# PAST, PRESENT AND FUTURE OF OUR STATE HIGHWAY SYSTEMS

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Through many years there have been both a personal desire and an official obligation in my mind to place in the record an acknowledgment of the great debt we, whether highway engineers or highway users, owe, and through time, will continue to owe, to Dean N. S. Shaler, of the Lawrence Scientific School of Harvard University.

This year's assembly in Boston of the Association of State Highway Officials of the North Atlantic States, brings together just the right groups to bear witness to the high merit of the pioneer breaking of trails of Dean Shaler, in applying science to road building. The topic assigned me in its unfolding reflects Dean Shaler's teachings and practice with clean-cut perspective of national dimensions.

Only a few days ago Dr. L. I. Hewes, of whom we in Public Roads are very proud for his contributions to the building of the science and practice of highway engineering, told me this story. As a young employee himself of the Massachusetts Highway Department, Dr. Hewes came to know Dean Shaler, and some time later in a conversation concerning highways, Dean Shaler, reviewing his own motives, said that when he was struggling through the mud and mire of the Civil War he made the solemn resolve that if God saw him through the war safely he would build Him some

decent roads. How well he kept that resolve is in the verities all about us, but to me his contribution to highway development has never received just recognition.

The thread of continuity of the advance through the slow learning of each step of the science and practice of highway engineering and administration which has brought us to the current status of our highway affairs, ties this whole discussion back to the early principles which have remained constant, since their early concept was sound. But Dean Shaler did not stop with the conceiving of sound principles. He undertook, through the only possible methods, to give life and the essential momentum to these principles. He first brought to the United States the road materials testing equipment from the School of Roads and Bridges (Ecole des Ponts et Chaussees) of France as the nucleus of the first highway testing laboratory, and established the first course in highway engineering. In the first class to graduate from this course were three men who were all worthy disciples of Dean Shaler,-- Logan Waller Page, A. N. Johnson and A. B. Fletcher. These men all occupied successive positions in which they developed their own high abilities, and in return contributed on an ever ascending scale to the advance of highway engineering theory and practice. At the time of his death in 1918, Logan Waller Page was Director of the Bureau of Public

Roads; before his retirement in 1936, A. N. Johnson was Dean of Engineering of the University of Maryland, and earlier had built the highway department for the State of Illinois; A. B. Fletcher, after long service as Secretary of the Massachusetts Highway Commission (1893-1910), went to California, where he became, after service in San Diego County, Chief Engineer for the Highway Commission when the State embarked on the first State-wide road program financed by a series of bond issues totaling $73,000,000. These men made highway history.

Dean Shaler became a member of the first State Highway Commission for Massachusetts. His acceptance of the position was predicated upon the appointment of qualified men as the other two members of the Board. The policies and operations of this first Massachusetts Highway Commission had a profound influence upon all subsequent highway history. The truth of this statement becomes apparent as we trace the actual unfolding of the whole pattern of highway administration and engineering through the years.

The Genesis of the State Highway Systems.

When we review the situation as it existed near the beginning of the century, and compare it with that of today, there is reason for optimism. Great change has taken place. We now have the organization, skill and equipment to attack the problems of the future because of the devotion and competency of the pioneers.

In 1892 Massachusetts enacted a State-aid law and created a highway department. New Jersey had passed State-aid legislation in 1891, but did not create a highway department until 1894. Every State in the North Atlantic group had a highway department by 1907, but it was not until 1917 that all of the States had established highway departments.

Each highway department since its creation has had constant additions to the load it must carry. Many were created to perform construction only--then the duty of maintenance was added. State systems were designated, and year by year additions were made. Primary State systems grew from 203,000 miles in 1921, to 329,000 miles in 1931, and include 337,000 miles at the present time.

The more important portions of the State systems included in the Primary Federal-aid System amounted to only 187,000 miles at the time of its initial designation. This system has now grown to 232,000 miles.

Difficulties of local authorities in building and maintaining secondary roads with the funds available to them, and a desire to obtain the benefits of State highway administration and technical knowledge, led several States to place all or a substantial portion of their secondary roads under the State highway department. In 1931 there were 45,000 miles in this category. In 1941 the figure had increased to 196,000, and now there are

211,000 miles. As a result of the Federal-aid Highway Act of 1944, every State now has supervisory responsibility for improvement of secondary roads. Federal-aid secondary road systems aggregating 378,000 miles have been designated, and are being rapidly improved.

