Urban Transportation Planning

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Lecture No. # 01

Introduction

The general aim of this course on urban transportation planning is to impart knowledge; first to understand the mobility pattern in urban areas, second to understand the factors that influences the level of mobility in urban areas. The factors particularly, the causal factors that influence mobility pattern in urban areas. Third to develop relationships between the level of mobility, and the causal factors; fourth to use this relationship to predict the future mobility pattern in urban areas, and fifth and final the use of predicted mobility pattern to understand the future requirements of transportation infrastructure to meet the future demand for transportation.

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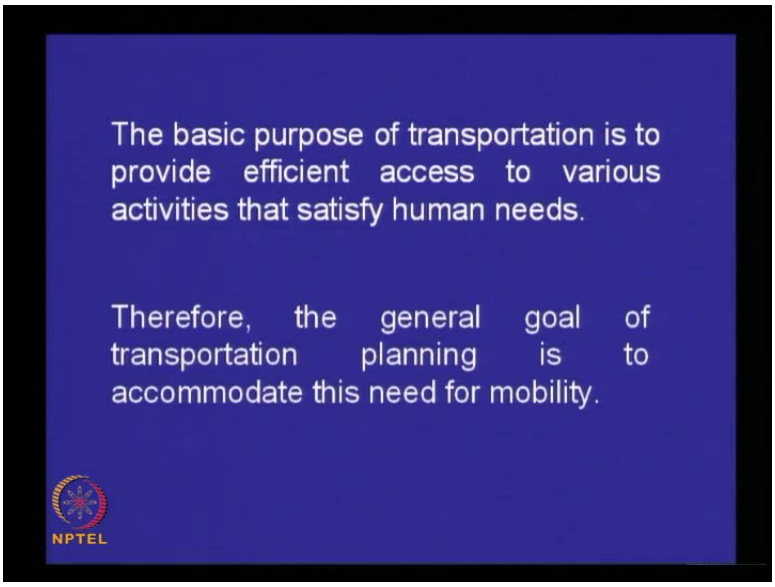

Before getting into the details of the planning process, let us try to understand certain aspects related to transportation itself that are relevant to the subject of this study. For example, if he asks a question as to what is the basic purpose of transportation? The answer is this, the basic purpose of transportation is to provide efficient access to various

activities that satisfy human needs. This is the definition or the answer to the question in a nut shell. Therefore, the general goal of transportation planning is to accommodate this need for mobility, is it not?

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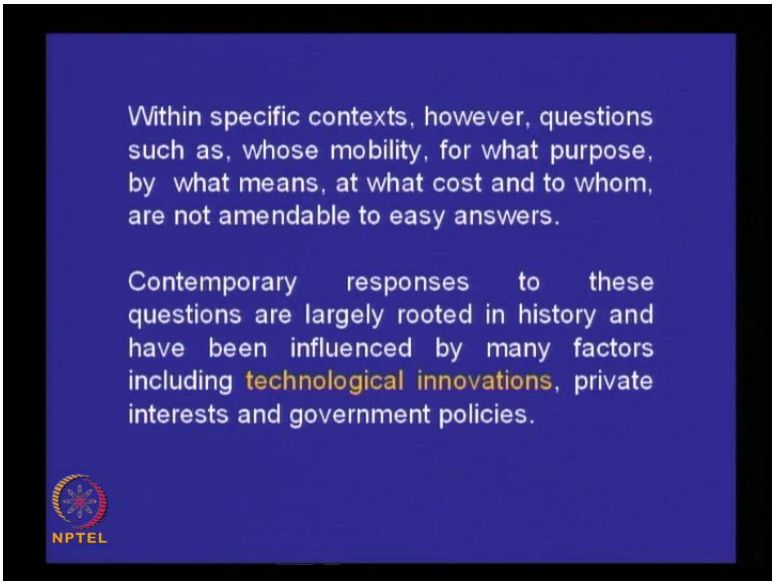

Within specific contexts, however, question such as, whose mobility for what purpose, by what means, at what cost and to whom, are not amenable to easy answers. Or in other words these are the questions to be answered when you get into the planning process in specific contexts. And contemporary responses or traditional answers to these questions are largely rooted in history. Historical aspects related to transportation as well as social economy characteristics of people living in urban areas. And have been influenced by many factors including technological innovations, very important and relevant for planning process private interest and government policies. First let us look into the technological innovations related to transportation first before going into the other relevant aspects.

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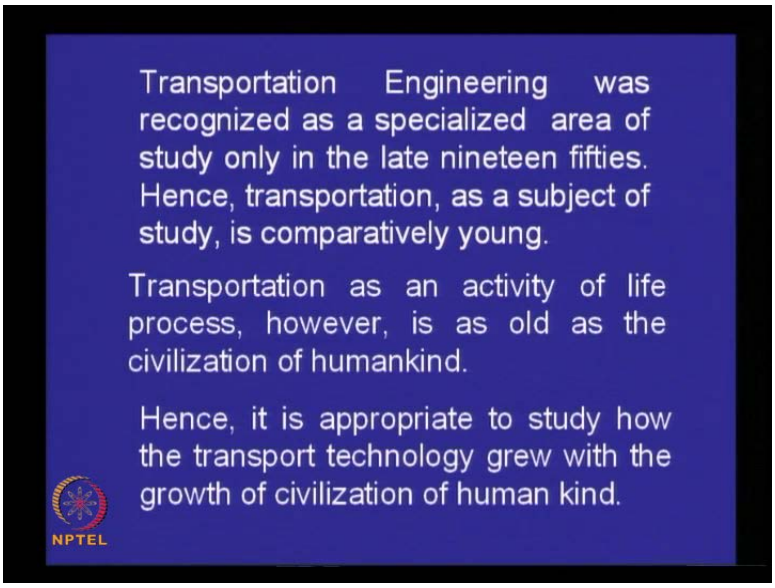

So, this is what we are going to see next development of transport technology historical aspects. And as you all know transportation was recognized as a specialized area of study in a formal way only in the late 1950s. Hence, transportation as a subject of study is comparatively young compared to your traditional streams of structural engineering, hydraulics, soil mechanics and so on. Transportation engineering is relatively younger stream of study. And transportation as an activity of life process; however, is as old as civilization of human kind, because there is no activity without transportation process. Hence, it is appropriate to consider transportation as a process to be as old as human civilization. Hence, it is appropriate to study how the transport technology grew with the growth of civilization of human kind.

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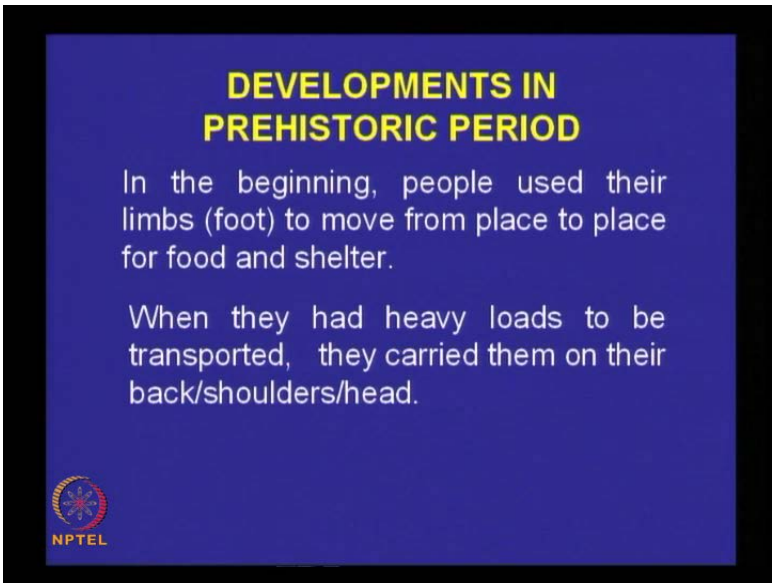

Let us first look into what happened in the development of this technology in pre historic period. As you all know in the beginning, people used their limbs mainly foot to move from place to place, mainly for two important purposes namely food and shelter. So, foot was the only mode of transportation at that point of time. Even today as you know foot is a very important mode of transportation providing access to all other modes of transportation. As well as aggress from all the different types of modes that we use even today. And when they had heavy loads to be transported, when they gathered more food items to be transported to their shelter they carried them on their back shoulder or head whichever way they found it to be more convenient. And they had their own way of packaging and fastening the goods to their body, and to the shoulder and so on carried safely to the destination.

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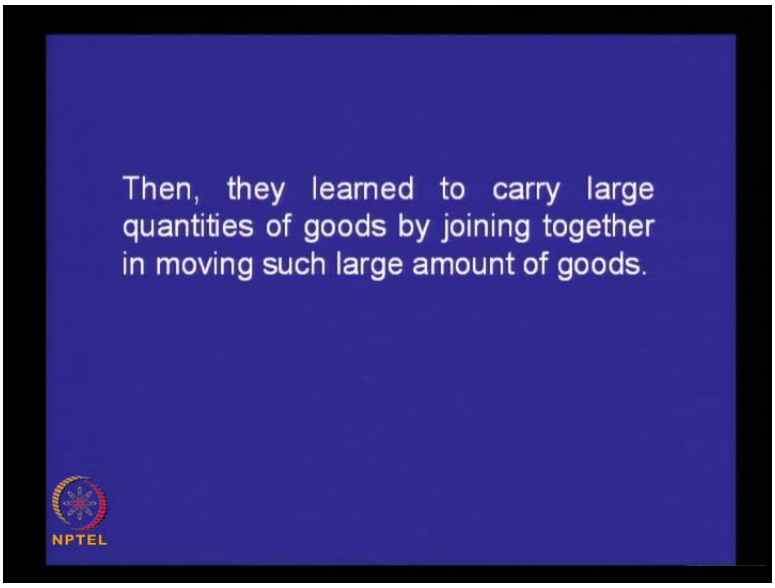

And the next step was learning about carrying large quantities of goods by joining together in moving such large amount of goods which led to the culture of group walking by a set of people in goods transportation. And as you know for carrying large quantity of goods they need to have a kind of specialized containers. They made these containers using huge animal skins fabricated in such that the skins can be tied onto large poles or wooden branches. And keeping the pole in a horizontal position, they loaded the material to be carried and then 2 or 4 people on both sides carried this huge consignment of goods from one place to another. Just to give an idea as to how this arrangement looked.

