

Highway Development: How Was Our Modern Road System Created?

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In the series of articles of which this is one, the Editors of Engineering-News Record have chosen to bring before their large audience a single idea. At least my conception of the thought behind this series is the constructive service that may be rendered by striking a balance of past developments and accomplishments in the field of highway improvement to assist in insuring future progress toward the most valuable ends, - a sort of "Stop! Look! Listen!" motive, inter-vened with the recognition of large and praiseworthy past results and with the acknowledgment of definite advancement in the science of highway engineering.

There is no question that we have reached the "Stop! Look! Listen!" stage. How and where we go from here will put an even higher test upon the quality and intelligence of highway leadership than the problems of the past, - not in every way, but in those phases requiring the weighing and determining of the highway services required, the application of the scientific principles that are evolving, the furthering of real research, and the formulating and balancing of future programs and budgets.

In less than two decades a wholly new transportation service has been put into operation. The scale is so large in every aspect that profound disturbances have certainly followed. Some of the facts

of this period are shown in the accompanying graphs. The matters of gain and loss are not here under analysis. Rather we are concerned with the way we have come, the influences which have given direction and the evidence existing in the present status which must largely determine the more important future developments. The impacts because of the momentum now attained by highway transport are confusing, and while there is greater need for the quality of imagination in highway leadership, it must be tempered by a full appreciation of the underlying principles of engineering and finance, themselves as yet scarcely defined in terms of today's dimensions.

There is the matter of multiplied administrative bodies. Seven times seven fails to include all within a relatively small area, and yet our present needs call for co-ordination among them all, beyond any heretofore-held conception. The certainty of lessening the number can be assured only through co-ordination.

Financing is reaching a stage which no longer permits subterfuge. In the flush of delight with each year's gift of new highways, we have closed our eyes to bad practices which are nearing their own self-extinction -- for example, the exhaustion of county credit to build state roads. Continuously with the development of the motor vehicle has come the pressure for the improvement of more and more mileage. This demand, yet vigorously claiming right of way, now comes into abrupt conflict with the strong, stubborn necessity for perfecting existing highways

to carry traffic more adequately and more economically. The forces arrayed on the side of better highways include all of the most courageous and experienced highway administrators, notwithstanding that this end may be reached only by the temporary curtailment of new mileage.

This all sounds confusing, but to these many more major problems might be added. It is not necessary. All of the bridges do not have to be crossed in advance. An orderly approach is the important effort and particularly if, in this way, simplification results. In medical science much time and effort are devoted to isolating the germ. Once accomplished, the disease cure may yet be highly difficult, but the efforts are given direction and definite objectives. In this field of highway science a parallel exists which may with equal certainty be relied upon to give not only true direction to their study but proper weight to the various detailed problems composing the whole.

The highway has ever taken its form and attributes from the vehicle or the character of transportation carried. Only in the details or for relatively short periods, has the highway determined the character or design of the vehicle, and never the motive power. True, the use of otherwise available transport facilities is restricted or prevented by the lack of suitable highways and thus the development of whole sections is retarded. This condition exists today in greater or less degree in all the countries of the Western Hemisphere and in a large way in many countries of the Eastern Hemisphere. Notwithstanding these widespread conditions, whatever is now, or has been, through

the years, wanting in the way of highway service, has been quantitative, i.e., the lack has been in miles, not in knowledge of how to provide roadways for the then existing mode of transport. Following whole development and the conclusion is inevitable that highways are the offspring of the mode of transport and take their characteristics from such parentage. That their building to adequate standards has never in any large country caught up with their apparent potential has probably been due to reaching the economic limits of the mode of transport; although it is also apparent that social inertia and political organization are responsible in some countries for the standards of highways far behind their demonstrated economic utility.

If out of all the experience of the past we find an unchanging quality, a characteristic that has remained constant, it becomes an invaluable guide to the future, a fixed standard of measurement by which to gauge accurately future policies. So in addition to recording the various phases and periods of our highway history, the attempt is made to bring out the constant factor, - to isolate the germ, - in order that it may be so compared.

The vehicle dictates the indispensable qualities of the road. Therefore the necessary highway facilities will be determined by the economic utility and utilization of the vehicle, i.e., the most desirable transport service with maximum economy. It seems probable that this principle has governed the whole of our highway development and will continue to do so. It certainly is supported by the history of more than three centuries.

