TRAFFIC ENGINEERING IN HIGHWAY ADMINISTRATION

By Thos. H. MacDonald
Commissioner of Public Roads

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When some 50 foreign highway engineers recently completed the studies in the theory and practice of highway engineering in the United States, one engineer's comment was particularly interesting to many of us in Public Roads. He was not most impressed by our construction practices or maintenance procedures, since in these respects his country compared favorably with ours. What appeared of particular significance was our insistence on the use of traffic facts to select our highway systems, to plan our programs of improvement, to design our roads, and to provide for their efficient operation. And he was impressed not only with how much information was collected and applied, but with how easily we obtained it.

In his experience, a traffic census meant the stationing of hundreds of men at arbitrarily chosen points to count traffic simultaneously for a specified interval, then doing nothing more until at some future time it was felt that the process should be repeated. There was no continuity of counts at key points to show traffic trends on which to predict future volumes; no continuous counts by hourly periods over a full year to show the traffic peaks on which geometric design should be based; no classification or weight studies to reveal the service their

highway systems rendered or to define vehicle-loading practices as a guide to structural design. As a consequence, little really useful data resulted.

He observed we collect all these needed data and do it easily. He found that comparatively few men operating throughout the year on statistically sound schedules displaced the hundreds counting simultaneously in his country. Here automatic traffic counters and other types of traffic-recording equipment and scientific sampling procedures greatly amplify each man's effort and correspondingly extend the scope and value of the data we obtain.

Perhaps this foreign visitor paid us a greater compliment than he realized when he observed that we not only accomplished what to him was an exceedingly difficult task, but did it easily.

This collection and analysis of pertinent traffic data is a product of built-in traffic research. A tribute should be paid to the Congress for including in the Hayden-Cartwright Act of 1934 one of the most important principles of administration that have been included in the Federal highway legislation. It is Section 11, quoted as follows:

> "With the approval of the Secretary of Agriculture, not to exceed 1-1/2 per centum of the amount apportioned for any year to any State under sections 1 and 4 of this Act may be used for surveys, plans, and engineering investigations of projects for future construction in such State, either on the Federal-aid highway system and extensions thereof or on secondary or feeder roads."

The legal authority to raise research from a detached, high-brow status to a living tool for intelligent and efficient administration, should be incorporated in every public appropriation to provide facilities to serve the public.

Skyrocketing highway usage and the tremendous pressures of expanding traffic volumes have forced us to develop specialized skills in highway transportation. Highway planning in the administrative field and traffic engineering in the design and operating field are powerful aids in our struggle to keep abreast of traffic demands. They are the more recent skills, but they have developed rapidly under force of necessity and with vigorous and capable champions. It is neither possible nor necessary to separate precisely the particular areas of these specialized techniques that together define the range of highway engineering. Probably there has been too much lost effort in attempting too fine definition of terms.

Sound development in planning or traffic engineering can come only through a thorough understanding and application of all the facts; and facts come only through painstaking research. Experience is a great and important teacher, but repetition without critical analysis of even a proven course may wear a rut so deep that other and perhaps more desirable courses are lost from view. The history of modern highway transportation in a major degree will be influenced by intelligent research effort. The Bureau of Public Roads is participating with

States, universities and other agencies in a wide variety of cooperative research projects, many of which are of direct interest in traffic engineering.

Chief among such projects are the engineering and economic investigations, originally called the highway planning surveys, being conducted on a continuing basis. Traffic-volume figures and traffic patterns, both rural and urban, required for long- and short-range highway planning, have equal value in traffic engineering. Urban origin-destination surveys and parking-habit studies provide the means for selecting systems and developing construction programs, but they likewise produce data needed for the design of new facilities, including decisions upon the location and capacity requirements of interchanges and traffic-control measures.

Beyond these general research and planning projects conducted more or less uniformly by all States, more specialized studies are under way in a number of States. In Maryland and in Virginia, through cooperation between the Federal and State governments and the respective State universities, studies of the sociological and economic aspects of highway use are in progress. In Colorado a detailed study of the relation between land use and productivity and highway needs is in the analysis stage. The results of these studies, all pioneer in nature, are expected to be of particular significance in the development of future secondary road policies.