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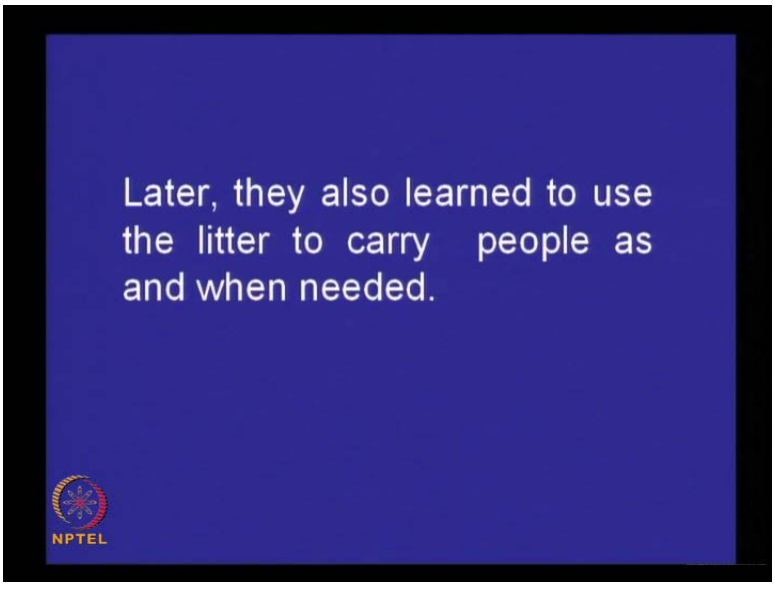

This is how goods transportation was made using a device called litter; used for transport of goods. And litter was also used then for passenger transportation particularly for transporting elderly people children and so on. Obviously, the pouch has to be modified to suit the requirements of human economies and they did that and used this modified litter for passenger transportation. And the litter used for passenger transportation looks like this. As you could see from the costume and other and other characteristics this belongs to some Asian region. And Europeans at the same time had their own version of litter used for passenger transportation those litters looked like this better fabricated and finished, but the purpose is same it was used for transporting elderly and children from place to place.

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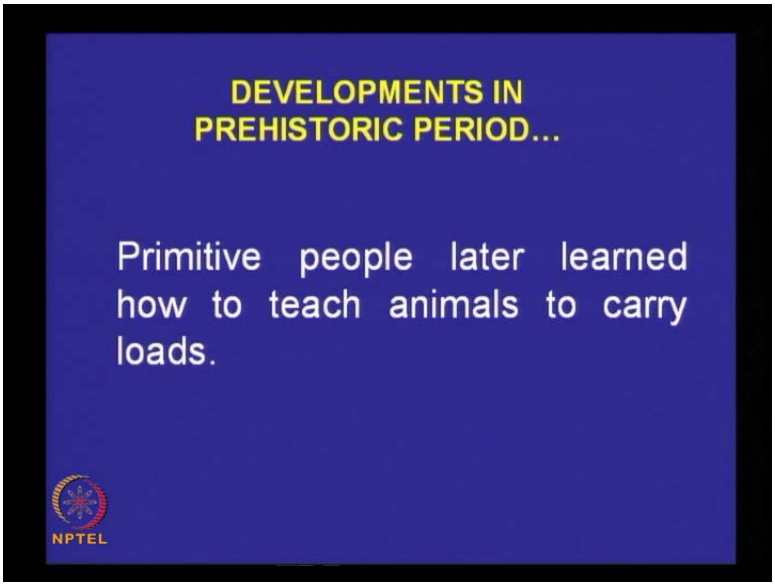

Then primitive people later learned how to teach animals to carry load obviously, when they wanted to carry more loads they thought why not make use as animals. And donkeys and camels were mainly used for this purpose, because these animals are more convenient for this particular purpose. This is how goods transportation using donkeys were done which were quite popular at that point of time. And camels used for goods transportation in certain parts of Asian countries as well as other parts of the world.

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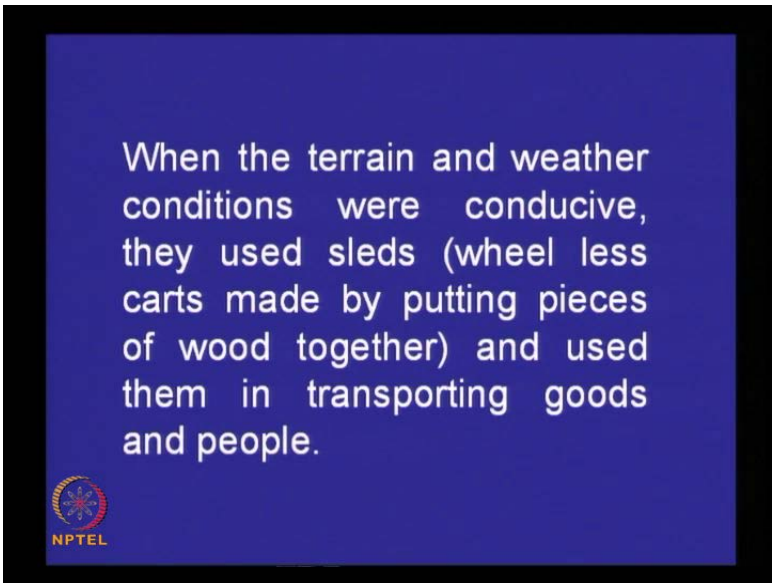

When the terrain and weather conditions were conducive like snow covered mountainous terrain, they used sleds, wheel less carts made by putting pieces of wood together and used them in transporting goods and people. And sleds as you know was drawn by dogs and this is how sleds looked, which was used for transporting people as well as goods. This is the closer view of the same this is terrain specific as well as this can be used only in conditions where the whole terrain is covered with snow.

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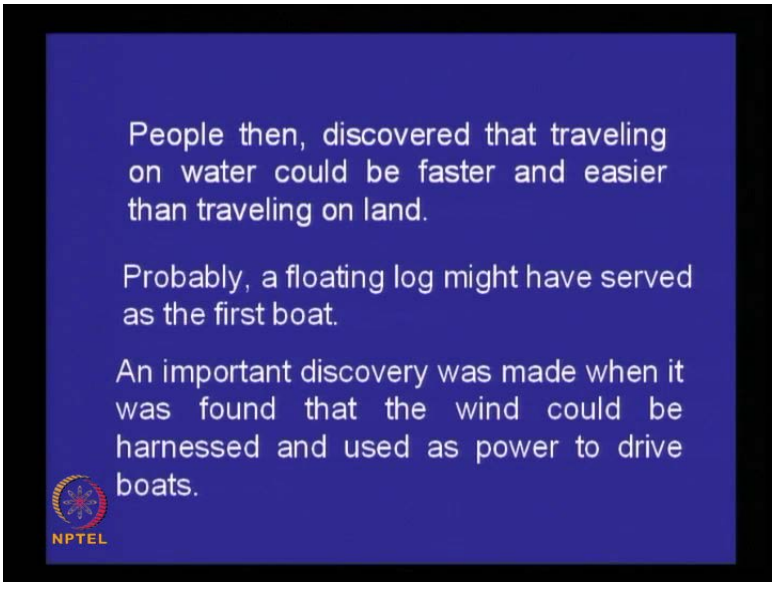

People then, discovered that that travelling on water could be faster and easier than travelling on land. May be by observing logs of woods being carried by jungle streams in a faster rate; they realized that using water as a mode of transportation may be more advantageous for faster and smoother movement. Probably, a floating log might have served as the first boat for the people to move from place to place. Just sitting over the log and moving around. An important discovery was made later when it was found that the wind could be harnessed and used as power to drive boats. They just had a feel of making use of winds as energy which can be harnessed for moving boats, but they did not get to the technical aspects of harnessing wind at that point of time.

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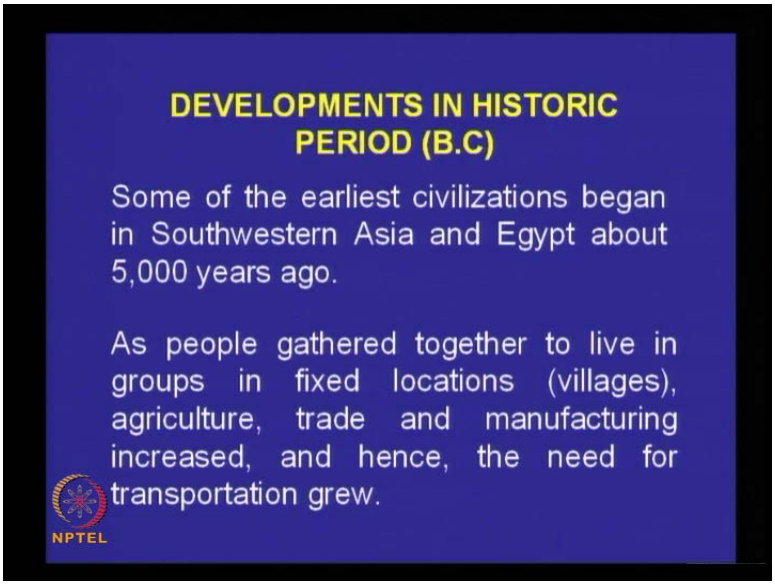

Now, let us look into the developments in historic period before Christ. Some of the earliest civilization as you know began in south western Asia and Egypt about 5000 years ago. As people gathered together to live in groups in fixed locations namely villages, agriculture, trade and manufacturing increased, and hence the need for transportation also grew.