Improvement of rural roads by system selection resulted in the collection of great volumes of traffic on main highways that poured into the cities. Pressure for relief of critical conditions on main city arteries began to be felt during the early thirties, and has continually grown in intensity since that time. It has produced a marked effect on State highway department activity. In 1930 the mileage of urban extensions of primary State highways under State control was so small that no statistical record was made. By 1941, 27,000 miles were under State control, and in 1947 the figure was 31,000 miles. A powerful impulse to urban improvements was given by the Federal-aid Highway Act of 1944 and supplemental legislation of 1948, which authorized large sums specifically for relief of city traffic problems.

The accompanying table is a statistical record of the growth of State highway department responsibility.

## MILEAGE OF ROADS AND STREETS UNDER STATE CONTROL, 1914 - 1947

| | 1914 | 1921 | 1931 | 1941 | 1944 | 1947 |
|---|---|---|---|---|---|---|
| tal Mileage der State Control..... | 40,000 | 203,000 | 374,000 | 555,000 | 564,000 | 579,000 |
| State Primary Systems..... | 40,000 | 203,000 | 329,000 | 332,000 | 335,000 | 337,000 |
| State Secondary Systems... | * | * | 45,000 | 196,000 | 200,000 | 211,000 |
| Urban Extensions..... | * | * | * | 27,000 | 29,000 | 31,000 |
| rfaced Mileage..... | * | 84,000 | 258,000 | 456,000 | 473,000 | 496,000 |
| State Primary Systems.... | * | 84,000 | 243,000 | 306,000 | 312,000 | 321,000 |
| State Secondary Systems... | * | * | 15,000 | 124,000 | 133,000 | 145,000 |
| Urban Extensions..... | * | * | * | 26,000 | 28,000 | 30,000 |

## MILEAGE OF THE PRIMARY FEDERAL-AID HIGHWAY SYSTEM, 1923 - 1947

| | 1923 | 1928 | 1931 | 1941 | 1944 | 1947 |
|---|---|---|---|---|---|---|
| tal Mileage..... | 169,000 | 189,000 | 202,000 | 235,000 | 231,000 | 232,000 |
| rfaced Mileage..... | * | 120,000 | 159,000 | 221,000 | 223,000 | 225,000 |

* Data not available

The Changing Pattern and Problems of State Highway Administration.

Since the days when State highway departments were first created, their duties and functions have grown continually in number and complexity. We have come a long way from the small organizations, limited funds and simple problems that confronted the early highway departments. There has been enormous growth in traffic volume, and in the size, weight and speed of vehicles. Where there were rather simple rural road problems, we now have complex problems relating to State primary, secondary and urban road systems. The pressure of necessity has required expansion of each highway department from a small, single-purpose group to a relatively large organization with numerous branches, each staffed with highly trained men of special skill and technical ability for each class of work. Thirty years ago highway engineers were general practitioners. The ills of highway transportation have been too varied and persistent for them alone to cure. We now have trained specialists who can cure the patient if the course of treatment prescribed is followed.

Importance of Planning Units. - One of the most important new units created when highway improvement and use had grown to a big scale operation was the highway planning survey.

Factual data resulting from these surveys have been of the greatest value in describing highway needs and what they will cost, but in many States the full value has not yet been realized. We all know that a great

amount of highway improvement is imperative, and that large amounts of funds must be provided for the purpose. Only when we have made the public see the situation as clearly as we see it, which will carry the conviction that it will be a serious blunder not to provide the needed funds, will we have reached the objective at which the surveys were aimed.

Soils and Materials Control. - Soil science is a development growing from the experiences of the past thirty years. We can now identify the good and bad soils and make proper provision in both design and location of highways and structures. Knowledge of how to combine local materials is of the greatest value in surfacing secondary roads. Both Maine and New Jersey have undertaken the preparation of engineering soils maps of their entire areas. Every State highway department will find that an active division devoted to the study and control of construction and materials, particularly soils, will pay for itself in economies and longer lasting roads.

Maintenance. - The great network of highways is composed of roads of all vintages. Every mile requires attention of some kind, and the older sections require constant repair to keep them in use. Every defect or break must be repaired before it becomes a traffic hazard. Snow must be removed and hills sanded in winter. Damage from storms and spring thaws must be repaired immediately. The nation's traffic could not be kept moving without the maintenance organizations.

Traffic Control. - Millions of vehicles moving on a great network of highways require constant regulation, direction and control. The accumulation

of years of experience in this field is presented in the new Manual on Uniform Traffic Control Devices for Streets and Highways. A traffic control division of sufficient strength to carry out a proper traffic control program is a necessity in every State.

