

THE COURSE OF ROAD AND CAR RESEARCH

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It happens that my early life was spent on a farm in eastern Ohio. And I don't suppose that here in Indiana you have ever had any roads as bad as those in that hilly region of clay and limestone. Our roads were narrow, crooked, and muddy, and we traveled them on the darkest nights with no lights at all. I can still hear the mud squashing under the horse's hoofs as he toiled along in the night, and the swishing of the muddy water as the buggy wheels rolled slowly forward through the mud.

Every year each one of us used to put in his two days of labor on the township roads. "Labor" was the word used for that chore, and it was the right word. In a small village over there the young men were offered release from this toilsome service if they would join the volunteer fire department of the town. Nearly all the boys did choose the easier and more exciting service of the fire department, joining up for three years. But the joke was that just after they had done so the State Legislature repealed the two-day road-labor law.

Some one has even suggested that it was the labor we put on those roads with our mattocks and shovels that made them so bad. Anyway, in spite of all our efforts, the roads we worked were really little better than those of colonial times. The first shot of the American Revolution fired at Lexington was supposed to have been heard round the world, you know. That may have been so; but the report traveled very slowly, because the roads then were so poor. A messenger was dispatched immediately to carry the report southward over the main post road with all possible speed. But it took four days for the word to reach New York. From there on south it went more slowly still. "For God's sake, send the man forward without the least delay," read the endorsement through the South. Yet it took five days to carry the message across Virginia, and six days across North Carolina. And thus, with colonial communication at its fastest, it was over two weeks before that historic shot at Lexington was heard even down south, let alone around the world.

But you all know, of course, how bad the roads were everywhere when there really were no roads as we know them today. In 1903, a young fellow who had built a horseless carriage was told by a group of business men that, if he could drive the contraption the 60 miles from Detroit to Flint in

one day, they would finance a company to build his car. As luck would have it, he did succeed in making the distance, but with difficulty. Even as late as 1915, this ad appeared in a Fargo, North Dakota, newspaper: "For sale, Velie auto—drove it from Illinois; on account of roads I can not drive it back."

THE BEGINNINGS OF CAR RESEARCH

Now the course of the experimentation or the research that resulted finally in the automobile began a long time ago, for the wish for a carriage that would go without horses is almost as old as written records. Active experimentation on self-moving road-carriages began more than a hundred years ago, using the steam engine as motive power. Those experiments were made chiefly in England, where a great many steam road-carriages were built, including some rather successful ones. But the development soon stopped. For this stoppage there were several reasons. One of the most important of these was that the roads of the time were not good enough to run such heavy vehicles on. Another reason was, of course, the opposition from the railroads and others, which resulted in the red-flag law, requiring that a man carrying a red flag must walk in front of each self-moving road-carriage. Besides, the vehicles themselves were not yet very good. An expressive fellow at the time spoke of one of those steam road-carriages as "that nasty, wheezin', crackin', gaspin', puffin', bustin' monster."

But the important thing was that out of that interest and experimentation came the primary elements which were finally assembled by our automobile pioneers to make the motor car. The sliding-gear transmission, for instance, was first used on one of those steam carriages in 1802. The important differential gear, which permits one of the driving wheels to travel faster than the other, as is necessary in rounding turns, appeared on one of those cars in 1828. This experimentation was continued in a spasmodic manner here and there in the world until, by the time our automobile pioneers began their work, every element essential to the automobile was known, although most of them in quite an embryonic state, to be sure.

One of the principal pioneers of the motor car was Elwood Haynes over at Kokomo. And with your permission I should like to quote here something he wrote in 1911, because it shows how quickly the automobile, once it had arrived, came to be the accepted thing. Young people today, you know, can hardly imagine what the world was like without the automobile and the roads it runs on. Telling of his first ride into town in his pioneer horseless carriage—the snappy 1894 model that now stands in the Smithsonian Institution—Elwood Haynes said this:

I remember after the little machine made its way along the city streets we were met by a "bevy" of girls on wheels. I shall never forget the expressions on their faces as they wheeled aside, separating like a flock of swans, and gazing wonder-eyed at the uncouth and utterly unexpected little machine. This was in 1894. A number of those young misses are married now and have children nearly grown. To these children there is nothing new about the automobile; but many of them are intensely interested in its rapid growth and in the pleasure which it has afforded to many of them.

It has been 30 years, a whole generation, since Elwood Haynes wrote that. Elwood Haynes doubtless remembered too that, driving to Chicago a little later, he was met not by a bevy of girls but by a policeman who arrested him for running a horseless carriage on Michigan Avenue.

