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THE DEVELOPMENT OF THE AUTOMOBILE

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Delivered before the Society March 17, 1958.

The motor vehicle must be considered an integral part of our highway transportation system. Transportation is a most important part of our economy. It helps to hold our country together, just as the Roman roads held the Roman Empire together for so many centuries.

The Public Carriers

Freight Carriers		Passenger Carriers	
By water almost	15%	By air	25%
By pipeline over	15%	By bus	30%
By trucks almost	20%	By rail over	45%
By rail over	50%		

The above table, however, does not include the terrific movement of people by means of private automobiles. Our Highway Transport System includes over 3,000,000 miles of roads. One out of every seven employed persons earns his living by serving in this system.

In USA there are 70,000,000 vehicles, - 70% of the world's vehicles. This figure, like the national debt, is incomprehensible. Consider a motor vehicle parade, arranged four abreast, with a car length between, at a speed of 15 mph, eight hours a day. It would require 800 days for such a parade to pass this building. The parade columns would be nearly 100,000 miles long.

90% of America's installed power is in our motor vehicles. In 1956, 6,920,000 vehicles were built. 4,600,000 were scrapped, at an average age of 12.3 years. If they all came off a single assembly line the speed would have to be about 27 miles per hour. This is now our biggest business.

How did it all start? In the beginning we can only conjecture. Loads were carried on animals - horses, donkeys, camels. Larger

loads were put on sledges drawn by animals. American Indians had progressed thus far.

However, the ancients did know what they wanted. You will remember the Arabian Nights story. The beautiful princess Nouronnihar was to be given in marriage to him who brought the finest present to the king. Three young princes searched the earth. One found an apple that would cure any illness. One found an ivory tube through which you could look to see any desired place in the world. The third found a magic carpet on which you could sit and wish yourself in any place on earth and immediately you were there. We have yet to develop such an ideal form of transportation. However, the magic carpet was expensive: it cost 20 purses of gold, and few could afford such a luxury. But anyone nowadays can afford some kind of automobile. So perhaps we are not doing so badly.

Then someone invented a wheel and axle which could easily be drawn with a very heavy load on it. And, of course, the operation was improved if it rolled on a smooth, hard surface with minimum grades. So far the motive power was always some animal.

We shall now look at a series of slides.

In the first picture we see a drawing of the Stevins Chariot, produced about 1600, which had a wind sail. It could tack across open country like a ship on the open sea. It was not very good when confined to a highway. It did carry 28 passengers, however.

Next we see the Bishop Wilkins improvement using a windmill. It could move on a road in any direction, if there was a wind. It did not have a tiller but a brake.

About 1649 this Nuremberg Carriage appeared in Germany. It had no visible source of power but probably some men are inside turning cranks.

In 1690 came Richard's Mechanical Carriage. The power was supplied by a footman operating pedals. If the owner desired exercise, he could change places with the footman. Note the steering arrangement using reins.

In 1769 came the first self-propelled vehicle, invented by Captain Joseph Cugnot of the French army. Note that the front wheel carried the engine and boiler: the first front wheel drive. To operate, he built a fire on the road under the boiler. When steam pressure was up, the throttle was opened and they drove as far as they could, then got out and built another fire. It averaged $2\frac{1}{2}$ mph. Note that the date is 15 years before Watt's steam engine.

In 1784 Murdock invented a Steam Carriage. He was an engineer in a Cornish mine which used steam for pumping water. He applied the same principle to drive a vehicle. He ran tests at night and frightened the good people who saw his fire moving down the road in the surrounding darkness. They were sure that the devil was abroad.

From 1801 comes this sketch of Richard Trevethick's Carriage. He built several. They were heavy, and most of the weight came on

large rear wheels, with light weight on small steering wheels. Note the clumsy tiller arrangement for steering. A fireman rode on the platform behind.

In 1824 came David Gordon's Pedomotive Car, driven by feet which kicked at the road. By levers and rods, each foot connected to a piston. A similar car was built in Germany in 1925. It was not very successful.

In 1827 Goldworthy Gurney Carriages appeared. Gurney built several. They really are busses. In four months he travelled 3644 miles carrying 2666 passengers.

In 1829 the William T. James Coach, the first practical steam carriage built in America. It was of heavy construction. Steering was accomplished by a cross bar and heavy chains to a swinging axle.

In 1833 the Church three wheel coach was built. It was eight feet tall and carried a load of fifty passengers.

