# The Highway Engineering and Highway Transport Fields and Their Need for Trained Men.

Address by Thos. H. MacDonald, Chief, U. S. Bureau of Public Roads before the Conference on Education for Highway Engineering and Highway Transport.
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In May, 1920, before the first conference on Highway Engineering and Highway Transport Education, it was my privilege to present a paper on a very similar subject. About the same groups made up that conference that are again represented here. The essential difference, then, is the fact that we now have to guide us three years experience in the development of a remarkable highway program, a program of highway improvement much beyond the conception of our most advanced ideas of only a few years since. Out of this experience there are certain tendencies crystallizing which indicate clearly and most emphatically responsibilities that must rest upon all those who are and who should be concerned with the business of education.

At the time of the first conference, this country had been passing through a time of intense industrial activity. We are now emerging slowly from a period of the greatest contrast, a period marked by industrial depression, liquidation, and deflation. From the record as it was stated then and out of these more recent experiences, materialize the principles of a major character if measured by their effect upon the highway development of this country, and major, too if measured by the difficulty of overcoming them effectively. In outline these principles may be stated.

1. During periods of industrial activity industry takes annually a large draft of technically trained men. This is true whether applies to the young men upon whose diploma the ink is scarcely dry, or to the trained, efficient engineer of many years experience.

2. The inducements of higher compensation, sure advancement and continuity of services are offered by industry to the individual of outstanding personality and technical preparation far in advance of the offers made by the public service.

3. During the periods of industrial depression there is a drift of engineers to the public service, but, generally speaking, not of the best qualified or experienced engineers.

Elaborating the point briefly, when the depression seized upon industry, large and small, and there came a general curtailment or shutting down of activities, many engineers sought the public service field, reluctantly and generally with greatly decreased compensation. Now that, despite major handicaps, a revival and expansion of industrial and commercial activity is again ahead, we can expect the repetition of our very recent experience of having the most available and best qualified engineers attracted and deflected to other fields. It will not be very long before this cycle is completed. These principles, which are in themselves an indictment, are the prologue. If this conference is to accomplish something big, and if it is to assist, in the months and years immediately ahead, in the achievement of definite progress, it must concern itself with educational measures and policies that are broader in their application than the technical curricula of our

educational institutions. It must do its part in helping to awaken and develop a real public conscience toward its own public service, and it must awaken the public's intelligence to a real appreciation of the magnitude and significance of the developing highway transportation.

First, consider the significance of recent highway legislation. The Federal Highway Act of November, 1921, gave us for the first time in the history of the United States, a plan for the development of a comprehensive system of highways serving the nation by perfecting a net work into every part of every State. It contemplates the service of highways for interstate and transcontinental traffic but none the less does it provide for local traffic. It brings this major system of highways so close to the communities that a properly developed system of local roads will reach all those who are not served directly. But the direct service which will be provided by the major system itself will reach a very large percentage of our total population and carry a very large amount of the total highway traffic.

Preliminary estimates show that there will be included in the major system, which we may call the Federal highway system, approximately 180,000 miles, and even considering the improvements which have been made, it will require ten to fifteen years, perhaps longer, to complete that system. Last year we added about 10,000 miles of completed highways to this system. This year the record will be smaller, but there are included in these yearly totals a large mileage which must yet be surfaced or improved with a higher type of surfacing before the system can possibly be considered completed.

The Federal Highway Act established as conditions precedent to the continued participation of the States in the allotment of Federal aid, these principles:

1. That each State should maintain a highway department properly organized and equipped to supervise and administer the construction of new highways, and to maintain those already built.
2. That each State must provide State funds to meet the Federal aid funds, and not be dependent upon the various subdivisions such as counties, to supply the State's quota, and
3. That, probably most important of all, each State must provide sufficient funds to maintain the roads which are built and lift the responsibility from the shoulders of the local communities. A majority of the States have already incorporated in their State legislation these principles, and it was the result of the successful working of these principles in some States over a considerable period of time that led the framers of this Act to require their universal adoption.

The States which must change their constitutions or their laws in order to comply with these requirements are already taking the necessary steps, and it is only a question of a very short time until they are made a part of the laws of all of the States. Note that this development in legislation accepts and provides for a plan of administration and supervision universal in its application, that can be satisfied only by an engineering organization.