THE BEGINNINGS OF ROAD RESEARCH

In roads, too, just as in the case of the motor car, the course of experimentation began a long time ago. The Roman Empire had nearly 50,000 miles of hard-surfaced roads. Even the white stripe in the center of the highway is said to have been used down in Mexico by the Spanish conquerors nearly 400 years ago.

But it was just about the time when the active effort to build a successful horseless carriage was under way in England in the early part of the last century that intelligent research on roads was begun also. It was then that road-building experiments were undertaken on his estate in Scotland by John Loudon McAdam. From his experiments, McAdam concluded that for a road made of crushed stone an expensive foundation was not necessary. The top layer, he decided, ought to be made of stones not exceeding one inch long in any direction nor weighing over six ounces. The first measure of the proper size was that if a stone would not go into a man's mouth it was too large. How far we have come since McAdam's time in this respect is shown by the fine testing and research laboratories devoted to roads and road materials here at Purdue and elsewhere. But this is not to say at all that the ultimate in road-research facilities and projects has been reached, for no doubt they could be extended still further with profit.

One day, so the story goes, McAdam was inspecting a stretch of road under construction and saw that the stones used in the top layer were much larger than the prescribed size. He accused the workman of laying the stones without testing them. But the man denied the accusation, and in support opened his mouth in which the stones had been tested, he said. The fellow's mouth was bigger than Joe E. Brown's, and McAdam saw also that he did not have a tooth in his head.

The efforts of McAdam to build better roads were, however, ridiculed and opposed by his contemporaries, just as were

those of the builders of horseless carriages in the same period. The poet Southey jeered at McAdam and spoke of the macadamizing of some of the streets of London as "quackadamizing." But there were some by whom McAdam's efforts were appreciated. Charles Dickens was one of these. He said that "Our shops, our horses' legs, our boots, our hearts have all been benefited by the introduction of McAdam." And in that saying Dickens expressed something of what the efforts of you men are accomplishing for the citizen today, although in a much more nearly perfect way than McAdam and his successors ever did.

Roads of the macadamized type were used for more than a century, or until the coming of the automobile with its rubber tires and fast motion, and the truck with its heavy weight, made such surfacing impractical on heavily traveled roads. It was not far from the farm where I grew up to the old National Pike, now US 40, construction of which began in 1806, and which was perhaps the longest of the macadamized roads. I remember the long piles of broken limestone for repairs stretching like triangular snakes beside the highway, with a man sitting on the end of each pile with a circular hammer laboriously cracking up more limestone to be spread on the road later. I remember, too, how every traveler used to go around rather than over those patches of fresh stone with its sharp edges, whenever that was possible.

Thus the course of research both on roads and on the motor car began pretty far back. But most of this research has been done in recent years, of course, and what it has accomplished is to make both roads and cars good enough, and especially cheap enough, to become so nearly universal. You have perhaps heard the definition of the engineer as a fellow who can do well for one dollar what any bungler can do poorly for two dollars.

WOODROW WILSON VIEWS WITH ALARM

In 1906, when Woodrow Wilson was president of Princeton University, he said this: "Nothing has spread socialistic feeling in this country more than the use of the automobile." The reason was, he said, that "to the countryman they are a picture of arrogance and wealth with all its independence and carelessness."

It is true that, 35 years ago when Woodrow Wilson said this, the automobile was little more than a rich man's toy. For at that time there were only a hundred thousand cars in the whole country, and surfaced roads were almost non-existent. But there were some things that at that time Mr. Wilson did not know about the future.

He did not know that, thanks to a marvelous evolution arising from extensive research and resultant industrial development, the cost of cars would be reduced by several fold

to the point at which every Tom, Dick, and Harry has one. Even if a fellow can not afford a new car, he can get a used one for a few dollars. One thing Mr. Wilson surely could not possibly have imagined. And that is all the cars which would one day be parked by WPA projects. In Detroit, incidentally, there is a used-car dealer who has long been advertising "WPA Specials."

For every car in use when Woodrow Wilson spoke there are 300 in service now. There are enough motor cars today for every one in the country to go automobile riding at once—and on Sunday afternoons it seems sometimes that all of them have. Nearly 85 per cent of white families on farms own cars today. Here in Indiana there is *more* than one car per farm. And, in addition, one Indiana farm in five has a motor truck.

Such is now the sad state of the country man, whom Woodrow Wilson feared was becoming a socialist from staring at the cars dusting along the roads of that day. "Dusting along" is used advisedly, for then the roads were always either dusty or muddy. As one of those country men myself at that time,—or country boy, rather,—I can say in passing that most of us were worried much more about the way those cars scared the living daylight out of our horses than we were about turning socialist.