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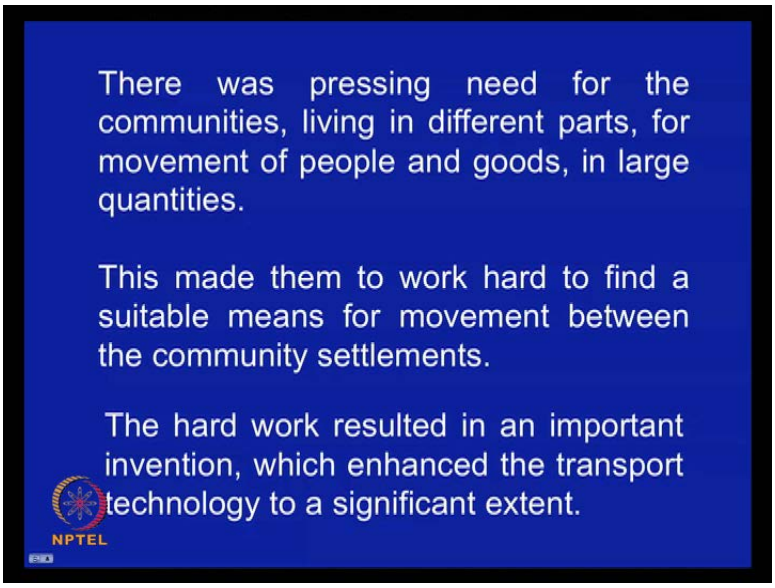

The pressing need for communities living in different parts form movement of people, and goods in large quantities on ground on the surface made them to work hard to find a suitable means of movement between the community settlements namely villages. This resulted in an important invention which enhanced the transport technology to a significant extent. What is this important invention anybody? Yes please.

Wheel sir, wheel.

Yes, the invention of wheel.

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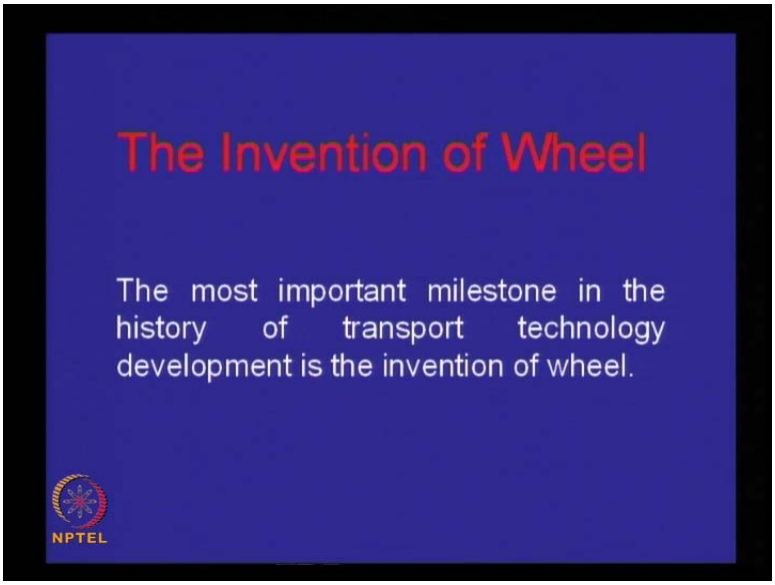

And the most important milestone in the history of transport technology development is the invention of wheel, no doubt about it. Historians disagree on the time of invention of wheel.

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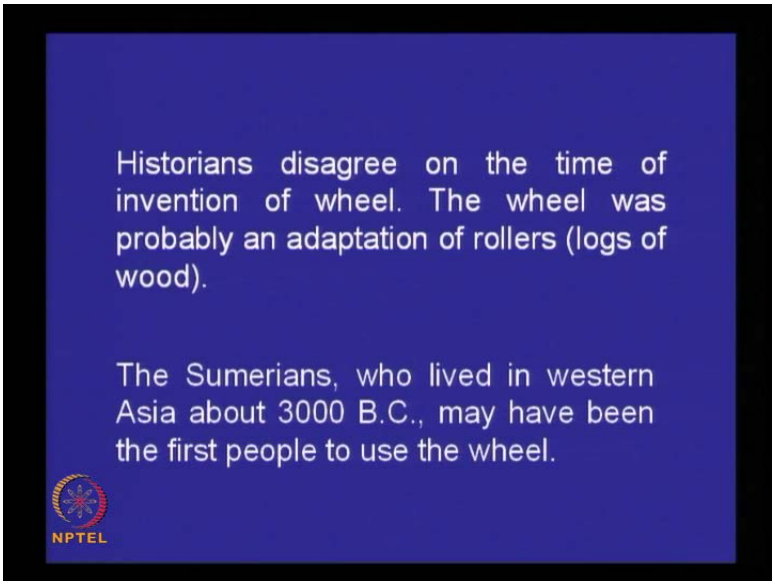

The wheel was probably as adaption of rollers or logs of wood which were found to be rolling on sloping terrains. The Sumerians, who lived in western Asia about 3000 B. C, may be the first people to use the wheel. This is supposed to be the first version of wheel just log of wood cut to size with a hole made to insert an axle.

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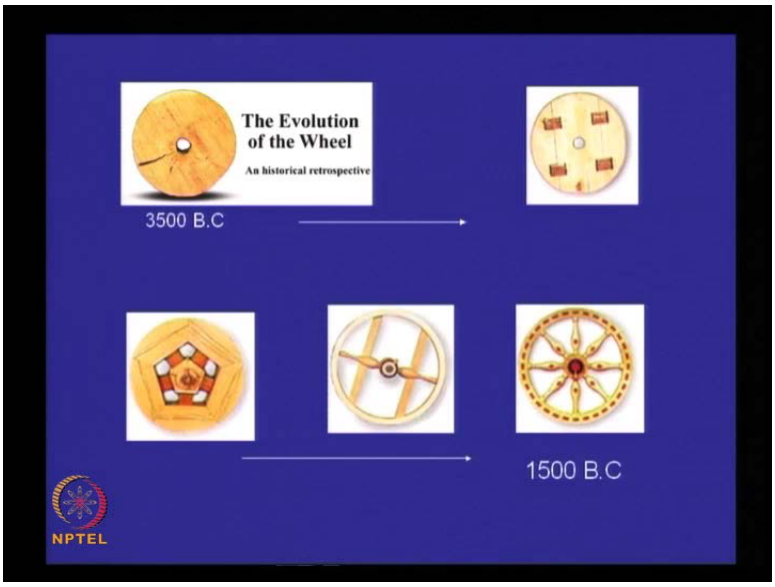

This is the first version developed in 3500 B C. As you could see, this is quite heavy the self weight of the wheel itself will make it difficult for the carts to roll on. So, they felt there could be a possibility to improve this wheel. The main objective was to reduce the weight by slashing portion which is not required by thin planks and reverting together and using the fabricated circular disk as wheel. And the next stage of wheel development was providing reinforcement for the hole that is made at the centre of the disk to carry the axle. You can see the reinforcement provided for this central portion and the subsequent development was towards reduction of weight of the wheel further.

This was attempted by removing certain portion of the wooden material at the middle and having a kind of a rim and spokes. And the final form of the wheel took this shape and this happened which is similar to our conventional bullock cart wheel, this happened in 1500 B C. What is if the time gap between the first and last stage of the wheel development?

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2000 years, it is a too longer period in my opinion it is not too long considering the technological advancement at that time. It is a reasonable time period which has enabled people to this stage in the development of wheel technology.

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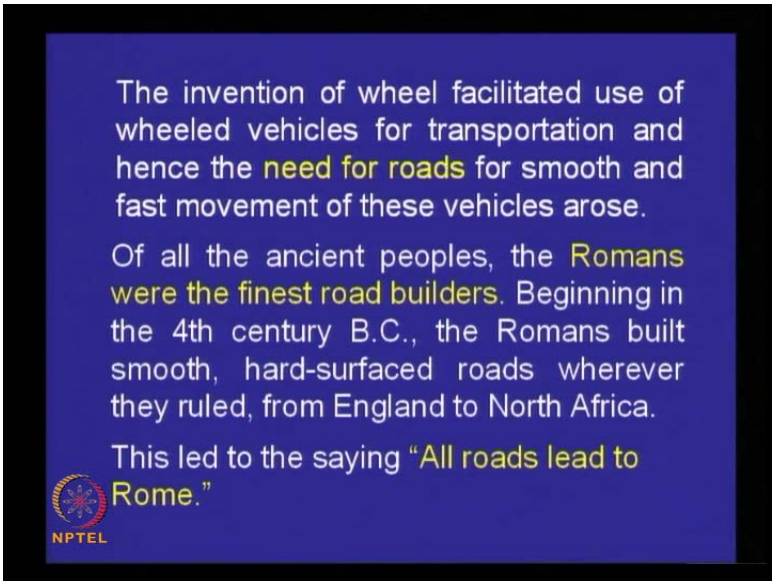

The invention of wheel facilitated use of wheeled vehicles for transportation obviously and hence the need for roads for smooth and fast movement of these vehicles arose. People started thinking about construction of roads, because they had to use the wheel carts at a faster rate making use of these roads. And of all the ancient people, the Romans were the finest road builders, beginning in the 4th century B C, the Romans built smooth hard surfaced roads wherever they ruled, from England to North Africa, this lead to a very popular saying, what is the popular saying? Please put up your hand.

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All roads lead to Rome. Romans were experts in road construction technology at that point of time.