The Colonial Period.
1607 - 1776

The Colonies of Virginia, Massachusetts and New York, by 1666 had enacted laws providing for clearing a lane for travel of trees, undergrowth and insurmountable obstructions. The Maryland Law of 1704 provided, in addition to clearing, for marking the roads by notches cut into the trees along the sides and by letters set on with marking irons. The major transportation of goods and persons which permitted the Colonies to grow into economic independence was by water. So great was the influence of this then available mode of transport, that a report by the Joint New England Railroad Committee in June, 1923, states: "More than seventy per cent of the New England population still live and the major part of our industrial activity is carried on within fifty miles of the seaboard."

The process of subduing and settling the country can be visualized as a gradual pushing back from the water as the nearer land was taken up. Long journeys overland were made on foot or horseback and pack horses were sufficient to carry the limited commerce inland from the water courses.

The trails across the Allegheny Mountains to the Ohio River valley were scouted first by hunters and Indian traders, then used by pioneer settlers, then by the Army, - but these were not roads of commerce as yet.

In the later days of the Colonies, the primitive cleared roads had been sufficiently improved by the counties with labor tax

that it was possible for people of wealth to travel by coach-and-four between the larger populations centers or to transport goods by wagon. The work done in general seems to be only that sufficient to permit the passage of stout wheeled vehicles drawn by ample animal power. The roads were no better than the vehicles had to have, but even so, they were probably a greater cost burden than today because of their small earning capacity.

The Toll Turnpike Period. 1785 - 1850

Immediately following the Revolution it appears that the newly acquired dignity of sovereign states found one expression in an increased activity in behalf of a more adequate land transportation. This undoubtedly grew out of the recognized necessity to stimulate commerce if they would insure economic as well as political independence.

The Legislature of Virginia in 1785 provided for the establishment of toll gates on the Little River turnpike west from Alexandria to the Shenandoah Valley. Connecticut followed by placing tolls on the Mohegan Road and the Old Post Road in 1792. A number of other States established toll roads as state projects, but in 1792 Pennsylvania granted a charter to the Philadelphia and Lancaster Turnpike Company to build a toll road, the Lancaster turnpike, 62 miles in length, from Philadelphia. This plan spread like wild fire in all the states, until thousands of miles were being built and operated by private companies. In 1808, the Secretary of the Treasury reported

770 miles completed in Connecticut and 3000 miles completed or under construction in New York. When it is considered that the state system of New York today comprises 13,929 miles, one obtains some idea of the extent of these toll roads of more than a century ago. The charters granted these early companies generally restricted the rates, routes and other details so that they afforded far greater protection to the public than the authorizations to build toll bridges granted by the present Congress. Even though these early roads were of low cost construction, highway traffic was not yet developed to the point of profitable dimensions. The horse-drawn vehicle, while requiring only a road that at best was surfaced with gravel or broken stone, could not support the moderate investment with toll rates which we would today regard as high. Few companies paid more than two or three per cent profit. Most of the companies failed or owned unprofitable investments by the time or even before the railroads came. With the advent of the railroads most of the remaining toll roads reverted to public control although here and there a few existed as local roads until recent times. Over continuous routes the collection of tolls and long distance traffic itself had ceased generally long before 1850.

In addition to granting charters for the building of toll roads, the states, although not in equal degree, undertook the laying out and building of many miles of so-called state roads. The principle of state aid was also established by appropriations to the localities to

assist them in improving roads. This state activity was prompted largely by commercial rivalry - the desire of the cities established on navigable waters, by this time grown to some importance, to hold or to extend their tributary trade area. It was this motive that prompted the State of Maryland, or perhaps more particularly the City of Baltimore, to undertake the building of the eastern end of the old National Pike from Baltimore to Cumberland, Maryland, there to connect with the portion under construction by the Federal Government over the mountains and into the valleys of the Ohio and Mississippi rivers. The Federal Government had undertaken the building of this road westward from Cumberland to take the traffic overland from the terminus of the Chesapeake and Ohio Canal which ran from Georgetown, D.C. to Cumberland, Maryland, and Baltimore saw in this her supremacy as a port threatened by Georgetown. It is evident today that Maryland's enterprise held commercial supremacy for her largest city.

It soon became evident as these roads were extended to considerable distances from the trade centers that the bulky goods of low value could not be transported profitably with the method at hand. It is recorded that merchandise and products of manufacture were transported overland from Philadelphia to Pittsburgh, where in some instances these goods were traded for grain and meat which were sent by water to New Orleans. There it might be possible to sell a small part but the rest was exchanged for cotton, indigo and raw sugar, the products of Louisiana, and these in turn were sent by water to Philadelphia, thus completing the transaction.