Secondary Roads. - Every State is now engaged in the improvement of secondary roads as a part of the Federal-aid program, and frequently in continuation of a program adopted on its own initiative. The special problems and contracts of this work require a full-fledged secondary road division.

Urban Roads. - Since 1944 every State not already concerned with urban road problems has been drawn rather precipitously into this work. Here we find problems of the greatest complexity requiring an entirely new approach and plan of activity. In a short space of time separate urban divisions have been created in our highway departments, and they are doing an excellent job in planning and designing for urban needs.

The Changing Pattern of Highway Financing.

Changes of large amplitude in highway financing have occurred over the last 50 years. In 1904 only about 80 million dollars were expended on all rural roads. Of this total, 54 million came from county and local property and poll taxes, 20 million from statute labor and labor taxes, $3\frac{1}{2}$ million from bond issues, and 2.6 million from the States in the form of expenditures on State-aid roads.

Twelve years later, the year 1915 reveals significant changes in the patterns of highway financing. Expenditures by or under supervision of the State highway departments in that year were 81 million dollars, of which 53 million were State funds and 28 million were contributed by counties and local units. Local expenditures not under State highway department supervision were 186 million, and the value of statute labor was estimated at 15 million; making a total of 282 million dollars in rural highway expenditures.

The period of the 1920's was one of accelerated progress in highway work and of equally great changes in the methods of highway financing. The Federal-aid program swung into action, with annual authorizations of 75 million dollars to the States. Beginning in Oregon in 1919, the gasoline tax rapidly spread to all the States; and the yield from all State road-user taxes increased from 128 million dollars in 1921 to 850 million in 1930. Bond issues by States, counties and municipalities greatly accelerated the construction program in this decade. Expenditures for all roads and streets were 1.3 billion dollars in 1921, 1.7 billion in 1925, and 2.5 billion in 1930.

The depression period of the early 1930's greatly complicated the financial problems of the State highway departments, as well as those of the counties and local units. Property taxes virtually vanished as a source of funds for State highways, and were greatly reduced at the county and local level. Fortunately the road-user revenues suffered only moderate

declines and soon resumed their upward trend, reaching a total of nearly 1½ billion dollars in 1941, of which 833 million were used for State highway purposes and 354 million for county and local roads. In the National Industrial Recovery Act and subsequent legislation, Federal-aid authorizations were stepped up, and funds were made available for secondary and urban improvements.

In the postwar period inflated costs, combined with the acute need for modernization of the highway plant, have introduced new problems in highway finance. Early estimates for 1948 indicate that both income and expenditures for all roads and streets in that year exceeded a total of 3 billion dollars--but even that great sum is not enough. Those who have been thinking and planning in terms of a nation-wide campaign to meet our highway needs, have visualized an annual program of 4 billion dollars in construction and maintenance expenditures during the next 10 to 15 years. As cost data accumulate to replace this round-number estimate with firm figures, they do not tend to reduce its magnitude. One of our most acute problems is that of finding the additional revenues needed to support this formidable program.

The Changing Pattern of Required Traffic Service.

The early years in the development of State highway systems were largely spent in joining urban centers of population with all-weather roads through the rural areas. We must now provide service on primary rural

roads, secondary roads and urban arteries. Daily postal service is now demanded as a matter of course by rural areas throughout the nation.

Consolidated schools not only permit economies in operation but also provide advantages in the range of education that would be impossible without the school bus and the improved rural roads.

The variety and volume of commodity movement over highways are constantly growing. More producing areas have been opened and the marketing of a greater variety of goods has been extended into a wider territory.

One of the first traffic surveys on a State-wide basis was in Connecticut in 1922. Even at this early date traffic was concentrated on the inter-city routes, the Post Road, the New Haven-Hartford and the Hartford-Springfield roads. An average daily traffic of 4,500 vehicles a day in 1922 on the Post Road increased to 16,000 in 1935 and 17,500 in 1937. The Merritt Parkway, a parallel route, was opened at this time. By 1941 the two roads were carrying a total of 30,000 vehicles a day.

The amount of commercial traffic has grown enormously since the State highway systems were first established. A main highway of average characteristics, which in 1931 carried 5,000 vehicles per day including 780 trucks, in 1947 had traffic of 9,500 vehicles a day, including 1,980 trucks. In 10 years truck traffic increased 250 per cent in number and by a far greater amount in weight of goods transported. In New England and the Middle Atlantic States approximately one vehicle in every five is a truck.

