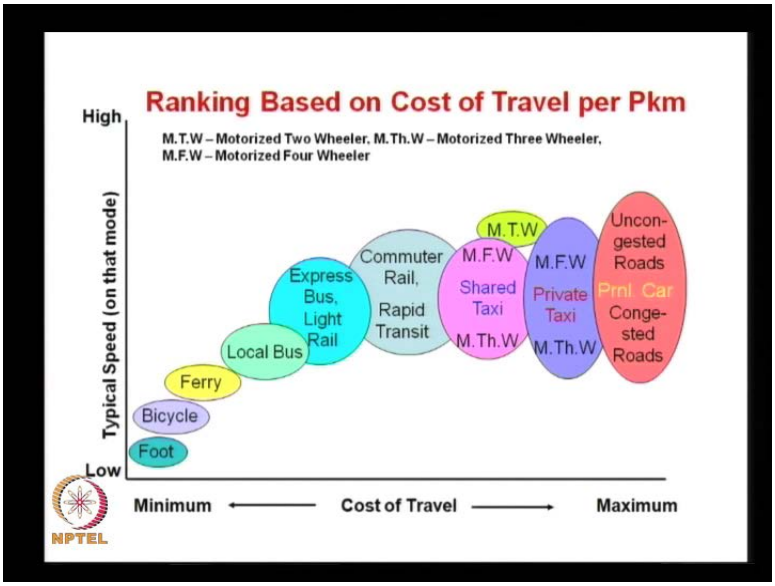

Let us try to rank these modes based on cost of travel per passenger kilo meter; Pkm stands for passenger kilo meter. The least expensive mode, where cost is nearly 0 is foot. Next comes bicycle, then probably ferry service, then local busses, next express bus sometimes light rail, commuter rail, rapid transit, then probably shared taxi, then motorized two wheeler, private taxi and finally personal car. So, this represents simultaneously the level of cost variation as well as the speed; I maintained a speed of the different mode simultaneously in all the cases.

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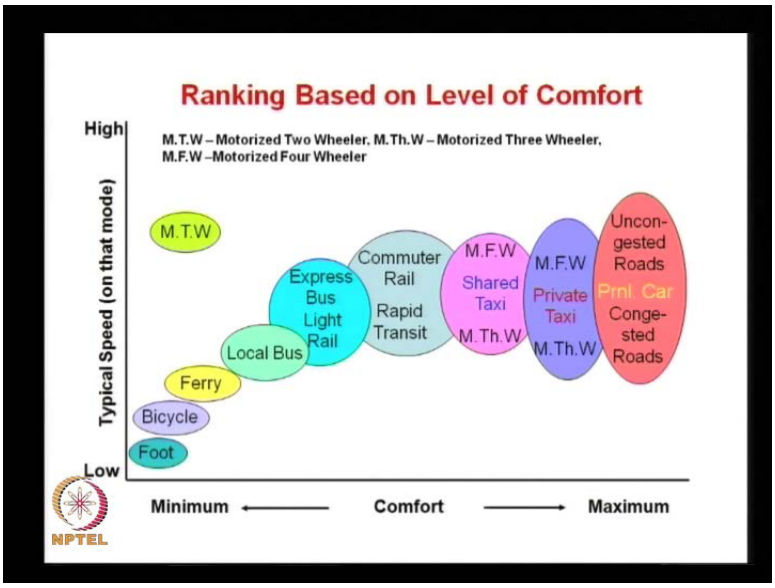

So, this is how we look at the available modes for travel in urban area. Let us try to rank the modes based on the level of comfort provided by the different modes which is a least comfortable mode?

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Yes, walking because we have to exert a lot to walk and negotiate distances. And, then comes bicycle, then motorized two wheeler; even though it is faster, it is not that comfortable because you are totally exposed to the heat, dust and smoke of the whole traffic stream is on you, when you drive your two wheeler in addition to the strain with which your driving the two wheelers. Then, probably ferry, local bus, express bus, light rail, then commuter rail rapid transit, then shared taxi, then comes private taxi and finally, personal car gives you the maximum comfort. Because you can choose or kind of car that you could like to and gives you complete comfort as you like air conditioned or you can even adjust the air condition level and so on.

I have indicated the level of shared taxi being little higher than the comfort level available in rapid transit or metro rail system, (( )) it acceptable?