In 1836 Walter Hancock built a steam carriage. Its speed was 14 mph. The weight was four tons. He had a London-Paddington bus line with five busses operating. He carried 12,700 passengers in a three-months period. Then he was put out of business by legislation. These carriages frightened the horses. So Parliament passed an ordinance limiting speed to three mph. The law required one footman to walk in front and another behind the vehicle to take care of the frightened horses. Then they passed the Railroad Act which reserved the use of the King's Highway to horses and horsedrawn vehicles. This effectually stopped all progress in the manufacture and use of self-propelled vehicles in England. The first part of the 19th Century was known as the "Golden Age of the Steam Wagon." By the time England awakened to their real value, America and most of Europe were ahead of the English.

There was a time when it was feared that the automobile would be taxed out of business in America. Right now 24¢ of our tax dollar goes to pay taxes on the car.

In Europe

1885 -- Here we see the Benz Three-wheeled carriage, the first vehicle to be driven by an internal combustion engine. It was built in Germany for individual transportation. Note the light construction - the light weight on the steering wheel - the clumsy tiller steering. Suppose it is jerked out of your hand on a dark night! How do you find it again? "Benz Benzine Buggy," it was called.

In 1886 the Daimler Motor Bicycle has a single cylinder engine which used mineral spirits as fuel.

In 1889, the Dedion- Bouton Steam Car had rather heavy bicycle-type wheels, a weight of 1300 pounds, and a speed of sixty kilometers per hour.

Also in 1889, the Peugeot car appeared, using a Daimler engine and a gear shift. This firm had built 80 cars by 1894.

In America

Three cars, the Duryea, Ford, and Haynes, developed about the same time.

The Duryea car, in 1892, was a motor buggy. It had a single cylinder gasoline engine, planetary transmission, and chain drive. It used tiller steering, but the front axle did not pivot about a center kingpin. Each wheel was mounted on its own steering knuckle. Why do we now use a steering wheel?

The first Ford car, in 1893, was also a buggy. It had light bicycle wheels, and in this picture appears to have a rear axle which turns.

In 1894 came the Haynes car, which can be seen now in the National Museum at Washington. It was driven on July 4, 1894. It was much the same as the Duryea car.

In 1895 occurred the first American automobile race. It was suggested by the Paris-Bordeau race in the spring of that year, which was the second such race for France. It was financed by the Chicago Times- Herald, which allowed $5,000 for prizes and $5,000 for expenses. It was to be conducted by the Army, and the date set was July 4. For publicity they offered a $500 prize for a name for the new vehicle. The judges chose the name "Motorcycle." They thought "Automobile" was too Frenchy. The Fourth came. Only the Haynes was ready.-- No race. It was postponed until Thanksgiving.

As Thanksgiving Day approached, there were 60 entrants. On the eve of the race only eleven said that they were ready. The next morning only six were able to reach the starting post. There were four gasoline cars and two electrics. The race course was from Jackson Park to Evanston and return, a distance of 53½ miles. Duryea came in first, the time, 10 hours, 23 minutes. Speed, 5¼ mph. Mueller arrived second, nearly two hours later.

The public was not interested. Newspapers quipped, "Old Dobbin is still in the ring." Incidentally, the Haynes car was not in the race. Haynes had wrecked his car in a race for a side bet. Also Henry Ford was heard to say, some twenty years later, that he had never wanted anything so much in his life as to go to this race, but no-one would loan him carfare.

Still the inventors labored. In March, 1898, occurred the first recorded sale of a car, - a Winton. They gave a guarantee that "It would run." In 1899 the first Packard, Olds, and Cadillac appeared. In 1900 a Packard car on a chassis dynamometer was built for an engineering test in Warren, Ohio. In 1907 came the Olds "Merry Oldsmobile" of the song. Note in its picture the horn and the tiller steering.

We have here an engineering drawing of 1907. There is a very large flywheel under the seat. There are semi-eliptical springs, a planetary transmission, and a chain drive from the jackshaft directly to the rear wheels.

Up to 1900 all cars had single cylinder engines. From 1900 to 1903 there were mostly two cylinders, with eight to twelve horsepower. In 1903 four-cylinder engines appeared with 20-40 hp. In 1907 Winton manufacturers announced that they would build only sixes. This they did up to the time that the firm went out of business. In 1915 there were seven eight-cylinder and three twelve-cylinder cars.

About 1900 Selden appeared with a patent on the Automobile: the whole car. He persuaded the car makers that they must be licensed under his patent. That is - all but Henry Ford. He refused to believe in its validity, and in the ensuing litigation Ford won out.

In the meantime the car makers had formed an association, the A.L.A.M. (the Association of Licensed Automobile Manufacturers). This still exists but is now called the A.M.A.

Further Developments

In 1915 the Winton Six was the most beautiful car. They are beginning to consider the appearance. They now have doors, wood artillery wheels, acetylene gas lamps, etc.

In 1911 the Pierce Arrow seven passenger Landau makes it possible to undertake extensive touring. In this photograph one sees it really loaded: trunks at the rear, on the top, and on the running boards.