What has happened in the 35 years since 1906 is thus the direct inverse of that which Woodrow Wilson feared. He said what he did in the belief—a belief well nigh universal at the time—that the market for automobiles would always be limited to a few wealthy people. How wrong that opinion was, it is easy to see now. But, as often as not, the experience of the man who tries to foresee future events is like that.

RECENT COURSE OF CAR RESEARCH

Neither can anyone say with certainty just what the future course of research on roads and cars will be. If we really knew what the roads and the cars of the future would be like, we would be building them that way now.

One way to get some idea of the future is of course to look at the past. In the case of the motor car, there are five main trends which, thanks to continual research, have been sustained pretty consistently now for many years. These are:

1. The trend toward greater comfort and better appearance.
2. The trend toward lower cost, both in purchase price and in operating expense.
3. The trend toward higher power and better performance.
4. The trend toward more miles, or more ton-miles, per gallon.
5. The trend toward greater safety.

The first of these trends, that toward greater comfort and better appearance, has been a particularly pronounced and important one, because it has contributed so much to customer satisfaction and pride of ownership. Not generally, though, do people appreciate how great the advances made in passenger comfort and ease of driving have been. One really has to ride in and drive one of the old cars to appreciate the improvement properly. But no doubt you do remember something about how rough riding cars used to be, particularly in the back seat. Remember also how hard they were to steer. Remember, too, how rough and noisy the engines were and how at certain speeds they used to vibrate until it seemed as though they would jump out from under the hood. All that is past now; but the improvements did not just happen. They are the result of much painstaking research and costly refinements in manufacturing methods. One of the outstanding improvements in motor cars has been in ease and security of steering. And you have here in Lafayette a major contributor to these advances in the person of David E. Ross.

The second trend in the evolution of the motor car, that toward lower cost both in purchase price and in operating expense, has been so extensive that the buyer today gets three times as much for his dollar as he did only 20 years ago. A typical 4-door sedan of wheelbase and weight comparable with a car selling today for \$800 cost in 1920 more than \$2,400. In addition, there has meanwhile been the no-less-valuable gain that the car of today is greatly superior to the 1920 car in appearance, in comfort, and in ease of driving. In *The Atlantic Monthly* for December was an article by Royal S. Kellogg, who has been driving cars for 25 years and who has kept a complete record of all his expenditures. Today, as his figures show, it is costing him only 40 per cent as much to drive a car as it did 25 years ago.

The improved highway has of course been one of the most important factors in lowering operating costs. According to figures compiled in a research by Iowa State College, with which you are perhaps familiar, the paved road reduces operating costs by more than a cent a mile by comparison with running on earth roads. This shows how right Thomas H. McDonald was when he said, "We pay for good roads whether we have them or not and we pay less if we have them than if we do not."

The third main trend in automobiles, that toward higher power and better performance, has been so consistent that the power of an engine of given size or displacement has in recent years been multiplied by two. When about 1924 the General Motors Proving Ground was established, there was provided there a test hill course of uniform 11.6 per cent grade. The test of the hill-climbing ability of a car was to start up that hill from the vertical curve at the bottom at an initial speed

of 10 miles per hour, and see how far up the course it could go in high gear. But long ago that test lost much of its value, because all cars could go clear to the top in high. And so the criterion was changed to the *speed* at which the car would go over the top from a 10-mile-per-hour start. Nowadays in that test cars accelerate up the hill at a fast rate and go right over the top at a high speed.

The fourth trend in cars is that toward more miles per gallon—or more precisely, with the continually increasing size, more ton-miles per gallon. And in this respect the improvement has been considerable, it having amounted to more than 20 per cent during the past ten years. This is so in spite of the limitation that car buyers have been demanding continual increases in power or performance, which are not consistent with getting most miles per gallon.

The last of the five trends in the evolution of the automobile, that toward greater safety, has resulted from large improvements in brakes, in tires, in lighting, in bodies and in the glass that goes into them, in steering and ease of control, and in the several advances that have made driving so much easier and less wearing on the man at the wheel. Better roads have played a large part here, too. One respect in which these advances seem to be reflected is in the 35-per-cent reduction since 1925 in fatal accidents per million car miles driven. And surely such reduction is badly needed.

Both the course and the extent of the trends just enumerated are the result of research, of course. And it is to be expected that this evolution will continue; for, in spite of the great progress already made, cars have not reached perfection at all. It is an old saying that no tree ever quite reaches heaven.