While it has often been stated that the canals and railroads put the highways out of business, it is evident that the highway transport developed inland commerce to the extent that it put itself out of business. That is, the mode of transport was no longer adequate to meet the demands of the rapidly growing commerce. A wave of canal development swept over the states to be followed very soon by the building of railroads, both enterprises engaging the attention of the states and commanding very large expenditures from both the private and the public purses. It is a matter of rather common knowledge that the states, or many of them, lost large sums invested in unprofitable canal enterprises, and also in railroad schemes. It is not so well known that some of the States had large investments in unprofitable toll road stock. Nile's Weekly Register of January 29, 1825, records the fact that the State of Pennsylvania owned \$1,799,097 worth of such stock which, during the year 1824, yielded a revenue of \$1,187.

As a move toward roadways that would carry the traffic more efficiently steel rails were laid to form tracks on which wagons, having their tires designed to fit the rail, were drawn by animal power. Before these were developed to any considerable extent the steam locomotive became a practical utility, and of course this displaced the horse-power.

The Dark Age of Highways 1850 - 1890

This period is chiefly noted by the loud outcries generally raised because of the lack of highways and the very bad condition

of those existing. This situation seems to have been general. One of the greatest epochs of the United States came early in this period with the great home seeking and gold hunting trails to the west and northwest. The movements of the pioneers recorded themselves in the Santa Fe, the Mormon, the Oregon and the Overland Trails, but these are all records of location or lines of travel followed by these processions. They were not roads in the sense of constructed or improved highways. They were not accomplishments in highway engineering in the narrow sense but they were supreme accomplishments in the human effort of empire building. Today great transcontinental highways are in the making along all of the paths followed by these pioneers.

While the mode of transport over these great trails was slow and laborious and took toll of animal and human life in great numbers, it was probably the one possible type to accomplish the purpose. After the first movement actually reached the coast, it is doubtful if improved roads would have greatly changed the history of that early period since these were the movements of settlers and home makers. The roads were not yet paths of commerce.

In the latter part of the period (1885) the safety bicycle was introduced and for the next decade swept the country before it. Hundreds of local clubs of cyclists were formed and a large number of these were brought together in a national organization called "The League of American Wheelmen." The advantage of the bicycle for recreation induced the enthusiast to travel afar and it was not long before the chief aim of the League became the promotion of better roads, and the Good

Roads Magazine, started by the League in 1891, became a potent force for road propoganda. In the bicycle it will be noted was a new vehicle for transport which if it were to be utilized to the best advantage required very good roads indeed; and in five or six years the bicycle accomplished more definite results in securing a definite attack upon the problem of road improvement than had been accomplished in the preceding third of a century. Fundamentally this is undoubtedly because the vehicle in order to be used to the full limit of its possibilities required much higher types of roadways than animal drawn vehicles.

State Aid and Early Federal Legislation.
1890 - 1916

Foreshadowing the very important structure of today's highway administration, the State of New Jersey in 1891 provided for aiding the counties through funds appropriated by the State, and established a State authority for administering in cooperation with the local authorities the use of these funds. The same principles were put into effect in Massachusetts in 1892, in Connecticut and California in 1896, in Maryland, New York and Vermont in 1898. The report of the Massachusetts State Highway Department of 1893, prepared by or under the direction of Dean Shaler of Harvard University, the first Chairman of the Commission, is a basic document portraying a broad engineering survey of the problem at hand. The two elements of the New Jersey Law, state aid funds and state engineering supervision, were curtailed by many of the states to the single one of extending engineering advice, conducting

demonstrations, and gathering information, all of which might be accepted or rejected by the local authorities at their discretion.

The Federal Government followed the same principle in establishing the Office of Road Inquiry in the Department of Agriculture by an act approved March 3, 1893. The authority granted was for the collection and dissemination of information, and the first appropriation was \$10,000.

While in many of the states the organization and funds provided were extremely limited, nevertheless these laws were extremely important, the majority of them marking the first adventure in the field which has now become the most important state activity, measured by the annual expenditure. The following schedule indicates the dates of the passage of these first state aid acts. It is not quite accurate in a way, since a few agencies existed prior to the year indicated which had sufficiently broad authority to enable them to engage in a limited way in collecting and disseminating information relative to highways.