Body changes become important from now on. Cars may be dated by body contours. The effect of stream lining is quite evident. Let us bring this body evolution a bit nearer home.

In 1929 a group of graduate students and myself noticed that car speeds were increasing and that a horsepower race was on. We concluded that higher speeds could be obtained by correcting the shape of the body, rather than by using more horsepower. At high speeds the power required to drive the car through the air is exceedingly large. It increases as the cube of the car speed. To double the car speed requires eight times the power. The car bores a hole through the air. It should be done with the least possible turbulence. Turbulent air has energy in it, which you paid for when you filled your gas tank.

A 1931 Reo Royale model was tested in a wind tunnel. The air flow pattern was traced on the plate by air moving at 70 mph. On this slide you can note the splash in front, and the turbulent eddies in the rear. This car had a top speed much greater than was expected. Both body and chassis designers claimed credit. Body engineers proved that improvement was due to rounded edges and corners of the body. The car looked better too.

The next slide shows something of the eddies behind a car with a vertical rear window as compared with one with a streamlined rear end. Smoke is released underneath the car. Note how it comes from beneath the car and eddies up to the top of the rear window.

Do you remember how the rear windows were muddied up when traveling on wet gravel roads?

Some streamlined cars by European designers really were streamlined! They look like antediluvian troglodytes.

The Function of the Body

The body is a package containing a passenger load. The required shape is a rectangular box. The dimensions are dictated by the dimensions of seated people. The body proper should be preceded by a front section which is shaped so that it will open up a hole in the air with the least splash. It should be followed by a rear section which will close the hole so as to lay the air back in place with the least turbulence.

There is increased turbulence with a cross wind. The airplane always drives directly into the air. The plane may drift with the crosswind but the air flow is parallel to the length of the fuselage. The car is often driven in a crosswind with the air flowing diagonally across the body. It must therefore be streamlined in this direction also.

In the lab we built a model of a midsection passenger compartment and a series of front and rear sections. These models we tested in a wind tunnel. Not sure of results, we found a way to measure the air resistance of a full-size vehicle. We built an envelope body around an actual automobile. The envelope was built of light wood and doped fabric. It was mounted on roller bearings so that it was free to move about six inches fore and aft. We then, so to speak, tied a string between the envelope and the car. As the car inside was driven on the road, the pull on the string was measured; that is, the force required to drive the envelope through the air was measured. This was a first for the University of Michigan.

In the test car, the envelope was longer, taller, and wider than the car inside. It had to bore a larger hole in the air. Yet the top speed of the combination was 7 mph higher than that of the car alone. The speed increase was due to the smoother contours of the rounded edges and corners.

We then made a plot of the air resistance force against vehicle speed. A practical model was designed and tested in the tunnel. It had a low resistance and did not look bad. But why not? The dove and the dolphin are streamlined by nature, and we like their contours too.

Ann Arbor and the Early Automobile

Further automobile history developed right here in Ann Arbor town. From Bulletin #6, Michigan Historical Collections we read that in 1900 "The firm of Staebler & Son was the oldest Ann Arbor bicycle dealer." The "Son" was Edward W. Staebler, who was later mayor of Ann Arbor from 1927 to 1931.

In the year 1900 the Staebler firm obtained the dealership for a three-wheeled gasoline car, the Trimoto. It weighed 500 pounds, had a $2\frac{1}{4}$ hp engine, and a list price of $425.00. They received a demonstrator vehicle in April, 1901. It was not good enough to sell. So they traded it in on a Toledo Steam Car and dealership. Throughout 1901 Staebler & Son remained the only dealership in town.

Three other cars were owned in Ann Arbor, however: a Locomobile, an Oldsmobile, and a steamer that was assembled in the Staebler & Son bicycle shop by a chap named Howard E. Coffin. In the Labor Day parade, 1901, the Daily Argus mentioned "Chauffeur Coffin and automobile."

This Howard Coffin was a resident of Ann Arbor and a student in the College of Engineering. To pay his way through school he worked as a letter carrier, and he built the car in his spare time. In 1903 he graduated with a B.S.M.E. and went to work for R.E. Olds. Many years later he became president of the Hudson Motor Car Company.

In 1912, the first auto engine test I myself ever made, as a student in the Engineering College, was on an Olds single cylinder engine of Coffin's design. About 1935 I really became quite sure of the above fact, when I examined Coffin's original calculations made as he laid out the design of the engine.

Coffin's residence had been torn down and in the attic they found a couple of boxes of notebooks, card files, and drawings. They were sent to me and I stored them in a closet. We had some old auto parts in a sort of automobile museum but could not hold the space against the inroads of research work. So the whole was given to the Edison Institute in Dearborn, together with Howard Coffin's notebooks. The car he built in Ann Arbor in 1900 may still be seen in the Edison Institute.