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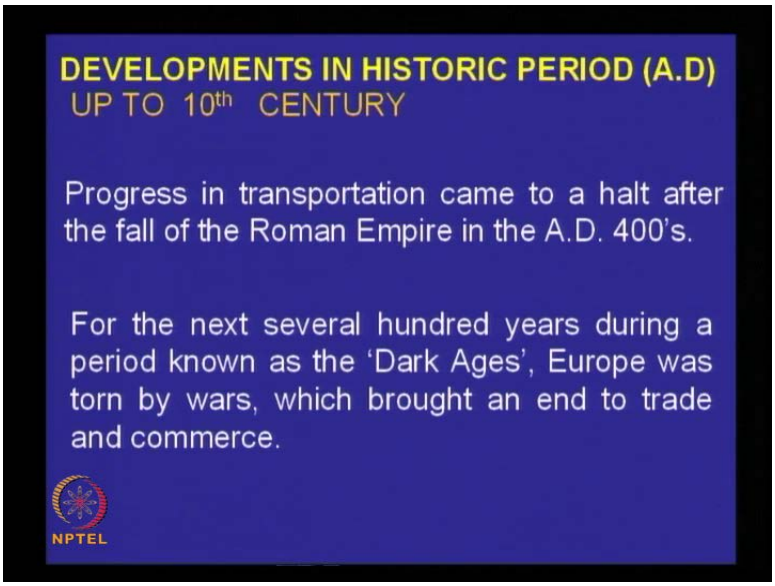

Then let us look into the developments in the historic period A D up to 10th century. Of course, progress in transportation came to a halt after the fall of the Roman Empire in the A D 400s. For the next several hundred years during a period known as the dark ages, Europe was torn by wars, which brought an end to the trade and commerce. The result of wars is end to or decrease in trade and commerce which again results in decreased transportation activity.

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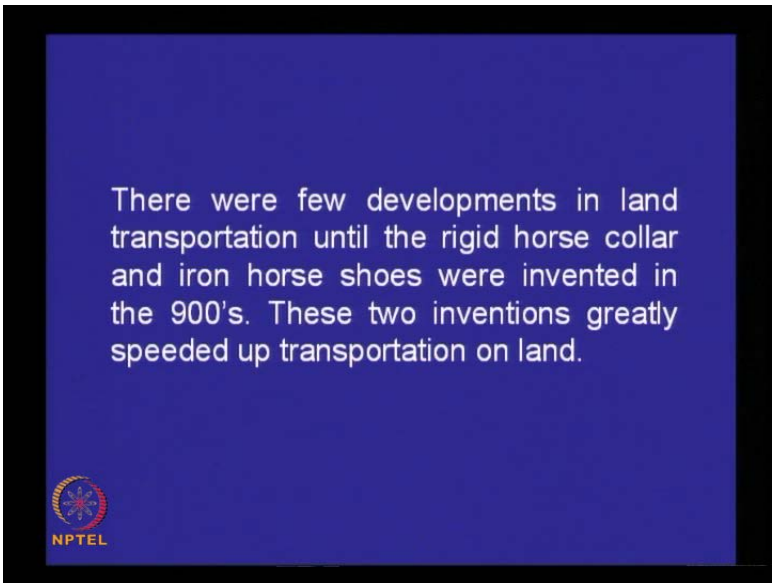

There were few developments in land transportation during this period until the rigid horse collar and iron horse shoes were invented in the 1900s. These two inventions greatly speeded transportation on land. How do you think that these inventions would have speeded up land transportation, invention of horse shoe, and collar until then they did not have a proper device to attach animal to the cart. And there was no device available to facilitate the animals to walk over long distances. That is how these two inventions were really significant in land transportation at that point of time. This is what they meant that device to attach the animal to the cart as well as the horse shoe etcetera was invented at that point of time.

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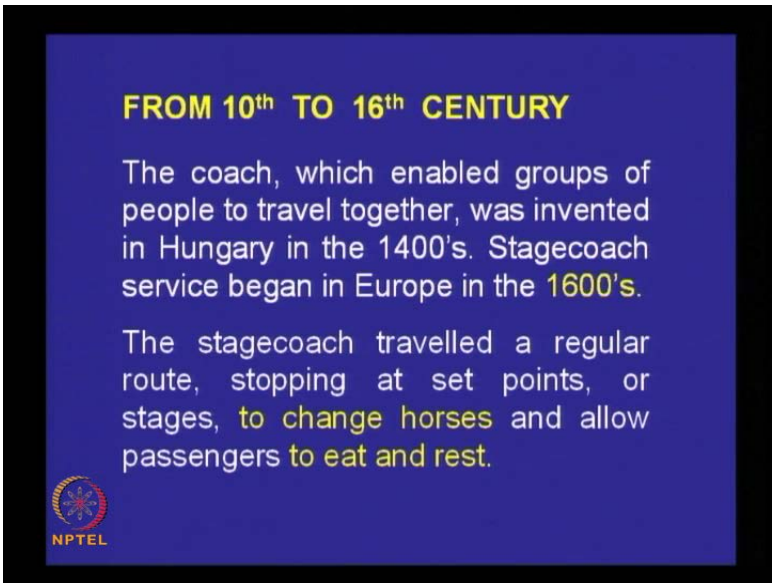

Then let us see, what happened from 10th to 16th century the coach, which enabled groups of people to travel together, was invented in Hungary in the 1400's. Stagecoach service began in Europe in the 1600's, the stage coach travelled a regular route stopping at set points or stages to change horses and allow passengers to eat and rest. A mode of transportation which follows a regular route and stops at set points is termed as a public transportation mode. So, these stage coaches were nothing but public transport mode used at that point of time.

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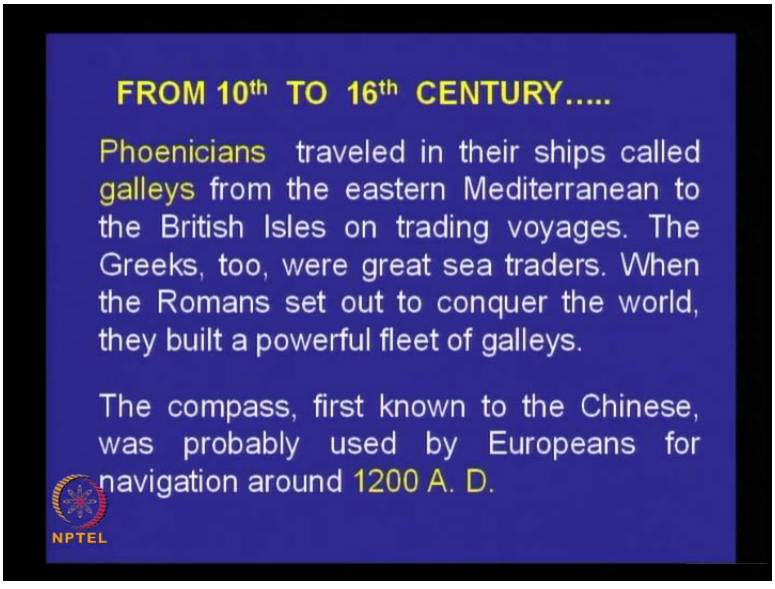

So, these are the stagecoaches a two tired one people travelling in stagecoaches for long distances, they simply public transport vehicle used for transporting people. There were private transport coaches too, they were looking like this. Phoenicians travelled in their ships called galleys from the eastern Mediterranean to the British Isles on trading voyages. The Greeks too were great sea traders when the roman has set out to conquer the world; they built a powerful fleet of galleys. The compass first known to the Chinese was first used by Europeans for navigation around 1200 A D, this is how the galleys looked. The ship driven by human muscular power and of course, the two sails were not very helpful it was mainly driven by human muscular power. These ships are named as galleys, then the developments from 17th to 19th century.

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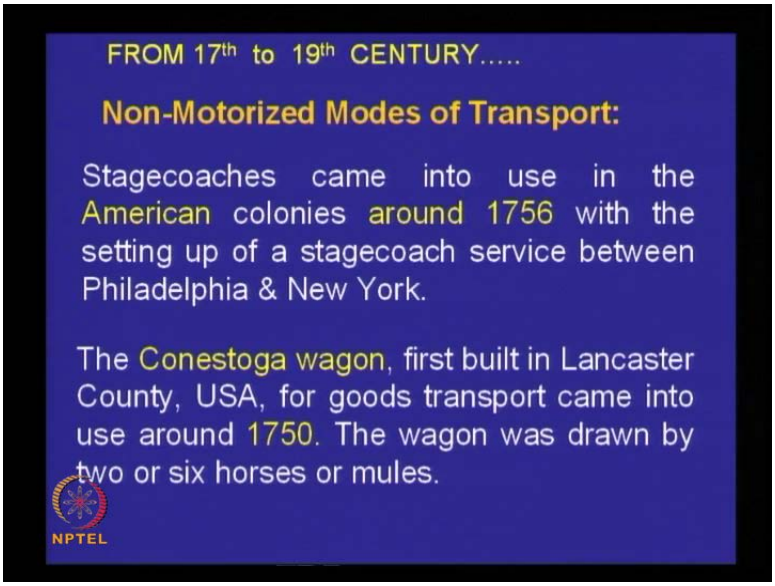

Let us first look into what happened in respect of non motorized mode of transportation. Stagecoaches came into the use in the American colonies around 1756 with the setting up of stagecoach service between Philadelphia and New York. This was a regular stagecoach service operated in the US at that point of time. The Conestoga wagon first built in Lancaster country, USA, for goods transport came into use around 1750, these are again coaches built exclusively for transporting goods. The wagon was drawn by two or six horses or mules depending upon the load to be carried.