Both in appearance and in details of engineering the evolution of the automobile has been made to follow public acceptance. And, if it should seem that in some respects this evolution might better have followed a somewhat different course, so perhaps as to emphasize economy rather than performance as has been done in the past, the explanation lies in public preference. The automobile maker has always kept his ear to the ground and his eyes open to see just what people want most. It is not his to dictate customer demands, but to fill them.

SOME SOCIAL CONSEQUENCES

When it comes to roads, the evolution in recent years is so familiar to all of you that I shall not attempt to outline it in any detail. If I should, you might be like Joe Louis when some one asked him once if he had seen the moving pictures of the first Louis-Schmeling fight. "No," he said, "I was at the fight."

I need not mention the fact that, starting from scratch, about a million miles of highway have been improved with surfacing of some kind. Nor need I say that as a result roads and cars are really making a neighborhood out of the nation. Thanks to all these roads, the name "pleasure car" is no longer descriptive. Surveys have shown that nowadays 55 per cent of passenger car mileage is used for business, and only 45 per cent for purely recreational or social purposes. Farmers use their cars two-thirds for business. This is why, as other surveys have shown, highway improvements boost farm values by from 20 to 50 per cent. It is why 24 cities—including Detroit, Cincinnati, Kansas City, and St. Louis—receive all their milk by truck, and why from 25 to 70 per cent of other farm products go to market in trucks and cars. It is why school buses now carry more passengers daily than all the crowded subways in New York City, and five times as many as the passengers who ride on Class I railroads. One child in eight now goes to school by motor bus. Youth movements are much discussed everywhere nowadays, but this is by far the biggest movement of youth going on anywhere. According to the latest figures that I have seen, Indiana is the second state in number of school buses, and it is fourth in number of children riding daily.

Educators got a shock recently in the answer of school children to the question of what part of the school program appeals to them most. "The school bus ride," they said. But that answer would not surprise any of those who understand the deep-seated human desire to go places, and to do so in a pleasant manner, as has been made possible by the automobile and by the roads you men have built.

This is why it is that fairy tales, which are just fanciful expressions of common human wishes, contain so many accounts of miraculous means of getting about. Remember the story of "Hop-O-My Thumb" and the "Seven-League Boots"? Surely you haven't forgotten about the magic shoes of the giant in "Jack the Giant Killer", nor about the flying carpet in the Arabian Nights, or the winged horse either. Even Cupid had wings, and he still seems to be flying everywhere in the world today. Always the toys most popular with children, and with grown-ups too, have thus been those on wheels. As you know, the electric trains bought at Christmas time are often run as much by boys over 30 as by kids under 15.

SOME GUESSES ABOUT THE FUTURE

As for the future of roads, it has already been said that no one really knows just what it will be. But some of the needs and probable advances of the immediate future may possibly be guessed with reasonable certainty. There is, for instance, no doubt that we are going to need more roads—or perhaps I

should say more *improved* roads. Recent surveys indicate that the increase in highway traffic by 1960 will be 65 per cent or more.

Here in Indiana now there is less than 300 feet of surfaced highway for each car, and the average for the nation is less than 200 feet. Surely also the parking of cars on costly pavements is not to be accepted as a permanent thing, even if it were a solution of the problem, which it is not.

A primary need of the present, as well as for the future, appears to be a really good surfacing for secondary roads that can be cheaply applied and maintained. Express motor ways, such as those which the Futurama at the New York World's Fair was an attempt to suggest, are going to be badly needed, too. And this need has become the more immediate in view of the importance of such highways in the current emphasis on national defense. But how lucky we are in this respect to have the thousands of miles of strategic highways already built. There is, further, the need for some adequate form of limited way within congested urban areas. The relief of traffic congestion within and around cities has, in fact, been designated as the nation's No. 1 traffic problem. Distance between two places is really measured not in miles but in hours. In this respect streets and roads need to be shorter, and in some cases safer. Night driving being as it is more than twice as hazardous as daytime driving, not to say much more tiring, there is still need also for improvement in lighting.

Solving all the problems incident to filling these needs is naturally going to require further research. And hence the proper course of road research for the immediate future is known in part at least. Research is here thought of as distinct from planning, but of course as an aid to the planner in yielding new elements for him to work with.