A survey recently agreed upon between Public Roads and Columbia University seeks to determine through analysis of origin-destination and other data the relation between urban land use and transportation requirements.

In nearly 20 States intensive cooperative studies are designed to show the relation between accident occurrence and the design features of the highway. In Minnesota this study is extended to show the influence of highway access points and roadside development on accident occurrence. Missouri, with the maintenance and traffic divisions of the highway department cooperating, is analyzing a recently completed study of the effect on driving practice of its mid-lane no-passing stripe.

Of far-reaching importance in highway safety is the motor truck braking project, now resumed after its wartime interruption. The cooperation of motor truck and equipment manufacturers, motor truck operators, motor vehicle administrators, other Federal Government agencies, State highway departments, and State police, assures positive improvement in truck braking ability.

Traffic engineering was earlier regarded as the function of directing and controlling traffic, largely through the means of signs, signals and markings. Now, however, traffic engineering is more generally recognized as one of the specialized phases of highway engineering, involving the development of the basic principles of

vehicular movement and driver behavior. It is no longer the narrow domain of the individual or unit, but a new science of traffic flow characteristics that is fundamental to street and highway design, operation and administrative policy.

This newer concept of traffic engineering is well illustrated in the research on driver behavior and vehicle performance conducted with the cooperation of many State highway departments, city traffic engineers and other organizations under the direction of Mr. O. K. Normann of the Bureau of Public Roads. Precise measurements are developing an understanding of individual driver performance, and when properly applied will result in greatly improved design and traffic-control practices, more comfortable driving and marked advance in highway safety.

Application of the results permits the design of the geometric features of streets and highways to induce desirable driving practices. We cannot re-make the drivers to fit the highway; we must design the highway to fit the drivers.

Highway operation could be made more efficient if all drivers were required to travel at certain uniform speeds and to maintain certain fixed spacings, or to drive only cars not exceeding a certain small size. But to impose such arbitrary restrictions would be impossible.

The studies of the driver in action show that for the large majority their natural desires are to travel within a reasonably small range of speeds, that they normally maintain spacings within reasonable limits, and that there is not a wide variation in sizes of passenger vehicles. Designs and regulations that are developed around these majority desires will be generally respected, and the few drivers who choose to violate the generally accepted standards of behavior can be dealt with appropriately.

Although the driving habits and practices of no two drivers are identical even under identical conditions, there is sufficient agreement among the practices of different drivers, especially when moving as a part of a traffic stream, to establish the effect of various street and highway design features on the safety and rate of traffic flow. Attention to details of highway design that affect driver behavior can induce proper driving and achieve desirable practices through natural inclination and without the slightest semblance of dictatorial regimentation.

In channelization of intersections, for example, efficiency and safety of movement can be enhanced by designing to make the natural path the proper one. Speed zoning, one of the more effective traffic-control measures, depends for its value on popular acceptance of the posted speeds, and thus the limits must appear reasonable to the majority of drivers.

Some of the most important results of research in driver behavior and traffic flow are contained in the comprehensive report of the Committee on Highway Capacity of the Highway Research Board. This report, prepared by the cooperative effort of many individuals, including those of this organization, will be of utmost value to highway engineers.

By the application of facts included, a new highway can be designed or an old one revamped with the assurance that the desired capacity and operating conditions will be attained. Also, it will be possible to compare the capacity of an entire street system as it is being operated, with the present or estimated future traffic demand. If the traffic demand exceeds the capacity under existing control methods, the traffic management practices may be appraised to determine the possibility of their improvement. The extent to which relief can be provided with the existing street system, through the use of recognized measures such as the elimination of curb parking, adoption of one-way streets, or improved and well-maintained traffic signal systems, can be ascertained. This report promises to be one of the most fundamental contributions to highway design and traffic management of recent years.

From investigations of driver behavior, entirely new criteria for determining the adequacy of the alignment on an existing road, and for the selection of the alignment of a new route, are evolving. There is no doubt that, by a similar approach, many of the most difficult urban

traffic problems can be solved. Substituting facts obtained through research for personal opinion may result in major shifts in the approach to many of our traffic problems.