This conference can evaluate the degree of accomplishment for the public benefit that lies between the results that will be secured by an adequate engineering organization, and the disappointments that will

result from the failures of an inadequate organization. Can the general public be awakened as keenly to this difference?

Second, the field for the highway engineer is not so limited as might first be thought. It is not sufficient that there shall be competent engineers in the public service alone. There must be equally competent and well qualified men in the field of the producers and the allied activities. This field is partially covered by the following:

1. Engineering organizations such as county, municipal, State and Federal highway departments.
2. Contractors engaged in highway construction.
3. Producers or manufacturers of highway material.
4. Consulting and private engineers.
5. Commercial laboratories and inspection service.
6. Industrial educational associations.
7. Engineering and educational institutions.
8. The technical press.
9. Traffic engineers.

This latter is a new and at this time almost undeveloped field, but in the future it promises to absorb many men who will be engaged in a most valuable service.

This list is not complete; there are many allied lines having relation to the general field of highway development.

Third, our production of serviceable highways is not keeping pace with the demand.

Because their use, their practicability and their continuing service are dependent upon improved highways, the growth and the use of the motor

vehicle is the best index to the need for, and the probable future increase in the mileage of modern highways. During the little more than a decade since 1910 the number of motor vehicles in service on our public highways has increased more than 2,000 per cent. Permit me to repeat the figures which I have used before, which indicate the lag in the development of highways of modern type over the development in the use of the motor vehicle.

1. During the period 1910 to 1921 the potential number of motor vehicles demanding highway service increased approximately 2,000 per cent. Our actual expenditures for construction and maintenance of highways increased about 400 per cent.
2. During the period 1910 to 1918 motor vehicles increased more than 1,100 per cent, highway expenditures about 120 per cent.
3. During the period 1918 to 1921 motor vehicles increased about 900 per cent of the number registered in 1910 and highway expenditures about 400 per cent on the same basis.

It is not asserted that these figures are directly comparable, but it cannot be disputed that they are indicative.

Fourth, consider briefly the matter of highway funds. The total estimated expenditures for highways by all agencies and from all sources during the year 1921 amounted to more than $700,000,000. The figures for this year will probably fall somewhat below the figures for last year.

On the basis of the more conservative estimate of actual expenditures, and without attempting to fix closely the proper percentage of cost for engineering services, there should be invested annually, at the present rate, for the engineering and administrative control alone, from 30 to 60 million dollars. Considering that easily from 40 to 60 per cent, depending upon the type of work, will be used for labor, there will be available annually from 250 to 400 millions of dollars. These funds are available for the employment of skilled and technically trained men in the contractors' organizations as well as for the employment of common labor.

It is hardly necessary to continue to tell of the large sums available, which may legitimately be used for the employment of highway engineers.

In summary, we find that the tendency of highway legislation is most favorable to the man who will consider the highway field as his future work. There are opportunities in more than a dozen of major fields directly connected with highway work. The rate of highway improvement has not kept pace with the demand which, together with the program now definitely recognized, make certain a long period of major activity.

The legitimate percentages of the total available funds which should be used for engineering and supervision are sufficient to insure employment to many men who are properly qualified and technically trained. As a commentary these facts do not, at least to me, indicate that the educational institutions should feel called upon to specialize in the teaching of highway engineering. For the graduate who would enter the highway engineering field I would personally prefer that he have a sound general course in mathematics, English, economics and kindred general subjects, rather than a number of specialized subjects. But, on the other hand, the

graduate who is to enter the highway field should not be trained for some other engineering field. Referring back to the principles which were developed in the opening paragraph there is here potentially a big, attractive field for the best trained men and the extent to which these men can be brought into this field and retained will be the measure of the economy and efficiency of the expenditure of the tremendous public funds which are inevitably to go into the building and the maintenance of our public highway system.

Bigger by far than any other problem before this conference is first the problem of awakening the public to the need for and the support of the highway administrative and engineering organizations engaged in this work, and second, that of educating the public to a proper use of the highways from the traffic standpoint.