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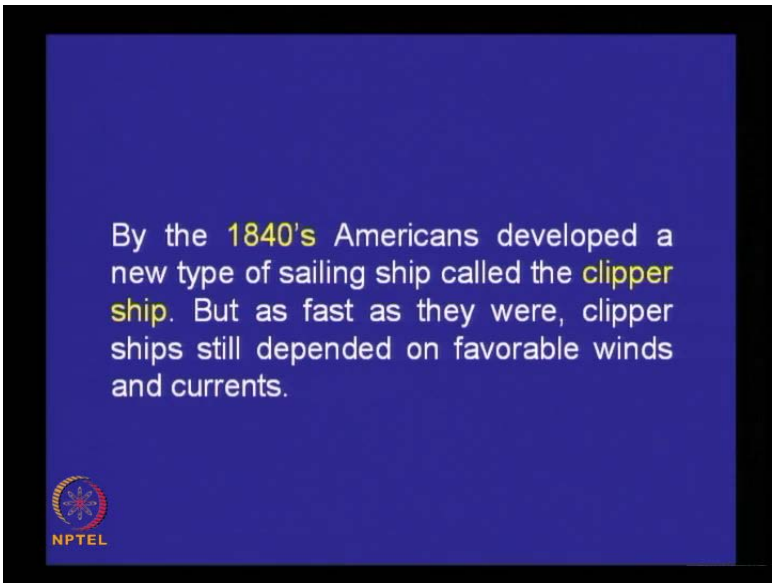

By the 1840's, Americans developed a new type of sailing ship called the clipper ship, but as fast as they were slipper ships still depended on favorable winds and currents. The clipper ships looked like this sails of different shapes and sizes used for moving the whole of the ship and wind was the main energy used for moving the ship.

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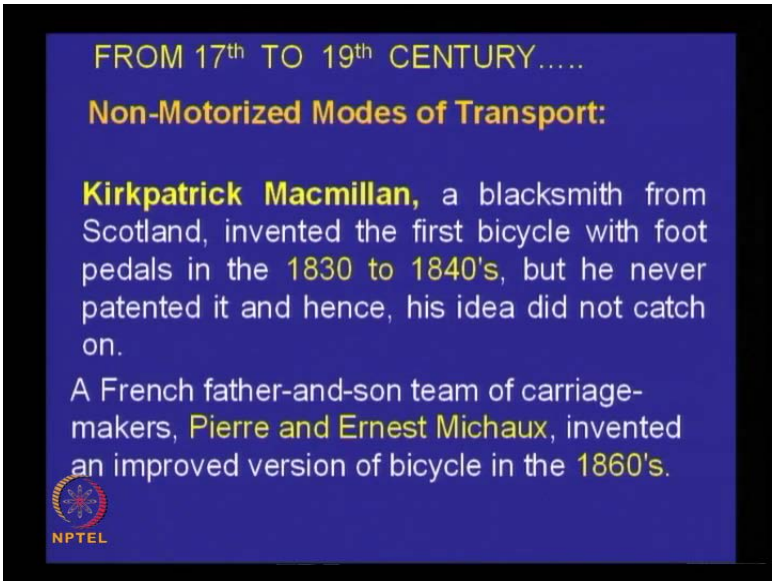

Continuing with non motorized mode of transport, Kirkpatrick Macmillan a blacksmith from Scotland invented the first bicycle with foot pedals in the 1830's to 1840's. But he never patented it hence his idea did not catch on. This implies that patenting and

invention was a must there had been a lot which enabled every invention to be patented, unless it is patented, it would not be acceptable for further production. That is how even though bicycle was invented by Kirkpatrick Macmillan way back in 1830 and 1840 it were not put into use unfortunately. Later, a French father and son team of carriage makers Pierre and Ernest Michaux invented an improved version of bicycle in the 1860s about 20 years later in France and they patented it the invention.

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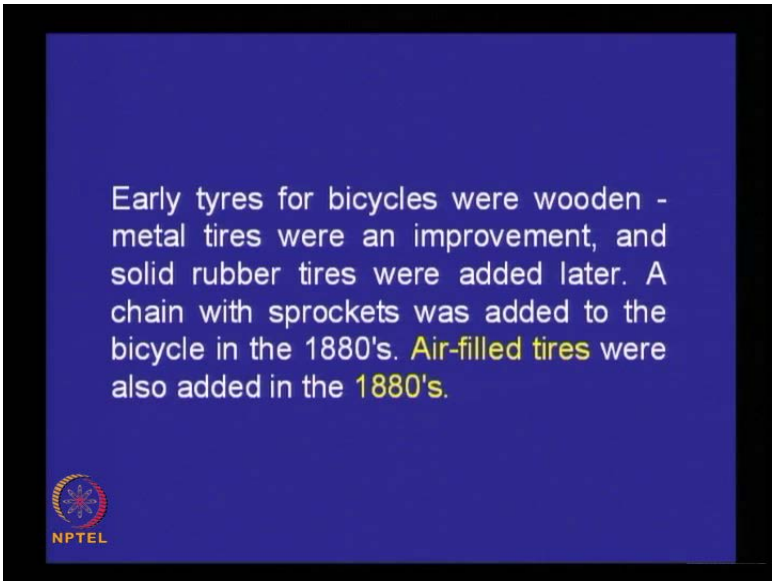

And that is how the bicycle technology caught on. And early tires for bicycles were wooden, metal tires were an improvement later and solid rubber tires were added subsequently. And chain with sprockets was added to the bicycle in the 1880’s, air filled tires were also added in the 1880s.

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In 1880's, they had a complete form of bicycle can be used with air filled tires. The bicycle invented in the early stage looked like this in 1869. A huge front wheel with a very small rear wheel seat almost resting on the mud guard of the front wheel and handle bar very close to the seat almost right above the front wheel axle. Could you imagine how a person can ride this kind of bicycle, but we should learn to understand this kind of technological development. And understand appreciating technological development is well known in Germany. For example, recently the invention of bicycle technology was appreciated and celebrated this way in Germany you can see the same version of bicycle used in procession near a gate.

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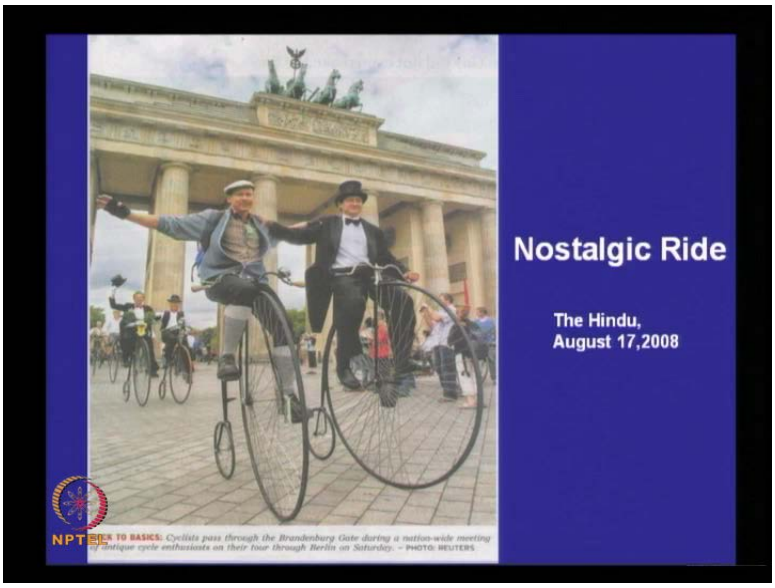

This is very well known in the history of Germany Brandenburg gate in Berlin. Of course, this was published in Hindu; our national newspaper on august 17th 2008.

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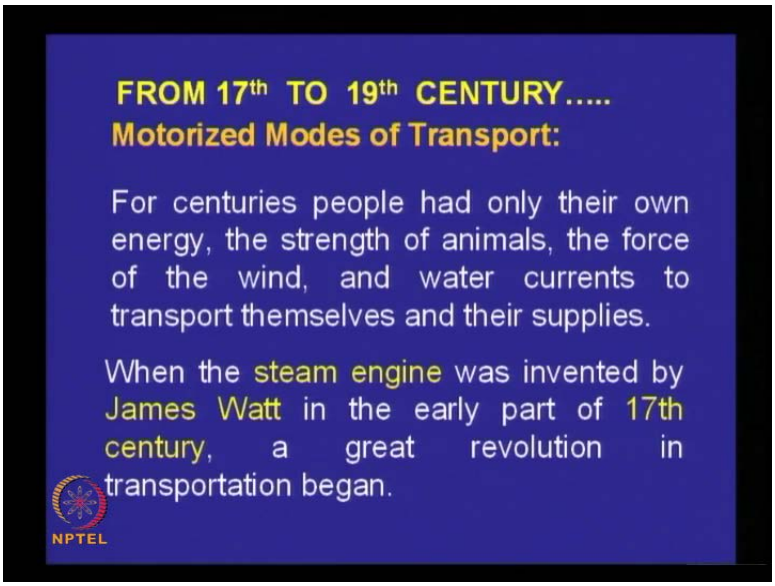

Let us look into the developments in terms of motorize modes of transport during the same period namely 17th to 19th century. For centuries people had only their own energy, the strength of animals, the force of the wind and water currents to transport themselves and their supplies until 17th century. When the steam engine was invented by James Watt in the early part of 17th century, great revolution in transportation began.

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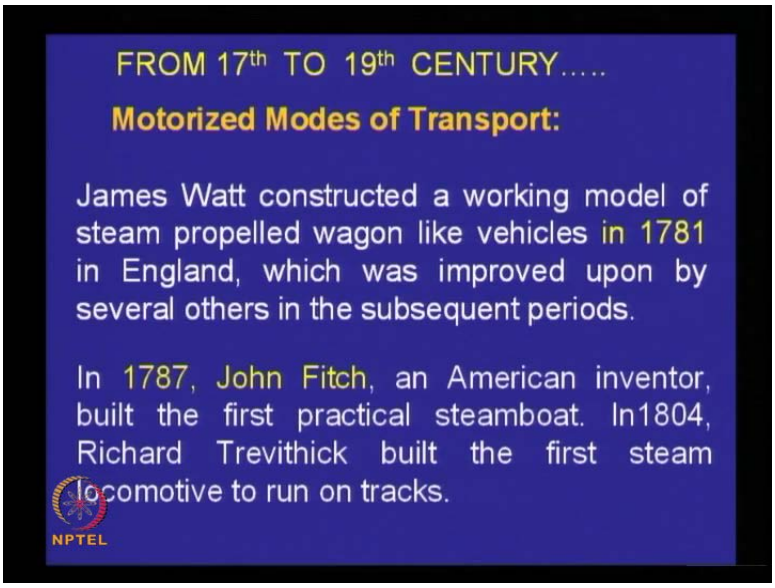

We can consider this invention as a very important second milestone in transport technology development, the first important milestone being invention of a wheel. James Watt constructed a working model of steam propelled wagon like vehicles in 1781 in England which was improved upon by several others in the subsequent periods. In 1787 John Fitch, an American inventor built the first practical steamboat. In 1804, Richard Trevithick built the first steam locomotive to run on tracks. This means that the first application of steam engine was in water way transportation this was first used in steam boat then used ion land transportation involving rail first and then road.