It goes without saying that research on roads should aim also at the best possible coordination between the road and the car, especially as affected by human limitations. In this connection you might like me to mention briefly some results of deceleration tests run recently at the General Motors Proving Ground and reported last month at the meeting of the Highway Research Board by Ernest E. Wilson. These tests showed that for comfort the average rate of deceleration from a speed of 70 miles per hour should not exceed 9 feet per second per second; but that a car can be brought to a stop from 70 miles per hour more than twice that fast, or at an average deceleration rate of 19.5 feet per second per second. Thus the maximum capability of present-day cars to stop on modern roads is considerably beyond the range of comfort and safety for the passengers, and therefore much higher naturally than the proper value for the designer of highways to use.

Peering on down the road toward what may possibly be still further ahead, Charles F. Kettering has said that "almost

anything our imagination is able to grasp will be the transportation system of the future." It seems safe to take in still more territory than Mr. Kettering did, and to guess that the future of roads will in all probability contain things that we can not even imagine today. Surely it would be presumptuous on our part to think that we can foresee all that will be imagined and realized in the future by the young men now entering road careers, such as those being prepared for that important service by Dean Potter and his staff here at Purdue.

Roads have always been made either of earth materials, processed to brick or cement, or of asphalt and petroleum residues. For the most part, this processing has consisted only of selection, sizing, and heating. Surely, when simple heating is about the only means used thus far for changing the composition of earth materials from the state in which they happen to occur in nature, there are other processes that will be thought of and adapted to road making in the future.

In the past, also, roads have been lighted almost altogether by radiation from glowing wires heated by electricity on the car itself. This, and particularly the recent improvements incorporating the sealed-beam lamps, is a great advance over the coal-oil lantern that used sometimes to be hung on buggies. But surely we do not suppose that our successors will accept the present inefficient and ineffective lighting system as the ultimate, when one of the principal problems of getting about at night is still to see where one is going without glaring other travelers off the road.

Up to now, too, traffic has been controlled solely by sight signals received by the driver in each car, poor though the reception sometimes is. Railroads used to do that, too, but they have given it up for something more certain. Is it not reasonable to suppose also that some better system of regulating the flow of traffic on highways than anything now available will be devised?

These few speculations are only guesses, of course, mentioned merely to emphasize the belief that in roads, as in other fields, we "ain't seen nothing yet." If these guesses should seem in any wise fantastic, are they any more so than would have been a prediction made in 1910 that by 1940 there would be 30 million motor cars in the country, together with a million miles of surfaced highways to drive them on? About that time, as a matter of fact, a prophecy made by W. C. Durant that some day 300,000 cars would be manufactured each year shocked bankers so severely as to make it almost impossible for him to secure the funds he needed then to meet an emergency. It turned out, though, that the number of cars manufactured, as an average for each of the thirty seasons since, has been nearly 10 times as large as Mr. Durant guessed.

Outstanding new developments in roads will, however, be realized only through a combination of imagination and pio-

neering research. Research of this kind takes a great deal of time, and because of that it is costly. But extensive research on roads is amply justified, for the highway business is not only a huge one on which the nation is expending more than a thousand million dollars every year but it is also one that intimately affects every citizen. Besides, it is characteristic of research, when intelligently conducted, that in the long run it usually yields, as a kind of by-product, savings that amount to more than the cost of the research. In fact, the cost of not doing research has a habit of being higher than the cost of doing it.

In the future, then, it looks as though the course of research on roads will be a widening in scope and a deepening in character. Its function should be to search out all the basic knowledge possible on every problem relating to roads and to the control of traffic on them. More and more, it seems, the practical "getter-doners," the planners and the builders, which you men are for the most part perhaps, are going to need the help of the no less practical "finder-outers." For as Abe Martin, that famous Indiana philosopher, said once, "It's funny how a fellow with facts can break up an argument."

THE MOTORIST'S STAKE IN HIGHWAY DEVELOPMENT

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When I was invited to appear on this program, I held no official position, and even though my status has recently changed, I am speaking particularly this afternoon as a private citizen, expressing only my own views on what I consider the motorist's stake in highway improvement.

May I restate that subject? To me it means "What is an ideal highway system?" My talk will be divided into two parts: first, a discussion of highway finances, and second, what to me would be an ideal highway system.

The first part of my talk covering the question of highway revenues is made possible very largely through the Indiana Automobile Taxpayers League, of which I have been president since its organization, and through Mr. Albert Wedeking, vice-president. Mr. M. V. Cameron has been executive secretary of the League and to him the motorists of Indiana are indebted for a most remarkable assemblage of factual data. Through the efforts of the Indiana Automobile Taxpayers League, and Mr. Cameron in particular, motorists are now able to get quickly a comprehensive view of this important question of highways.