The highway administrator theoretically has two broad avenues of solution for the whole multitude of difficulties that beset highway transportation. He can construct superior streets and highways with increased capacity, convenience and safety, to replace or supplement existing facilities--and he can improve, without major construction, the operating characteristics of the streets and highways already in place. Practical highway administration requires that both these avenues be followed.

The first choice--that of constructing new and superior streets or highways--has many advantages. Progress in highway technology makes it possible now to build highways that are relatively free from traffic interferences, and with proper planning and design they will remain efficient for years to come. One of the best examples is the modern expressway. Vehicles move freely and without time-consuming intersection stops because the expressway is separated in grade from intersecting streets. The hazard and delay on streets or highways with parking and direct access from abutting property are eliminated. There are not sudden, uncontrolled entrances from the roadside. Pedestrians are protected from moving traffic, and troublesome left-turn vehicle

movements are handled easily by the characteristic expressway design. Thus it is evident that expressways and other high-type arterial designs are effective and durable solutions to the traffic handling problem.

But the construction of such efficient facilities is not the complete answer, particularly in the urban areas. The planning, design and construction of an arterial urban system is a long-range, time-consuming undertaking. Traffic and location studies, preparation of plans, financing, acquisition of right-of-way and re-housing of persons whose properties are directly affected, are some of the complicating factors that must precede actual construction. Meanwhile, traffic pressure is developing to a point where some form of relief is an immediate necessity. Other steps, less spectacular, perhaps, but equally essential, must be taken if a balanced solution is to be obtained. The intelligent integration of these other measures, with the major construction programs, presents a serious challenge to modern highway administration. In Houston, Texas, we have an outstanding example of the effective coordination of design and traffic management in the Gulf Freeway, although this facility does not, nor was it intended to, solve the whole Houston traffic problem.

The wisdom of the past cautions us to "make no little plans," but large or comprehensive plans do not mean grandiose facilities. While the expressway has an essential place where traffic loads are heavy, its wholesale application cannot be warranted.

The experience of the past few years suggests that we have not been fully aware of the dangers of prescribing too elaborate a design for a given set of conditions. More often than not the proposals for improvement of urban routes require the taking of additional right-of-way if a cross section of adequate width for the anticipated traffic is to be developed. We cannot afford to compromise on such essential items as lane width, lateral clearances, or the width of the separating strip, since we know from researches in traffic behavior that unsatisfactory operating conditions would be certain to result. The actual monetary cost of slashing the needed width from frontages in business districts is always high, not only because of the expense of building demolition or adjustment, but also because of the disruption of overhead and subsurface utilities. The intangible losses resulting from the necessary adjustments to the whole business community may be much greater.

Where traffic cannot be accommodated on a single facility without undue disruption of abutting property, one-way street operation may, with proper traffic control, serve adequately either as an expedient or possibly a more permanent solution. Parking controls, channelization and other traffic operation improvements may be similarly justified either as interim or permanent solutions.

We recently have two proposals to accommodate traffic in both directions on a single facility through small cities. In one, the businessmen along the principal street feared their businesses would be impaired by the remote relocation of the traffic route. In the other, a development through a residential area would require the removal of many fine shade trees and the loss of lawns, to the detriment of residential property that may have been owned for generations in the same families. In neither case does it seem that the attempt to force through the standardized type of arterial facility can be worth the cost to the community. In both cases pairs of one-way streets may well be the solution.

Traffic-control improvements can be accepted in lieu of increased capacity improvements only with caution. Unless all pertinent facts are taken into account for each situation and a custom-tailored solution for the particular condition is designed, these measures cannot be fully successful. Traffic regulations and control measures that are too easily formulated may be too easily modified. Substitution of traffic control for construction cannot be accepted unless there is assurance that measures consistent with the needs of the arterial traffic will be perpetuated.

Highway transportation is not limited by legal boundary lines. In our consultations with the National Security Resources Board and the Department of National Defense during the preparation of the report

"Highway Needs of the National Defense," just published, the importance of routes for free movement through cities and across State lines was repeatedly underscored. While the possible requirements of war transportation are the more dramatic, the huge economic waste of urban congestion and rural major route inadequacies, should be reasons no less compelling for remedial action.

What form might this action take?