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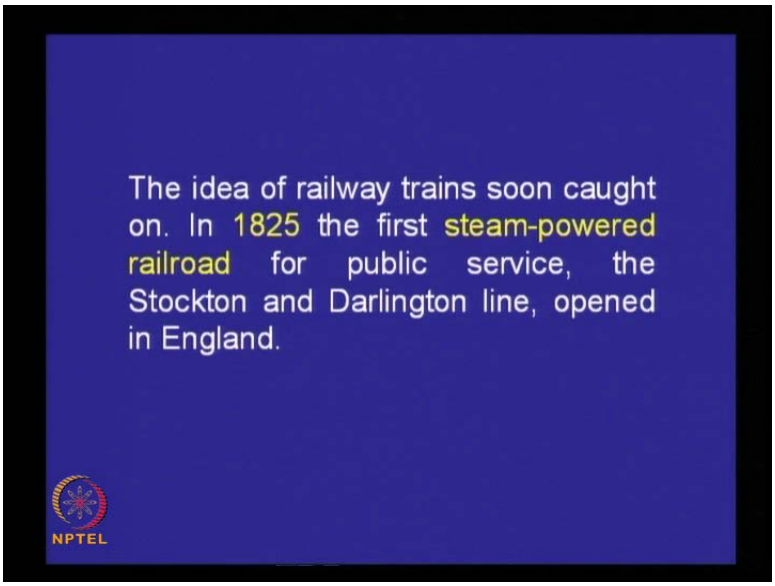

The idea of railway trains soon caught on in 1825, the first steam powered railroad for public service, the Stockton and Darlington line opened in England in 1825. And if you want to have a look at the shape of the train which was used for this service, this is the train which was running between the two cities. You can just look at the size of the wheels the chimney system engine and so on.

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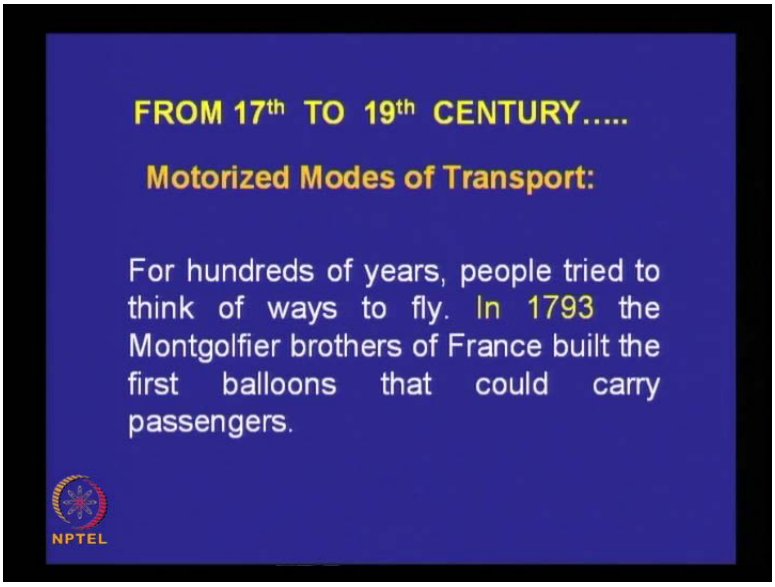

Then for 100s of years people tried to think of ways to fly there is no end too ambition to move faster and faster. In 1793, the Montgolfier brothers of France built the first balloons that could carry passengers when it comes to air transportation we remember always the Wright brothers who invented the aircraft. Even prior to that, again brothers from France first invented balloons which can carry people using which one can fly.

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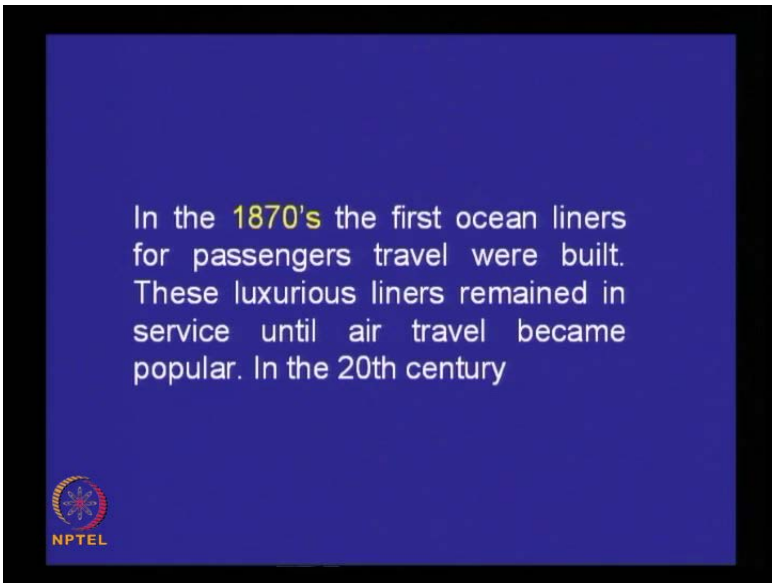

In the 1870s, the first ocean liners for passengers to travel were built; these luxurious liners remained in service until air travel became popular in the 20th century. In those days for international, intercontinental travel the only mode of transportation available was water way transportation. That is how these luxury liners were very popular for international as well as intercontinental travel.

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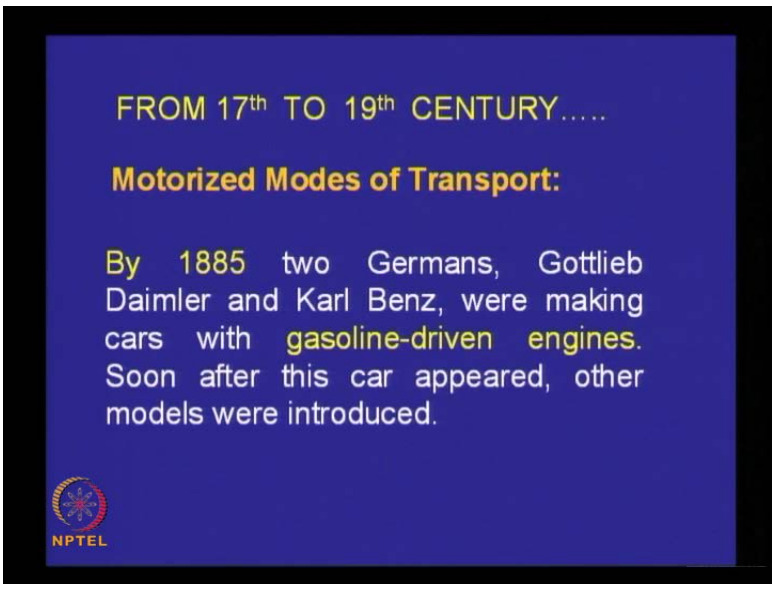

The liners looked like this; huge ones to accommodate 1000's of passengers and large quantity of goods (No audio from: 30:53 to 30:59) continuing with motorized mode of

transportation. By 1885, two Germans, Gottlieb Daimler and Karl Benz, were making cars with gasoline driven engines not steam gasoline, gasoline driven engines. Soon after this car appeared, other models were also introduced.

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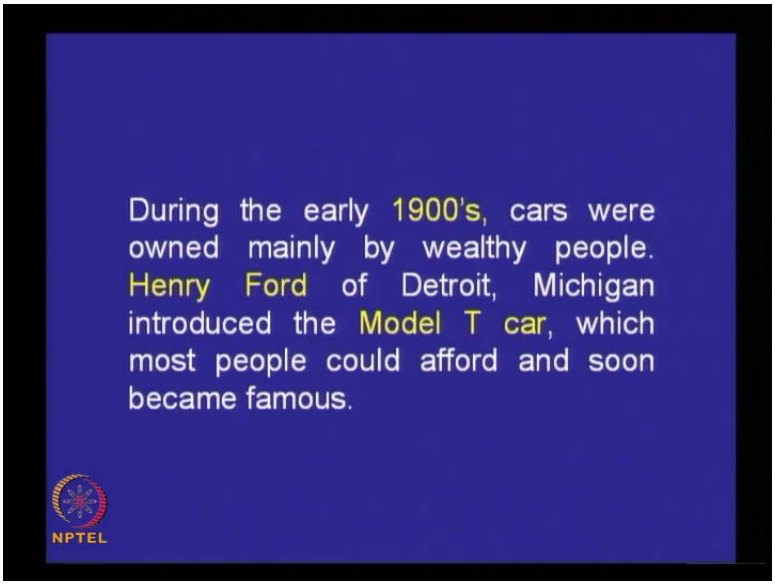

During the early 1900's, cars were owned mainly by wealthy people obviously, the cars were very expensive only the wealthy people could own cars. Henry Ford of Detroit, Michigan in the US introduced model T car, which most people could afford and soon became famous. Peoples car which is quit cheap can be afforded by a middle class person was introduced by Henry ford in 1900 the model T car looked like this. Introduced by Henry ford, I do not understand why it is named a model T car, it looks like inverted letter T capital letter T that is the only connectivity; I could get out of the shape of this car.

