THE ENGINEER AND THE ROAD

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Just where should the engineer be rated in a review of modern road development? For how much of its seemingly inevitable wastefulness should he be blamed? With how many of its amazingly intelligent steps of progress may he be credited? Just who is he, anyway, and why should he be needed at all? In the past, has he met his obligations and done his full duty fearlessly and intelligently? What about the future? Is the engineer destined to play a larger part or is he to be relegated to the post of adviser without any rights of veto on purely technical matters? Is the engineer of the future to merit larger responsibilities and should he prepare himself for them? The answer to this last question is undoubtedly yes.

Just what expectancy may a young engineer risk in training his mind and in otherwise preparing himself mentally and physically for a career as a road engineer, as well as in being able to perform his duties as an engineer without fear of consequence if he is reasonably sound in judgment and right always in principle? With your pardon for a personal reference, my own career as a fairly young state highway engineer of Texas was considerably influenced by a commissioner, quite old, but with a full life of service behind him. My composure had been considerably disturbed by some unfavorable and unfair editorials and colored news stories, and it seemed that other matters of concern were looming large and my worries were mounting. My friend the commissioner said, "Gibb, you should not let those criticisms worry you. You know these stories are prejudiced and untrue. Don't be afraid of criticism, anyway. The only thing you should be afraid of is being wrong."

In this fine institution of Indiana, Dean Potter and his capable staff are training more young engineers than any similar institution in America. Back of Dean Potter stand David Ross, President Elliott, John Wheeler, and other officers and officials of Purdue. It has not been necessary for me to come to Purdue to know that men are being trained here for fields of service well beyond the requirements of the various curricula. The quality of your leadership proves that. The institution I have the honor to represent, the Agricultural and Mechanical College of Texas, is second only to Purdue in the number of young men being trained for service as engineers. Many of our young men and yours will go into the highway service of the national government, some state government, or
perhaps some other political subdivision. Public money pays for construction. This means politics, not necessarily bad, but politics just the same and, frequently, not for the best interests of the masses. My considered opinion is that the engineer must participate to a greater degree in the planning, design, selection of materials and type, construction, maintenance, and operation of road systems than in the past, and also in those phases that might be called non-technical. Furthermore, it is believed that road contractors, material men, equipment firms, and salesmen of various and sundry items affecting road construction would very much prefer that this be the case and that an engineer of unquestioned integrity be charged with decision in all cases involving plan, design, construction and maintenance where a technically-trained mind is needed. Are we training our young engineers to take over with full responsibility for all matters that point to a decision by an unbiased and unfettered professional engineer?

HIGHWAY LOCATION

Let us take the question of highway location. If the opinions of the most experienced highway engineers of the states and of the Federal Government are to be given credence, we must believe that the greatest single problem confronting the road builder today is one of right-of-way for new locations and for widening and otherwise improving existing roads. Of course, in the case of roads already planned, this is “spilled milk”; but as a basis for the future, just how much responsibility does the engineer have for this condition? If he was permitted to, why did he not plan direct routes and secure plenty of land for right-of-way when it could have been had for a fraction of what it would cost today? If the engineer was in a position to plan properly and did not do so, why? Was it too much trouble to fight the thing through? Did he lack courage or vision? Was it due to some sort of inferiority complex that has seemed to bother engineers as professional men in recent decades? Is it not a moral certainty in any state that the responsibility for poor location and narrow rights-of-way will eventually be laid at the door of the engineer, no matter what his connection might have been?