While each situation requires individual study and solution, the solutions must be based on an accepted uniform concept of design and traffic control if the many individual actions are to result in an efficient national transportation system. By uniform design we do not, of course, mean the same numbers of lanes irrespective of traffic volumes, or uniform curvature or gradient irrespective of terrain. What we mean is uniformity of design standards consistent with traffic and topographic conditions. The motorist is now coming to expect reasonable uniformity in signs, signals and markings. There is even more reason for him to expect uniformity in design as it affects his driving practices.

The first step in such a program cannot be better illustrated than by the study now under way in Albuquerque. Here, city, State and Federal funds and technical personnel have been pooled to finance a comprehensive survey of the transportation needs of the metropolitan area. The work is under the general direction of the Automotive Safety

Foundation, which is supplying engineering and other technical assistance. The survey consists of many separate studies, no one of which is new or unique. But nowhere else to our knowledge has the entire group of essential studies been conducted at one time with the objective of arriving at a complete solution of the entire problem.

From these basic studies the probable traffic requirements for a reasonable future period will be determined, taking into account probable public as well as private transportation services. This traffic potential will then be compared with the capacity of the street system to provide for the necessary total movement in reasonable conformity with the individual desires as shown by the origin-destination studies. Then, if the existing facilities when operated under the most modern traffic-control techniques prove inadequate, the necessary number and character of additional facilities will be determined. At the same time changes necessary in legal or administrative procedures to bring about the needed improvements in traffic management will be recommended.

This survey is but the first step toward a solution of the problem. The next and more critical steps will be the adoption of the recommended plan and the commitment of the agencies involved to the action necessary to put the plan into effect.

While much good work is being accomplished in a fine spirit of cooperation between States and cities, there are many plans that are still collecting dust in State and city offices. Some of these perhaps

were too elaborate, and so far beyond the possibility of financing with funds in sight that they were quietly dropped. Others failed because the many agencies involved in the particular cities could not agree among themselves, and the city administration had no single spokesman. Others are not getting action because of the inability of the State and city officials to agree upon plan details or financing. In most cases where progress is stalled, unrealistic planning or administrative deficiencies may be primarily responsible.

Some cities are recognizing that they are not organized to cope with today's traffic, and are taking steps to rectify that situation. Los Angeles, New York, Evansville and Providence, to name the four you will hear about later today, are examples of cities that have resolved to end the frustrations resulting from attempts to manage present traffic through administrative processes inherited from the past. They are to be commended. But their number must be multiplied if we are to expect noticeable improvement in traffic management on a national scale.

Likewise, some States have authority and a desire to cooperate with the cities in improving tr ffic control and operation. But the great majority are so limited by law or administrative practice that effective cooperation in a realistic manner is virtually impossible. A study now in progress, which also is to be discussed this afternoon by Mr. Norman Hebden, reveals with striking clarity the difficulties confronting effective State-city action in this field.

The city, for its part, must so organize its traffic management that it can take full advantage of modern techniques and equipment. It must be prepared to make the best possible use of existing facilities before it can expect aid from outside sources. In return for such aid it must be prepared to give assurance of the continuance of whatever form of traffic control is needed to insure permanence of the designed freedom of traffic flow.

The State, on its part, must recognize a responsibility for assisting municipalities with their traffic-management problems, to aid in improvement of State-wide highway transportation, and to reduce the need for constructing added facilities, and must obtain where necessary the legal authority for such cooperation. That authority should permit the State to give technical assistance in bringing traffic management practices up to a desirable standard. It should also permit financial participation with the city in traffic-control installation on routes of State-wide interest as a means of assuring continuance of appropriate control practices and permanence of designed capacity and safety on such routes.

Action in State legislatures and city councils will generally be required before such a program can be effectuated. With fair understanding of the problem and with firm resolve on the part of men of good faith there is no reason to doubt that real cooperation can be achieved.

Certainly no group is better qualified than the Institute of Traffic Engineers to take a major responsibility of leadership in this effort. You represent cities and States, you are skilled practitioners in this field of growing importance, and you are accustomed to working with one another in a spirit of cooperation.

The States and cities must be assisted to organize their legal and administrative authority and machinery to permit this cooperative approach to effective traffic control. The Federal Government, as an equal partner with each State, stands ready to assist technically and to participate financially.