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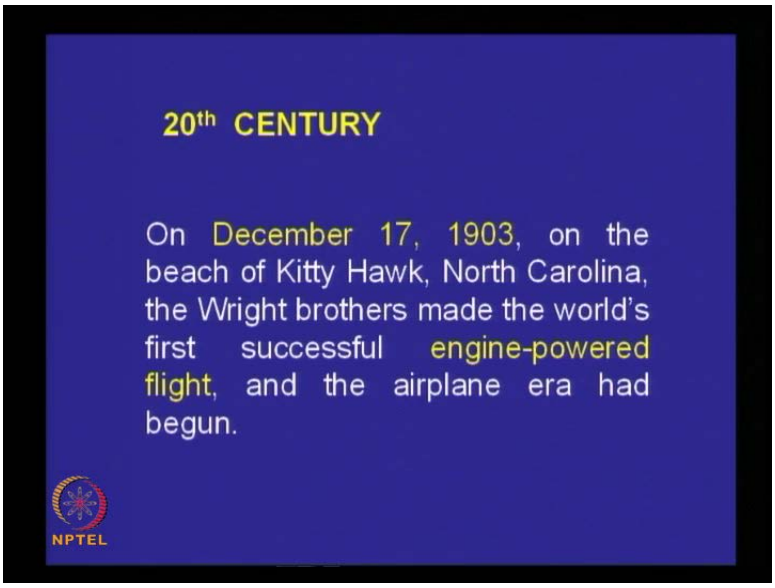

Then the developments in 20th century on December 17th 1903, on the beach of Kitty Hawk, North Carolina, the Wright brothers made the world has first successful engine powered flight and the airplane era had begun December 17th 1903.

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Let us look at the photograph taken at that time on the same day, I will just read out the foot note for this photograph. On December 17th 1903 the Wright brothers make history as they first fly a powered aircraft. With Orville Wright at the controls, that is in the aircraft, aircraft stayed aloft for 12 seconds in first attempt, covering a distance of 120

feet. Three more flights took place at Kitty Hawk the same beach that day, the longest lasting 59 seconds and covering 852 feet on the same day. Perseverance fighting for success and achieved a significant progress on the same day just from 12 seconds to 59 seconds and just from 120 feet to 852 feet of coverage.

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And the commercial version of aircraft was introduced in 1936 first commercial flight was introduced in 1936, named Douglas DC 3 was the model first successful commercial airliner operated in 1936 (No audio from: 34:48 to 34:54). This is about the history of transportation technology development in brief. In this historical background, let us try to understand the transportation and their related technology today. We will see the developments mode wise like let us say road transport technology today.

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I have just shown the different types of vehicles used for road transportation starting from private vehicles, cars, public transport buses and then goods transportation vehicle. What is the maximum speed one can achieve using car today at the global level?

140 kilometers per hour.

140 kilometers per hour, it is fine for Indian conditions. For example, in Germany the speeds normally achieved ranges between 180 to 200 plus kilometers per hour the reason being there is no speed limit in the auto bonds of Germany. So, generally you can understand that it is possible to move at a speed of 200 plus kilometers per hour in a private road transport vehicle like car. That is the level of transport technology development today as far as private transportation by road is concerned. Buses even articulated buses can reach a speed of 100 plus kilometers easily for commercial operations provided the road condition is conducive for such speeds.

It is quite common in developed countries buses being operated in the speed ranges of 90 to 120 kilometers per hour. And another important aspect to be considered here is in terms of public transportation, the size of the vehicle is increasing even in road transportation. Look at the size of the trucks used in road transportation, number of axles and wheels. Even these heavy trucks maintain speed of about 100 plus kilometers per hour on intercity roads.

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So, that is the technological development as far as road transport is concerned today. Let us look into the development in rail transportation. What is the maximum speed that can be achieved by rail?

513 kilometers per hour.

513 kilometers per hour. When was it achieved and where was it achieved?

Bullet trains.

It is little higher value and let me just start of from the German railway system and then I will get back to you about the maximum speed that can be achieved by rail transportation. What you see here is train in Deutsche Bahn German rail system the Koln Frankfurt line, Koln is the name of the city near Bahn, the former capital of Germany has brought Deutsche Bahn. D B is Deutsche Bahn to top of the high speed league with trains capable of running 330 kilometers per hour. And a reduction in journey time form 2 hours 15 minutes to just over an hour for travel between these two cities namely Koln and Frankfurt. This is a reality, in most countries trains are operated at speeds of 300 plus kilometers today.

The advantage this kind of high speed trains is that over moderate and short distance intercity travels, train can be integrated with air transportation. To make this point clear, I will give an example I attended a conference in Bahn in Germany, in the year 2006. I

travelled by Vienna to Bahn by rail, my return journey was by air from Kohl to Frankfurt and Frankfurt to Chennai. A few days before by return journey, I contacted the travel agent to get the tickets confirmed and the additional details about the time of reporting and so on. At that time I was informed that, I have to go to Koln railway station for checking in my baggage and take a train to Frankfurt airport, and then fly from Frankfurt to Chennai.

I was surprised and annoyed to hear that an air traveler is asked to travel by train over a short stretch between kohl and Frankfurt. Then, I came to know that travel by train for this particular stretch is faster than air considering door to door travel time, the access time, the aggress time. And the time required for reporting at the airport and then time required to get out of the airport and reach your destination point and so on. If you consider door to door travel time for this stretch of 200 kilometers, train travel is faster than air travel, then I was really happy. And I reported at Koln railway station, my baggage was checked in at the railway station itself. The train started on time when I entered the train, it was a pleasant surprise.

It was so spacious much bigger see it is than normally you find in aircraft, quite comfortable. The route was along the river rain from Koln to Frankfurt it was a pleasant ride the journey time was just an hour and 10 minutes. When the train stopped at Frankfurt, I realized that I was inside Frankfurt airport. Train comes into the terminal building area and I got out of the train, took an escalator and directly get into the gate through, which I have to get into aircraft. So, this implies that high speed trains facilitate reduction of travel time when your travel time or when travel involves different stretches involving both short and long stretches.

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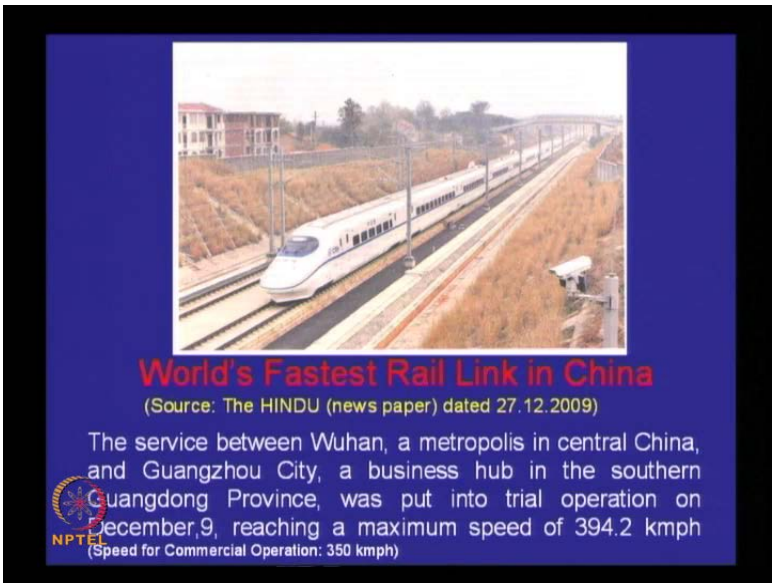

And there are other developments recently world has fastest railway link in china was introduced. This was a news item published in the national newspaper Hindu on 27 12 2009. The service between Wuhan, a metropolis in central china and Guangzhou city, a business hub in the southern Guangdong province, was put into trail operation on December 9 th reaching a maximum speed of 394.2 kilometers per hour. We are concerned with commercial operating of different modes. Even though experimentally they would have tried at higher speeds our concern is about commercial operating speeds. And commercial operating speed of this train is fixed as 350 kilometers per hour.

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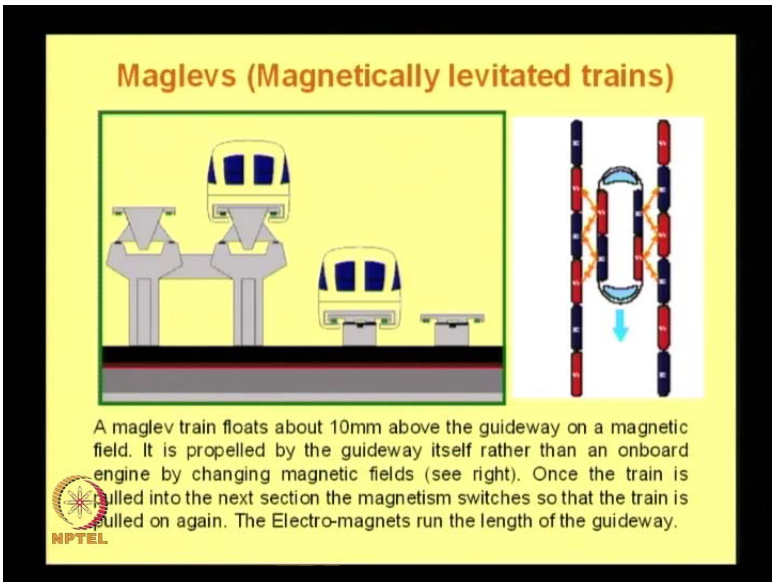

And some of you would have heard about Maglev has technology used in rail transportation and a maglev train magnetic levitation system and the trains are called magnetically levitated trains. And a maglev train floats about 10 millimeters above the guide way on a magnetic field it is propelled by a guide way itself rather than on board engine by changing magnetic fields. There is no engine for maglev trains, the train is propelled by the guide way itself because of the embedded magnetic system the guide way. Once the train is pulled to the next session, as you could see in this sketch on the right side, the magnetism switches on switches so that the train is pulled on again.