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No, it is we look at it based on the comfort available; that is the only consideration here. And, the consideration based on which this ranking has been given particularly for these

two modes, is that in the case of shared taxi a seat is assured for everybody; you do not stand in a shared taxi and travel. Whereas, in the case of rapid transit as well as commuter rail; you may or may not get a seat. So, that is the consideration they put or the level of comfort of shared taxi to be little higher than level of the comfort level available in the case of commuter rail.

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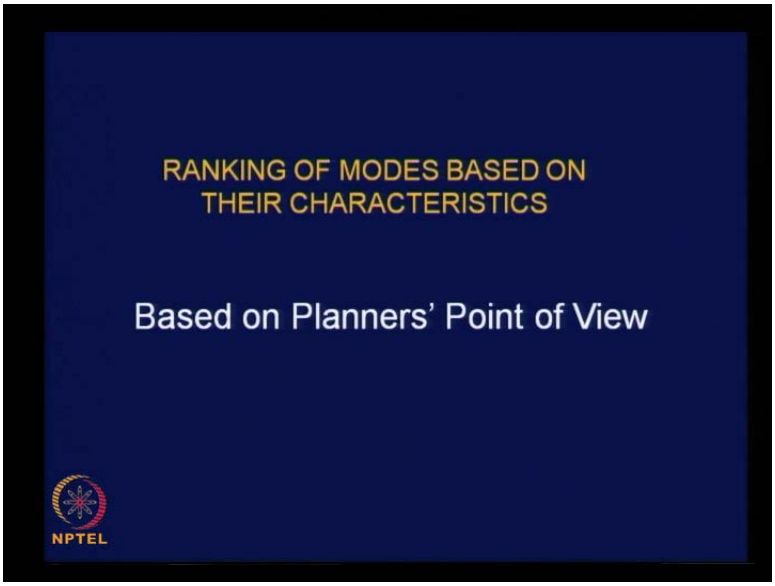

Now, let us rank the modes based on their characteristics for the purpose of planning in planner's point of view. Of course, planner's have to consider all the aspect considered by the users, starting from accessibility, speed, cost comfort and so on that is not all planner should take a over view and give serious consideration to the level of impact these modes make on environment as well as energy. So, these are the facts or the factors which influence the cauterization of different modes by the users.

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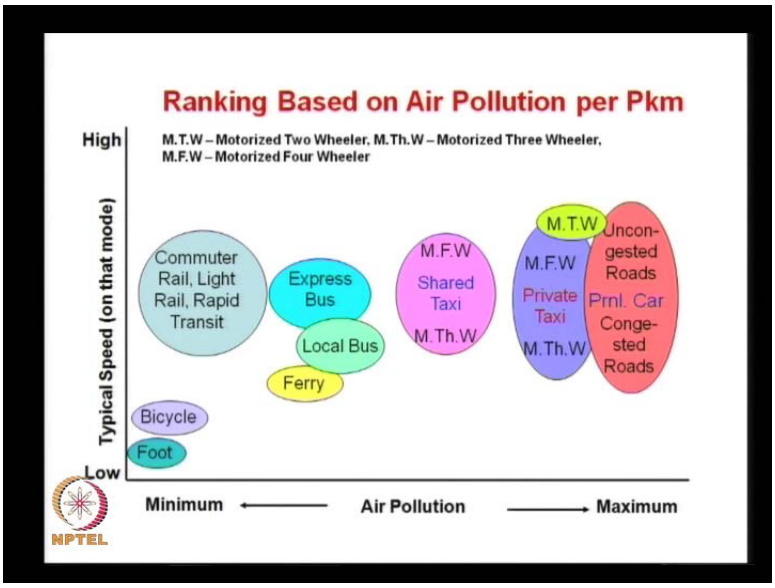

Let us try to rank the modes based on the level of air pollution they may generate; simultaneously considering their speed. Of course, you all know the least polluting mode is foot and then bicycle, commuter rail, light rail as well as rapid transit; I have put all the modes in rail transit together. Why it is least polluting? Because yes, please.

The volumes are so high per capita or per person. (( ))

I appreciate your point; we consider pollution as the amount of pollution per passenger kilo meter; that is one aspect. So, that we have a common base for all the modes, that is the idea of (( )) ranking the modes based on the pollution level per passenger kilo meter. But please remember in the case of urban areas, the tractive force for the rail system is derived from electricity, which is a non polluting source. That is how the rail system provides you a least polluting mode of urban transport; whether it is commuter rail, light rail or rapid transit. Then, probably ferry because the freshen resistance offered to the ferry, the vehicle involved in ferry is much less compared to other type of vehicles. Then, express busses and then local busses, why local busses are shown here as slightly highly polluting compared to express busses? Both are busses only.