This same period was marked by the formation and activity of a large number of organizations devoted to furthering ways and means to accomplish highway improvement. The American Road Builders' Association, forerunner of our today's American Road Builders' Association, the American Automobile Association, the American Highway Association, the National Association of Automobile Manufacturers, and the American Motor Car Manufacturers Association, parents of today's National Automobile Chamber of Commerce, were all very active in bringing together in annual conferences, and even more frequently, group meetings of the very considerable number of engineers, contractors, manufacturers, highway users, and producers of all kinds of materials and equipment. It is to the credit of the National Grange that this farmers' organization early put its support behind the road movement and has consistently advocated every sound proposition for the advancement of highway transport. In addition to the educational activities carried on to enlarge the information of their own members and of the general public, all of these organizations have been very active in helping to frame and to secure legislative support from the State legislatures and from the United States Congress.

The importance of the small beginning made by a number of states in establishing an organization without funds to build roads and with only limited appropriations to gather and to disseminate information which might or might not be used by the local authorities in control of the road taxes, was not at the moment appreciated. It has not been until recent years that the real significance of this small beginning has been manifest. These organizations attracted

young, enthusiastic technical graduates whose first duty was to acquire information. The process of acquiring was not easy, but it was a soft job compared to disseminating the information to the county supervisors and local officials and getting this information used by them. This process resulted in sifting what might be done down to the essentials of what could be done. For example, the educational campaigns and demonstrations put on for the purpose of exploiting the possibilities of maintaining earth roads by use of the split-log drag was the forerunner of the most important item in our present road program - continuous maintenance. In these states also - of which Illinois is a good example - the idea of research was given strong support to make the best possible use of available resources and to develop methods best adapted to the particular conditions met within the state.

Beginning in 1907 a number of the state highway departments of the Mississippi Valley met in annual conference and there soon began to grow out of these contacts plans and specifications for roads, for materials, and particularly for bridges particularly adapted to that area. And today the Mississippi Valley Highway Association is one of the most helpful organizations in furthering sound highway administration. Later similar associations were formed by the eastern highway departments and by the western highway departments. The similarity of the problems to be met in each of these areas has made these organizations highly desirable, and their members seem to feel that for the details of their administrative and technical problems

these annual meetings are the most helpful.

In 1914, at the call of Logan Waller Page, Director of the Bureau of Public Roads, representatives of a number of the state highway departments met at St. Louis and planned a national organization of state and federal highway officials. This organization was perfected at a meeting in Washington in December, 1914, and thus was formed the American Association of State Highway Officials. This organization undertook at once the preparation of legislation to submit to the federal Congress for the purpose of securing federal appropriations to assist the states in the development of their road programs. A bill was drafted, approved by the Association, submitted to Congress, and made a law on July 11, 1916. At the close of this period forty-two states had made appropriations and were contributing state aid to the counties or towns. A few of these were also working on state road programs independently of the counties. In the other states the road funds were being used by the local authorities under the supervision or with the help of the state highway organization. Six states had as yet no state highway organization of whatever character.

In 1902 the State of Rhode Island provided for laying out and building at state expense a system of state roads. A few other states soon followed, notably Connecticut, Maryland and California, and a number of others, which did not assume full responsibility for building the system, required the state aid funds provided to be expended upon a definite plan of routes connecting the population centers throughout each state.

Modern Period.
1916 - 1928

The only reason for placing the beginning of this period at 1916 rather than 1914 is that it marks the real renewal of Federal highway legislation after a lapse of approximately a century. The year 1914 marks the break in the curve of expenditures for motor vehicles, from which time the astonishing yearly increase has been broken only four years in the 13-year period. It is of interest to note that these breaks occurred at regular intervals of three years.

Highway expenditures since the same year have continued to increase on a less rapidly ascending scale broken only one year.

The Federal highway legislation of July 11, 1921¹⁹¹⁶ set up an appropriation covering a five-year period under an Act which was in detail previously agreed upon by the state and federal highway officials. It marked the first notable achievement of the American Association of State Highway Officials, since this Association, while greatly assisted by other organizations previously mentioned, was able to voice the support of the combined official state highway organizations and to carry to Congress a plan thus unanimously supported. This legislation provided the very important principle that in order to qualify for participation a state must establish a state highway department adequate to carry the direct responsibility for the expenditure of the combined state and federal funds. It also provided that the states should each accept through legislative action the terms and conditions established. Thus immediately following 1916, the state legislature of each state enacted

and in general extended state highway legislation. It marked the beginning on a national scale of modern highway legislation. Before the stage was set for wide operations we were engaged in the war, so that not more than one-half million dollars of the federal funds had been expended by 1919. The first federal appropriation was not limited to a definite system of roads but the Bureau of Public Roads requested from each state a map showing a five-year program, that is, the roads on which the funds during the five-year period would be expended. In 1921 a new federal law amending the former Act was passed, providing in much greater detail the principles on which federal participation would be extended. The most important of the new principles was the provision for the laying out of a system of highways, inter-state and inter-county, in character, to consist of not more than seven per cent of the total highway mileage of each state. By cooperation among the states themselves and between the states and the Bureau of Public Roads, a system of roads was laid out so coordinated as to form a national system of 170,000 miles, to which additions have been made so that at the present date it totals 188,000 miles. In addition there are 105,000 miles under jurisdiction of the state highway departments.