Positive, negative, north, South Pole changes the electromagnets run the length of entire length of the guide way that is one important thing to be understood. This implies that the system is quite expensive, complex, difficult to maintain and can be used under very special conditions. The maglev system was first developed in Germany and a demonstration piece of maglev train was run in Berlin for quite sometime. And Germany has found that this system may not be operated to be economically viable in Germany. And they were trying for markets outside Germany in the process they fixed a country which can buy this technology and run trains on commercial basis. The name of the country is, could you guess?

China.

Right and Chinese have bought the technology, and they are running maglev trains today.

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This is the train in January 2003, the world has first maglev train was inaugurated in Shanghai, China. It links the new Shanghai Pudong international airport to the center of Pudong, on the eastern part of Shanghai. The system has a length of about 30 kilometers with maximum speed of about 440 kilometers per hour. It takes about 8 minutes to go from one end to the other, making it the fastest urban transit system in the whole of the world. Or I would say the fastest rail transportation system in the whole of the world 440 kilometers per hour, the commercial speed. And in July 2006, I happened to visit Shanghai for attending a conference for travel from the airport to Pudong city centre, I used the same system.

And found that I took exactly the same time, to reach the city centre from the airport. The train is quite comfortable, they have separate space for putting up baggage's and the information system is very good. The advantage enjoyed by this system here is, it is a point to point service there is no intermediate stop. That way, in spite of the complexity involved in the operation maintenance system, they are able to operate the system successfully. And I was told that the system is operating in an economically viable way I am still, unable to believe, but considering the cost of travel by taxi from airport to Shanghai. I am partially convinced that system may be economically viable at least for air travelers.

If you want to travel by taxi, it is quite expensive the travel by this train was quite cheap.

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Development in water way transportation, the development is mainly in the size of the vessels that are sued for carrying fright as well as passengers. A very large ship usually between and 100 thousands and 400 thousands displacement tons, used for transporting oil and other liquids in large quantities. That is what is happening today bigger and bigger vessels to transport bulk commodities over long distance.

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Another important development in water way as you could guess is containerization of transportation, which has really revolutionized goods transportation process by all the

three modes roads, railways as well as waterway transportation or the benefit enjoyed by water way transportation by containerization is considerably more compared to the benefit derived by this process; by other two modes namely rail ways and road ways. Containership being loaded at a port is shown here, the container ships can carry up to 15 thousand containers per ship.

And it is a very complex process because the containers are to be arranged in such a way that they are easy to be handled at a particular port, at a particular point of time. Their destinations time of arrivals etcetera are computerized and there is kind of operation research process going on in handling the containers and transporting and loading, unloading of containers and so on. If they looks quite simple the process is quite complex.

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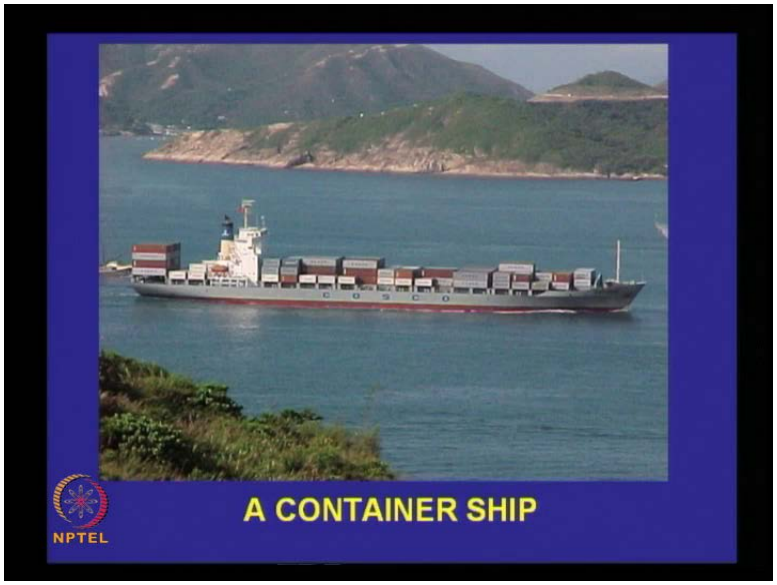

When you take an overview of the container vessels looks like this, just containers tagged as match boxes in 1000s on huge vessels, and vessels being moved at reasonable speed from one continent to another continent.

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Then in air transportation as you know the average journey speed in the case of commercial aircraft is about 1000 kilometers per hour today. Even though the instantaneous speeds could be slightly higher than the average speed is about 1000 kilometers per hour and we enjoyed high speed air travel for some time.

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Some of you could heard about Concorde aircraft which was operated at speed of 2000 plus kilometers per hour, and it was grounded in November 2003 due to commercial viability to some extent and technical reasons. There were some technical snags, there

where the company was not willing to take risks and even at that time the aircraft was operated between selected cities like Paris London, Paris New York, and Paris Toronto and so on, where the terminal facility was sufficient to handle this kind of aircraft. Today unfortunately, Concorde is not being operated. So, it is history we have touched air travel speed of 2000 plus kilometers earlier now, travelling only at a speed of 1000 kilometers per hour.

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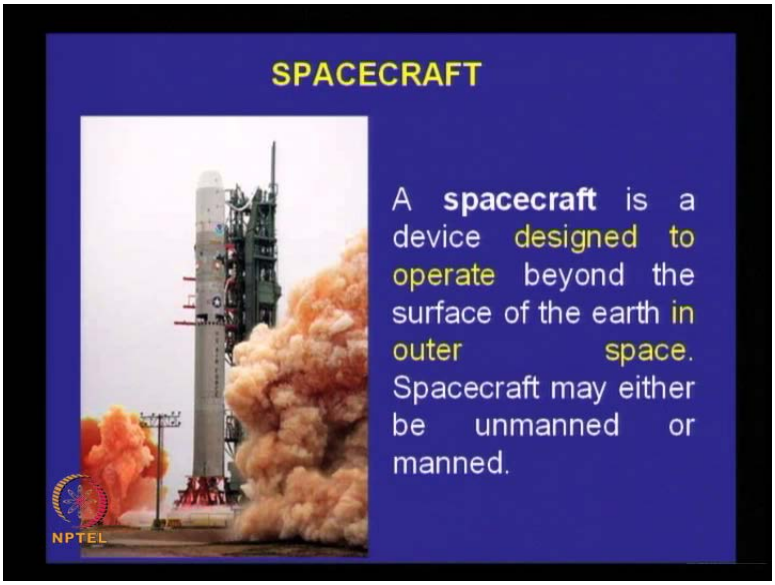

And now we are in space age and transport technology has extended over space, and spacecraft is a device designed to operate beyond the surface of the earth in outer space. Spacecraft may either be unmanned or manned as you know.

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And space craft has are designed for a variety of missions as you know which may include communication, earth observation, meteorology, planetary exploration, space tourism and so on. The term spacecraft is also used to describe artificial satellites.

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And what is happening in spacecraft technology today, there is an interesting development taken place recently international space station ISS. ISS is an international collaboration involving the efforts of 16 countries built to maintain a long term human

presence in outer space. What is the purpose? Providing platform for micro gravity experimentation and serving as a first step to far reaching space exploration later.

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The 16 countries involved in this project are these starting from Austrians space agency, Belgium space agency, brazil, Britain, Canada, Spain, European space agency placed in Germany French space agency and German aerospace again placed in Germany, Italian space agency, Japanese space agency, Netherlands, Norway space agency, Russia then Spanish space agency and Sweden is also involved in this project. What do they do with this project? They collaborate in providing expertise in fabricating the aircraft providing personal and so on for the project. So, basic objective is to just facilitate human presence in space for long period of time and study the effect of micro gravity on human like process and other related activities which would reach to far reaching consequences later to reach out to outer space far beyond what has been done so far.

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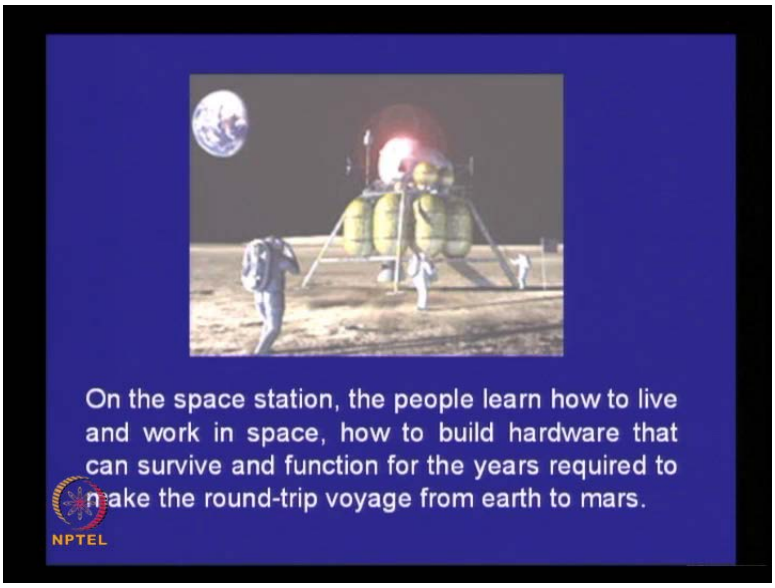

On the space station, the people learn how to live and work in space, how to build hardware that can survive and function for the years required to make the round trip voyage from earth to mars. So, that is the immediate objective, making the voyage from earth to mars, I think we have seen certain aspects related to the history of technological development, related the transportation and then current state of art of transport technology with this we will close our discussion for today. To summarize I would say that in the prehistoric period, the main mode of transportation used was foot of either humans or animals.

Later the invention of wheel revolutionized the transport technology which lead to operation of coaches on well laid out roads. And later the invention of steam engine which is a very important milestone revolutionized the transport technology facilitating faster movement by all the three modes water way, land transportation as well as air transportation. And today, transport technology has extended to outer space, a very significant extent and it is possible that with further development transportation technology. We reach out far into space to explore more and more for well being of humans, with this we will close for today. Thank you.