Although the volume of truck traffic has increased nearly three times since 1931, the proportion of trucks that carry heavy loads is even more significant. In 1931 only about 8 trucks in every thousand had axle loads of 18,000 pounds, and there were practically no axle loads in excess of 20,000 pounds. In 1947, 76 trucks in every thousand had axle loads of 18,000 pounds or more, 33 of which were 20,000 pounds or more.

Highway capacity was a controversial subject with no generally accepted conclusions in 1925. No one had sufficient factual data to permit reliable deductions. The data have now been obtained.

The actual way people operate their cars in traffic has been measured in hundreds of thousands of cases in various sections of the country where congestion and traffic volumes have been critical. We can now make accurate determinations of observed speed and volume of vehicles and interference with movement under various conditions.

The maximum possible capacity of a 2-lane road, under ideal conditions, has been found to be 2,000 vehicles per hour. This same volume under similar conditions can be accommodated by a single lane of a multi-lane road. We have found that this possible capacity is seldom obtained. Interference by cross traffic in cities can reduce possible capacities as much as 50 per cent. Signalized control, left turns, entrance to off-street parking lots and alleys, all tend to reduce possible lane capacities of city streets to something seldom exceeding 500 vehicles per lane per hour. Curb parking reduces capacities as much as 50 per cent, regardless of the number of lanes, on a 2-way street.

As a result of these investigations, we now know that when hourly volumes in rural areas approach 400 vehicles per lane on a 2-lane road, or 1,000 vehicles on a multi-lane road, congestion becomes noticeable, and that it will not be long before these critical sections must be considered for replacement, reconstruction or improvement.

In this North Atlantic area these determinations must be recognized for their governing influence upon future highway design and consequent programing of highway funds.

The Special Category of Maintenance.

No activity of our highway departments has had a steadier or larger growth than that of maintenance; and in no field has the benefit of organized and expert supervision been more conspicuous.

Our earliest State highway departments did not have a special maintenance branch or division. Completed roads were turned over to the counties for maintenance. This procedure was short-lived as the counties did not maintain the roads. The State highway departments took over, but the job was not large by present standards. Not many miles had been surfaced.

But the job grew like the mythical bean stalk. By 1921 the States were maintaining 202,915 miles at a cost of $64,833,000. In 1930 they were maintaining 324,498 miles at a cost of $191,684,000. In 1947 the figures had risen to 579,459 miles and $367,509,000.

The mileage to be maintained had mounted rapidly, but expenditures grew at a far greater rate. This was partly due to decreased purchasing value of the maintenance dollar, but only partly. Present maintenance standards compare with 1921 standards as our 1949 passenger cars compare with the Model T cars then in use. Snow removal alone accounts for many millions of additional cost.

Recently wide publicity was given to the use of water from a natural warm spring to melt snow and ice on a section of highway. The method is of no importance to most maintenance men, since they do not have a warm spring to supply the water, but the way editors played up the story should be significant to them. The public wants the highways kept open continuously and in perfect condition for safe use, and anything pertaining to the subject gets a high news value rating.

In 1921 State maintenance work required 16.7 per cent of a total expenditure of $388,475,000 for State construction, maintenance and administration. In 1930 we spent $2\frac{1}{2}$ times as much for these things, and the maintenance portion had increased to 20.1 per cent. In 1947 we spent $3\frac{1}{2}$ times as much as in 1921, and maintenance work required 26.6 per cent of the total. Details are given in the attached table.

Maintenance costs have us in a vicious circle. Roads that average more than eighteen years of service life are carrying loads and traffic volume that were never contemplated. The necessary costs of keeping

these roads in service consume a large portion of the funds that otherwise would be available for construction. And, to compound the dilemma, maintenance unit costs have skyrocketed. It costs $190 today to buy the same maintenance that could be bought for $100 in 1935. There is some consolation in the knowledge that the design and construction of the roads we are now building will bring us lowered maintenance costs as they replace those that are old and worn-out. But that reduction is still in the unpredictable future. We are now at the mercy of circumstance, and the too unchallenged misuse and abuse of our highways which now exist, will postpone the day of reasonable maintenance costs indefinitely.

Mileage maintained by State highway departments, maintenance costs and expenditures for construction, maintenance and administration.

| | Miles Maintained | Expenditure for Construction, Maintenance and Administration | Maintenance Expenditure | Maintenance cost as a percentage of direct expenditure on highways |
|---|---|---|---|---|
| 1921 | 202,915 | $ 388,475,000 | $ 64,833,000 | 16.7 |
| 1930 | 324,498 | 952,606,000 | 191,684,000 | 20.1 |
| 1947 | 579,459 | 1,382,395,000 | 364,509,000 | 26.6 |

It must be remembered that these maintenance costs are for the primary roads. If we add the costs of local roads our estimates for 1948 are 72 cents spent for maintenance for each one dollar spent for construction.