My belief is that the engineer's viewpoint has not particularly changed as to highway location in the last one hundred and twenty-five years. Witness the testimony of Mr. James Dean, Civil Engineer, before an investigating committee of the House of Commons on April 1, 1819:

The first and most obvious improvement is to shorten distances; but even that must be governed by circumstances often of a local nature; a sound foundation, and the contiguity of good stone or gravel to a road should not be overlooked in choosing a new line, or departing from an old one.
It is my further belief that selfish influences tending to control the location of a highway have not shown any considerable variance over the same period. About 1806 Congress made provision for what was commonly called the Western Road. The road was to begin at Washington and extend west to Wheeling or thereabouts. It seems that a delegation from Washington, Pennsylvania, waited on President Thomas Jefferson and told him that the route of the western road if carried through their town "would be but a mile longer, would pass through better ground and be made at less expense." On August 6, 1808, President Jefferson addressed the following letter to Secretary of the Treasury Albert Gallatin:

On the subject of the western road, our first error was the admitting a deviation to Brownsville, and thus suffering a first encroachment on its principle. This made a point d'appui to force a second, and I am told a third holds itself in reserve, so that a few towns in that quarter seem to consider all this expense as undertaken merely for their benefit. I should have listened to these solicitations with more patience, had it not been for the unworthy motives presented to influence me by some of those interested. Sometimes an opposition by force was held up, sometimes entranceering effects, as if I were to barter away, on such motives, a public trust committed to me for a different object. It seems, however, that our first error having made Brownsville, and no longer Cumberland, the point of departure, we must now go no further back in examining the claim of Washington. I have, therefore, written to the Commissioners, the letter of which I enclose a copy. The time saved by sending it to them direct may be important, as they may be near their return. I am doubtful whether they have money enough left for a thorough examination. If they have, their report will enable us to decide on this second deflection. But what will Wheeling say if we take the road from it, to give it to Washington? I do not know its size or importance, nor whether some obstacles to navigation may not oppose our crossing at a higher place. I salute you with constant affection.1

This has a familiar sound to most highway engineers and might apply to any number of cases in any state where roads are being built.

The particular thing that does vary is the engineer's influence and effect. It goes from practically zero in some cases to the limit of human perfection in others. In very few cases is the engineer adequately protected by law in the security of his decision.

THE TIME FACTOR

Probably one of the greatest handicaps the highway engineer has had might be called the time factor. He has had no chance to prepare himself for his problem. From 1915 to 1930 the engineer who specialized in highways was only a few

1 The Writings of Thomas Jefferson, Volume XII, pp. 118-119.
steps ahead of an intelligent section of the general public interested in roads. The advent of the automobile naturally caused this uncertainty, and even in 1915 or 1920 the engineer was at a loss to develop the trend of motor vehicles and was under severe restrictions in planning. Since 1920 most of the states in the Union have had at one time or another most of the following situations:

1. Where local authority controlled in both location and design of highways.

2. Where local authority effectively influenced location and design.

3. Where the engineer was given no option as to location or the materials with which to build his road, and simply did the best he could.

4. Where the state political influences had largely controlled the policy of location and design.

5. Where some influence by reason of public outcry against accidents has charged engineers with poor location and design.

6. Where engineers in varying degrees have been guilty of lack of vision and some lack of courage.

7. Where engineers were given the authority and charged with the responsibility of location, design, and construction and have measured up to the test.

8. Where the cost of right-of-way and its acquisition becomes the principal problem of a highway department.

The engineer has had his part in all of these situations. He has influenced them and has either advanced or retarded progress. If a general survey of all forty-eight states were made at this time, it is my firm conviction that a definite relation would be found between a state's standing as to substantial and intelligent progress in highways and the responsibility and effectiveness of its highway engineer. Undoubtedly, the best results have been obtained where the engineer has been executive head, with complete control of his organization in the execution of policies and orders of the governing body. Better results have always been noted when engineers were in charge of location, design, type, construction, and maintenance, and have had not only the responsibility but the authority for all procedure and for personnel. All our states will find themselves making more progress when the people insist that engineers of ability and integrity be continued in charge of their road systems and that their advice be followed in all matters affecting the utility and economy of the program.

