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FEDERAL AND STATE POLICIES IN THE CONSTRUCTION  
OF THE FEDERAL AID HIGHWAY SYSTEM.

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In November 1921, the Federal Highway Act became a law. In the two-year period since, in addition to administering very large programs of highway construction and maintenance, the State highway departments of the 48 States and the Bureau of Public Roads have selected, correlated, and agreed upon the highway system which is to be first improved under the terms of this Act. This is truly a noteworthy accomplishment. It is at once a promise and an assurance of progress in the development of adequate highways for this nation. There is the appeal of something fine, the challenge of security in our form of government, in the successful planning of this great system of interstate and inter-county highways, through the joint effort of the sovereign States and the Federal Government, each recognizing the aspirations of the other.

Other nations have in times past built great road systems under military dictate, largely for purposes of conquest. The United States plans a system of highways to serve her people in the pursuit of economic freedom and happiness. As now visualized in the first real map of the major system of highways, the conception is truly national, but like all other of our great national institutions the scheme has been built from the foundation up and not from the top down. We, of the Bureau of Public Roads, are proud of this national plan,

yet we most cordially and gladly give the credit for its accomplishment to the State highway departments.

The choosing of such a system has been a most difficult task. That it has now been brought to a successful conclusion is largely due to the selective processes which the highway departments have been exercising for years. Without this prior classification, which has been the cause of constant and vigorous protests where local and often selfish interests recoiled against the action of the State departments, the welding of a great network of major highways covering the whole nation into a comprehensive plan could not have been possible. The recent task largely narrowed to a process of joining the selected systems of the States, and here again the departments have shown a wonderful spirit of cooperation. Conflicts at State lines have been settled in friendly conference around the table. It is more than evident that the highway departments and the field organizations of the Bureau have carried on the negotiations with sincere good will and mutual respect.

The task ahead is defined. It will be completed.

The present map includes 168,881 miles in the Federal aid system, about 30,000 miles less than the legal maximum based upon the certified total public road mileage in the United States of 2,886,061 miles. While there remain some details yet to be adjusted, they are in the main relatively unimportant and will not be allowed to cause controversy between the States and the Bureau. Only in one case was it necessary for the Secretary to hold a hearing before making his decision, and this was sought by an Association having no official status. I am

convinced by the experience in this matter that no State Highway department should accept financial contributions from any source outside public revenues unless no obligation, actual or implied, is thus incurred. That which may appear to be the proper course to follow today may not be in five years or less. Conditions in the highway field have undergone the most abrupt and unforeseen changes. Each highway department must remain free, morally and legally, to follow the course dictated by the most urgent needs of highway service.

The State and Federal governments are financially able, and the State and Federal highway departments are administratively and technically competent to build the roads in the order of greatest importance in the different sections of the country without the assistance of any voluntary organization, if such aid in the end shall become a source of embarrassment.

As indicative of the task ahead, the combined mileage of State systems as of January 1, 1922, is 220,000 miles. Of these, 30,200 miles are reported surfaced, or 36 per cent. The Federal aid system now approved is about 80 per cent of the total State highway mileage, and may be considered to this same extent coincident. Applying the same pro rata of improvement the first of the year 1922, about 30 per cent of the Federal aid system was surfaced, or about 50,000 miles. Of Federal aid highways on July 1, 1923, there had been completed 26,556 miles, and there were under construction 14,771 miles, a total of 41,307 miles of all types. Of these 8,586 miles were graded and drained, and

32,621 miles surfaced. All but a very small percentage of this mileage is on the Federal aid system as now established, and although, admittedly, the above figure of 50,000 miles of surfaced roadways on this system is very rough, still it is apparent that the surfaced improvements added in the four-year period 1920-1923, have been equal to or greater than all the surfacing placed in all the prior years.

A careful study is being made, State by State, of the improvement status of this definite Federal aid system. If these estimates are found to be approximately correct, at the end of this year there will be about 60,000 miles of surfaced roadways, and about 8,700 miles graded. This leaves 110,000 miles to be surfaced. To surface this mileage in the ensuing decade, that is, by 1934, there must be an annual program of 11,000 miles of completed new construction. In addition, there must be the "stepping up" of many miles of lower to higher types, the reconstruction of surfaces built before the present traffic, and the widening of roadways to carry the increased traffic. During the ten-year period there will necessarily be added a considerable increment to the present approved mileage.

Nor does this yet represent the size of the essential construction program to bring this major system up to a satisfactory operating basis in the next ten years. There are many miles of the system crossing Indian reservations, National Parks, and National Forests in our western and southwestern empire. There are many new and important bridges required and a large program of bridge reconstruction, especially

in the east and south. Added to all this is the ever increasing need of safety improvements, such as the elimination of railroad grade crossings.

These and similar problems are not to be indefinitely deferred. They must be met. From the standpoint of financing new construction, the most acute situations exist in a number of the western States. The new map shows the extensive network covering the eastern and Mississippi Valley States, focusing in a few lines east and west across the Rocky Mountain system, the great central plateau, and the Sierra Nevada system, finally to meet and multiply into the highways of the Pacific Coast States. While limited in number, these in-between connecting links present serious problems, financial and engineering; - not through an unbroken length, but at times for long distances, where there is little or no local development, where the physical obstacles to road construction are unusually difficult, or where these necessary links are not so located that they, at the same time, serve the most urgent highway service needs of the communities or the whole State.