The Problem of Urban Arterial Roads.

A pressing need in the whole highway transport picture is the relief of traffic congestion in our urban areas. No longer can our cities tolerate the economic losses inherent in delays, stoppages and general disruption of schedules for the movement of people and goods, not to add the cost and anguish resulting from too many accidents. This particularly applies to the North Atlantic States, where the people in the urban places of 5,000 population or over, in accordance with the 1940 census, constitute 41 per cent of the urban population of the nation. The development of a system of arterial routes in each city is vital to relieve urban traffic congestion. The improvement of the mass transit system, and the solution of the terminal problem to provide adequate parking for passenger cars and loading docks for trucks, are much needed companion efforts. Properly located and designed arterial routes, in which traffic can flow freely, set the pattern for a logical city plan. They must be recognized as the backbone of all city developments, whether of new areas or neighborhoods to meet the expanding needs of the city, the redevelopment of decadent areas, or the rehabilitation of existing industrial, commercial and residential areas of a static population.

One has but to examine existing urban arterial routes to have faith that the development of new free-flowing routes is an important

element in the relief of traffic congestion. Present major routes in our cities are lined with commercial establishments, and must serve several types of traffic which interfere with one another. Through traffic wants to travel at reasonable speed without stopping. Neighborhood shopping traffic is primarily interested in reaching the front doors of the shops. Buses and trolleys if possible move rapidly, but stop frequently to pick up passengers. Cross traffic wants to cross and to turn without stopping at intersections, and pedestrians want to cross everywhere. Congestion increases approaching the center of the city because traffic increases, width decreases, crossings become more frequent and roadside interference grows in intensity. Street capacity drops where volume increases, resulting in greater congestion and higher accident potentials.

The development of arterial routes in urban areas requires long study and courage, particularly where the demolition or moving of existing home units or the displacement of residents is necessary. In such cases every effort should be made to plan and to time the work so that a minimum of hardship will be experienced by residents. Satisfactory results will be attained only by the full cooperation of all interested organizations, particularly the departments of the city government, other city organizations such as real estate boards, and the State highway departments. The city organizations can help materially by aiding residents to establish themselves in new quarters where necessary, and at times to house them

temporarily while buildings are being moved or other steps taken to house them. The cities should be willing to undertake this work. Indeed, the city should take a leading part in such efforts, for in the final analysis the greatest benefits from these improvements are derived by the city and its inhabitants. Measures of this nature have been undertaken in a number of cities, an outstanding example being New York City. The State can also contribute to the welfare of tenants by programing its work to conform to the time and manner in which the right-of-way becomes available. For example, certain structures, such as grade separations and walls, can be constructed in advance of other work requiring demolition or moving of homes, thus postponing the time when it will be absolutely necessary for tenants to be relocated.

Whether new routes will retain their capacity for serving traffic safely and efficiently will depend on their design. Too often highways, which were all that could be desired when completed, gradually deteriorate until their replacement is inevitable due, not to lack of maintenance or even to an unexpected increase in traffic beyond original capacity, but to obsolescence. The chief cause of obsolescence is not the lack of vision of highway engineers or the increased use by automobile and truck, as has been so often stated. The true cause is the increasing interference from the uncontrolled roadsides, which reduces capacity and increases accident potential from the day the highway is opened to traffic. Such obsolescence

is avoidable. If the highway is designed with complete control of access, and maintained adequately, it will continue to have the full designed capacity to serve traffic indefinitely. Further, it will not be lined with the unsightly and hazardous conglomeration of roadside businesses, which now disgrace the entrance routes to our cities. Instead the roadsides will improve in appearance with time, and businesses will be stabilized where they are and not be subjected to mushroom competing businesses. With the excellent examples of controlled access highways in the form of the parkways in New York and Connecticut, it is amazing that the advantages of control of access have not been more fully exploited, particularly in the other North Atlantic States.

In conclusion, the highway engineers and builders of this Association have the heritage of a rich past. The principles of highway administration and engineering, which, under the inspired leadership of Dean Shaler, grew and broadened into established practice in all the States of this area, impose an obligation upon those who now carry the authority and the responsibility of highway administrators to keep faith with the traditions of the past. We have come this far because of the sound foundation built by the pioneers.