DESIGN

With reference to design, both geometric and structural, how has the engineer fared? In the early days of the motor-
vehicle period, he had very little opportunity for constructive study or planning and practically no option. A portion of his funds came from local sources, his route was usually selected, and in many cases his type was set up in the order of election for a local bond issue. In these cases the engineer was not hired to think but to set stakes. Is it any wonder that even now the road engineer is frequently depicted by the cartoonist with a transit before him or on his shoulder? As late as 1925 many practicing engineers considered that highway engineering required very little professional skill. The design of a highway grade was considered a matter of templates, planimeters, and simple arithmetic. Any road making material not coming under the terms of stone or gravel was simply earth and assumed to have uniform characteristics. The experience of English engineers in the early part of the nineteenth century in connection with clays, gravels, loads, and subsoil requirements, was of record but not generally known. Some of the most interesting observations on road construction in England naturally came through John Macadam. In a report to the Board of Agriculture of England in 1821 Macadam makes the following observation:

The erroneous opinion so long acted upon, and so tenaciously adhered to, that by placing a large quantity of stone under the roads, a remedy will be found for the sinking into wet clay, or other soft soils, or in other words, that a road may be made sufficiently strong, artificially, to carry heavy carriages, though the subsoil be in a wet state, and by such means to avert the inconveniences of the natural soil receiving water from rain, or other causes, has produced most of the defects of the roads of Great Britain.

At one time I had formed the opinion that this practice was only a useless expense, but experience has convinced me that it is likewise positively injurious.

With regard to types, the same early period saw the beginning of a great super-technical era involving different kinds of materials, equipment, types, etc. Great stress was put on methods and means of doing things and importance was given to minor details, while many fundamentals were ignored or forgotten. Naturally, of course, engineers cannot be separated from this movement because, as a rule, they are part and parcel to a sustained pressure on the other engineer we have been discussing—the one charged, normally, with expenditures of public funds on highways. The only real trouble here seemed to be our road engineer's inability to find time to do much thinking of his own. Most of his work was cut out for him, or else he had to develop a negative mind and was always compelled to set up a defense within his own group. He managed to weather this period principally because he was getting people out of the mud and public clamor was satisfied. Then, again, it was a very poor section of road
that did not show tangible benefits in the way of progress and rapidly increased motor traffic.

Undoubtedly the greatest decade for progress in highway building, motor-vehicle design, and public interest has been the 1930's. The highway engineer, too, has improved his status and is enlarging his scope of activity. In my opinion this has been due in some measure to a public aroused by motor-vehicle accidents on the streets and highways of the nation. I shall attempt no analysis of highway-accident statistics and their causes. With some knowledge of accidental deaths in the home and at other points, it has always been a matter of wonderment to me that the death rate from motor-vehicle operation has not been higher.

In the triumvirate of the manufacturer, the road builder (which includes the road engineer), and the driver we have a variety of purposes and obligations. There are only a few manufacturers, but they secure competent engineers and follow their advice in matters involving safe construction. Unquestionably, this has been one of the principal factors in keeping the accident rate as low as it has been. The manufacturer can change his model from year to year and incorporate new safety devices. Road builders are public bodies responsible to the people and are usually limited in finances. Frequently they have been influenced by political pressure. The engineer's place has been largely determined by his own personal characteristics and his willingness to fight for principles. Assuming that he has done his best, he cannot develop yearly models. As a general rule his location, width of right-of-way, and other factors do not justify extensive betterments. He must simply improve the best he can until he relocates and builds. The driver is one of nearly thirty million people of every possible personal characteristic and impulse. He is not responsible to the builder of the machine he drives nor to the builder of the road. He is operating under certain laws, often loosely enforced, if at all.