The next important step came through the request of the American Association of State Highway Officials to the Secretary of Agriculture to appoint a committee representative of the state and federal highway organizations to determine and select a system of through routes. As a result of the work of this committee there was set up a system named by

action of the states "The United States Highway System," including 95,000 miles of interstate routes. The routes running east and west were given even numbers and those running north and south odd numbers; each route carrying continuously throughout its length an identical number on a distinctive marker in the form of the United States shield, upon which also there is displayed the name of the state. In addition to this system of U.S. highways a complete code of warning and directional signs was established and has been put into general use throughout the United States by the state highway departments.

It will be noted that these latter two steps were accomplished through cooperation between the states and the Federal Government. Construction of the so-called 7 per cent system has been proceeding at such a rate that at the present time 75,000 miles have been improved to some definite stage with Federal aid. In addition the states have improved a very large mileage without Federal contributions.

Many conclusions might be drawn covering the development, but taken from the standpoint of the engineer perhaps these are of greatest interest. We cannot take credit in the United States for the development of any new type of construction up to the building of the first concrete road in 1893 in Bellefontaine, Ohio. The engineer of the United States can take credit for the development of the concrete road up to its present standard of perfection and for the control of materials and the mechanical processes and equipment which today make possible a higher rate of production of this type with less hand labor than any other type of construction.

The profession can also take credit for the development of methods of construction, maintenance, utilization of local materials and bituminous processes that are serving traffic not always in a de luxe way to be sure, but in such a way as to meet a tremendous problem. And it can take credit for instituting programs of research of rapidly growing dimensions in both the physical and economic fields.

Probably more of the existing legislation, state and federal, has been written by engineers than applies to any other public activity. The progress of the past ten years is a triumph for the principle of co-operative effort between state and federal governments.

Looking to the future there is just now a considerable amount of highly superficial agitation and propaganda for this and that in the way of future highway development. There is just one principle discoverable that runs constant throughout our history of road development and that is, to build the roads on the basis of serving the required utilization of the vehicle with economy - this is the one sure guide. Without discussing or arguing the situation, a correct application of the measurable, through research, utility of the motor vehicle will very quickly point out the fallacies in many advocated plans of improvement. The most fallacious of these plans originates in the congestion now existing in metropolitan areas and this traffic is assumed to continue in unbroken numbers from end to end of the continent, thus necessitating great continental routes of four, six or even more lanes. This multi-lane traffic problem lies within metropolitan areas and closely connected large centers of population. The really big problem is today the same as it has been

since the first settlement at Jamestown: To facilitate this most intimate type of transportation by means of roads which are capable of carrying the vehicle with economy for the greatest possible number of people.

The highway is an ever changing service, not a museum piece.

Dates of Passage of State-Aid Highway Laws.

Year in which first State-aid law was passed	State	:Year in which :first State-aid :law was passed	State
1891	New Jersey	: 1909	Colorado
1892	Massachusetts	: 1909	New Mexico
1895	California	: 1909	North Dakota
1895	Connecticut	: 1909	Utah
1898	Maryland	: 1909	West Virginia
1898	Vermont	: 1910	Louisiana
1898	New York	: 1911	Alabama
1901	Maine	: 1911	Kansas
1901	North Carolina	: 1911	Nebraska
1902	Rhode Island	: 1911	Nevada
1903	Delaware	: 1911	Oklahoma
1903	New Hampshire	: 1911	South Dakota
1903	Pennsylvania	: 1911	Wisconsin
1904	Iowa	: 1911	Wyoming
1904	Ohio	: 1912	Kentucky
1905	Idaho	: 1913	Arkansas
1905	Illinois	: 1913	Montana
1905	Michigan	: 1913	Oregon
1905	Minnesota	: 1915	Florida
1905	Washington	: 1915	Mississippi
1906	Virginia	: 1915	Tennessee
1907	Missouri	: 1917	Indiana
1908	Georgia	: 1917	South Carolina
1909	Arizona	: 1917	Texas