(( ))

Yes, stoppages of busses means increased fuel consumption, increased emission and increased air pollution. Then, shared taxi, then private taxi; little polluting on a higher

side and then motorized two wheeler and highly polluting culprit is personal car. So, obviously planner's have to encourage the least polluting modes starting from foot, bicycle, rail system, bus system and ferry to some extent. And at the planning stage we need to give least important to the other modes; starting from shared taxi, private taxi, personal car and so on.

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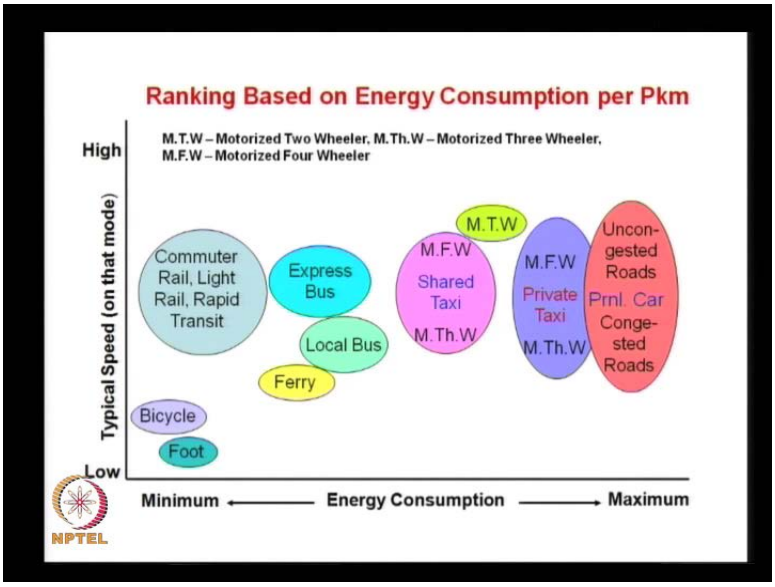

Then, ranking of the available modes based on energy consumption per passenger kilo meter; it has been found that bicycle is the least energy consuming mode of transportation. Next, comes the mode foot per passenger kilo meter, then commuter rail, light rail, rapid transit. Why rail transit is less energy consuming compared to bus? Because.

(( ))

Yes, please.

(( ))

Not only that; the tractive resistance in the case of railway system is relatively less because the wheels are metal wheels and the path way is again metal rail and the contact surface is much less compared to other systems. That is how the tractive resistance is relatively less which increases the energy efficiency of the system to a great extent. Ferry, then express bus, local bus, shared taxi, motorized two wheeler, private taxi and

personal car. Again, personal car is the culprit in this particular case also, the main reason being, the occupancy of personal cars is relatively less; even though the private taxies and shared taxies could be cars, occupancy level is expected to be much higher compared to private cars.

And, we look at the energy consumption per passenger kilo meter. That is how private cars become highly energy inefficient mode of transportation. Are you able to appreciate the ranking of the different modes of transportation based on user's point of view as well as based on planner's point of view? What is the moral of the story, after doing this ranking process? We need to encourage as planner's put your selves in the shoes of the planner, transport system planner. What are the modes which will be more efficient in providing sustainable transportation?

(( ))

Public transportation mode, any other mode, how about non motorized modes? Bicycle, even foot to some extent. So, this is how you must look at sustainability in planning for transportation system, whether it is urban regional or national level systems. Now, let us try to summarize, what we have seen in this lecture number 2. We have seen in transportation system there are 4 major modes and 3 minor modes. And, it is possible to identify a set of components for each of these modes and we identified 4 important components of these modes of transportation; they are the way, the vehicle, the terminal and the control. Then we realized that there are 6 important steps in the development of each of these components, starting from planning, evaluation, design, construction, maintenance as well as operation.

Then we looked at the list of modes available for urban travel. We found that there are nine different modes of transportation available for urban transportation. Then, we ranked these modes of transport based on user's point of view, considering the important aspects such as speed, accessibility, cost of transportation as well as level of comfort. Then based on the planner's point of view, we ranked the modes considering environmental impact as well as energy consumption as the basis. Finally, we realized that it is very important to encourage non motorized modes of transportation and urban mass transit to design a sustainable transportation system with this we conclude this lecture. And we will see the rest of it in the next class.