SAFETY

We are often asked to compare the accident records of rail lines and some air lines with those of the motor vehicle and the highway. One essential difference should be recognized before making such comparisons on an equivalent basis. In the case of railroads and air lines the same general agency that plans and maintains the transportation is also in charge of operation. Their engineer, as a rule, has a large part, not only in construction, design, and maintenance, but also in operation. This brings one to speculate as to the effect on the motor-vehicle accident rate if highly trained engineers were provided the necessary funds, given the proper authority, and told to construct and operate a system of national highways, giving preference in all cases to the preservation of human
life. Our democratic form of government will not permit such an arrangement, and it is perhaps best that it should not; but it does bring to mind the great possibilities of lifesaving on the highways with the adoption of just a few rather simple rules and regulations, the breaking of which would bring serious results to violators. With our highways as they are at present, it has been estimated, conservatively in my judgment, that a well-trained non-political, impartial, and courageous enforcement organization in any state could be operated at a cost of a full tank of fuel per year for each motor vehicle; and thus, for all practical purposes, safety on the highways could be secured.

PUBLIC ROADS ADMINISTRATION

It has been said that the decade just past showed more progress than the years before. This has been true not only in public interest, in growth of the highway systems and improvement of the motor vehicles, but in the necessity for the engineer and in the enlargement of his activity in highway problems outside his purely technical status. The people themselves have begun to recognize the value of engineering service in the councils of those in authority. One of the greatest assets the road builders of the United States have had during the past twenty-four years has been the Bureau of Public Roads, now the Public Roads Administration. The success of the work of the Bureau has been due largely to the efforts and influence of one man—Thomas H. MacDonald, an engineer, who has been Chief of this Bureau since the passage of the first Federal Aid Act in 1916. Mr. MacDonald possesses a wide knowledge of highway engineering. He has kept up with the times and with the progress made both at home and abroad in more detail than one would imagine. At the same time, Mr. MacDonald's chief value to the states and to the nation has been his quality of leadership, his exercise of sound judgment in matters of administration, finance, and planning, and his vision of what the highway system of the future should be. Mr. MacDonald is at this time chairman of a nation-wide committee that is planning the highways of the future and is making recommendations to the United States Government and to the states as to how best to avoid the mistakes of the past and to plan better for the future. The committee referred to is composed principally of highway engineers.

CONCLUSION

In the way of a summary, the highway engineer of 1915 ran lines, plotted cross-sections, figured quantities, gave estimates, and hauled gravel on to a dump flanked by uniform road ditches. In the 1920's, the road engineer went through many different stages. He found himself generally on the defensive and with little opportunity to give constructive
thinking to his location, design, and type of road. He was circumscribed by many restrictions and regulations, political and otherwise, offering no encouragement to a long-range program. The 1930's were somewhat of a reversal. The depression brought many engineers by force of necessity into the highway field and, for a long period of time, in many states highway work was the principal livelihood for many engineers who had started out with other plans. The 1930's are gone, and at their end the engineer who was able to plan, design, construct, and maintain a modern roadway has become somewhat of a specialist. For the first time he is able to select his design speed and determine what classification his highway is to carry. He is able to provide right-of-way that will be sufficient for the life of the road. He has become a landscape engineer because the people are demanding beauty as well as utility along the roads.

It is with a note of encouragement, therefore, that we look into the future and seem to see the ever-increasing part that the engineer must play in the proper development of our national highway system and our Union. To occupy his proper sphere in the scheme of transportation on the highways, he must be taught something besides concrete, steel, soils, and things of that nature. He must take his place in the councils of men and speak up. He must be taught to lead and not always to follow. It is not too much to say that he must go into politics of the right kind. The future seems to offer opportunities, and it is believed that the highway engineer is on his way to greater service. Young men are being trained at Purdue, at Texas A. & M., and at other forward-looking colleges with this in view.

LOOKING TOWARD THE FUTURE OF INDIANA ROADS

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Highways, as a means of quick, convenient, and safe transportation for the majority of our population and for the movement of an increasing percentage of our farm and factory products are today entering upon a new stage of development—a stage which challenges the roadbuilding industry to meet the needs of the future as well as those of the present.

Never before in our history have the attention and the interest of the general public been centered more searchingly upon highways—their construction, their maintenance, their financing, and their uses. Neither has there been a more widespread realization of the importance of roads in our social and economic life, or—because of war conditions on other continents—a more general realization of the importance of roads as a phase of our national defense.