The sliding scale of financial cooperation does not meet these conditions. It alleviates, but does not cure. The agricultural depression has hurried the acute status, it is not the cause. The Bureau understands this condition and is in sympathy with its proper solution. This right solution can and must be found. There can be more than one approach. A readjustment of the terms of cooperation to meet specific extraordinary conditions, the general development of more economical design or construction. With the existing status of construction, both as to types and extent, Federal participation in maintenance as a general policy is not the logical solution.

## HIGHWAY TRAFFIC.

The indicated necessary improvement program on the major highway system is large. It must be considered most seriously, but in the light of the amazing growth in highway traffic.

Economic data is becoming available by which we may measure the need for, and usefulness of, improved highways with certainty, and the conclusion is inevitable that the annual mileage of new roads is lagging behind the expansion of highway traffic. Highway transport is seeking to serve more rapidly than the handicap of inadequate highways is being removed. The State Highway Department of California and the Bureau have made two traffic studies covering the State system, the first in 1920, the second in 1922. At the same one hundred and three counting stations, the two-year numerical increase in daily traffic was 47 per cent, thus closely reflecting the 54 per cent increase in registrations.

The Baltimore milk transportation survey shows 36 per cent of the city's supply now brought in by motor truck. In 1919 only 18 per cent reached the city in this way.

The Connecticut highway transport survey developed beyond question the fact that the direct connections between population centers are the major traffic lines, that the traffic is reasonably proportional to the population concentration in the centers directly connected, and that the heavy traffic both in weight and number is restricted to a relatively small percentage of the total mileage of public roads within the State.

The Bureau's predicted total registration for this year is 14,700,000, and for the following year 16,500,000 plus. The extension of freight and passenger lines is bringing rapidly to the individual, highway transport service, whether he is a car owner or not.

The report of Special Committee IV of the United State Chamber of Commerce on the "Relation of Highways and Motor Transport to other Transportation Agencies" states as one of its major conclusions:

"Trunk highways in any area should be able to carry the normal vehicular traffic of that area, and, if the traffic economically justifies the use of especially heavy trucks, highways with stronger sub-bases must be provided. This constitutes a problem requiring particular attention in the design of highway systems and in the regulation of traffic. In other respects present types of highways, present routes connecting principal centers of population and production, and the present trend in size, weight and speed restrictions of vehicles using highways show a rational system of highway development that should be continued."

Highway traffic presents a cross section of the business and social life of the communities. Upon this fact and the definite traffic data now being gathered may be predicated the character, amount and weight of the traffic which the highways should be designed to carry.

The results of the California and Connecticut transport surveys will be available soon. The Bureau is now cooperating with Pennsylvania in similar traffic studies, and desires to work along these lines with other States as the funds available permit.

HIGHWAY FUNDS.

There is a large discussion, much of it critical, of the expenditures for highway purposes. There is particular criticism directed against bonds to pay for the improvements. The tendency on the part of the uninformed and unthinking is to condemn expenditures for such purposes because they are, in and of themselves, large in amount. They forget that no one can pass upon the reasonableness and necessity of a public outlay of money without considering at the same time the utility and value which is brought to the use of the public because of such an expenditure. It is just as logical to judge the soundness of a business concern by looking only at the liability side of its statement without comparing it with the asset side, as it is to criticize expenditures for highway construction without taking into account the value of service which such highways render, i.e. their earning capacity. We have recognized for years the terrific annual loss due to bad roads and the possible savings, direct and indirect, which accrue to the users of improved roads. A milk truck taking the milk of a certain group of farmers to the Baltimore market had to operate over a 5-mile stretch of unimproved road to reach a surfaced road. The regular price of transporting milk is 3 cents per gallon. In this case the operator of the truck charges his farmer patrons 1/2 cent per gallon extra for the six-months period from October to April because of the bad road conditions. These farmers are actually paying \$900 annually more than the regular charges, or \$180 per mile, or the interest at 5 per



cent on \$3600 per mile. This is the actual increased cost for milk alone. Considering the other traffic which exists, it would be economy to spend a considerable amount to improve this road even though it should be necessary to borrow the money in order to do it. There is good reason to question the sincerity of these self-constituted "watch dogs" of public funds, who set in motion propaganda against highway expenditures and are silent as to the net savings resulting from them.

In 1921 the Bureau made a thorough survey of all highway expenditures. The results are illuminating. Of the total \$1,036,587,772, there was expended by or under the State highway departments \$413,241,662, or 40 per cent, while under local authorities there was expended \$623,346,110, or 60 per cent. These expenditures were divided as follows:

Expenditures - 1921

By or under control of State Highway Departments

State and State-aid construction....	\$291,973,813	.....	70.7 %
State and State-aid maintenance.....	74,526,746	.....	18 %
Engineering and administration .....	18,881,855	.....	4.6 %
All other items ... (a) .....	27,859,248	.....	6.7 %
Total, States .....	\$413,241,662	.....	39.9 %

(a) Includes payments of interest and principal of highway bonds, purchase of gravel pits, quarries, etc.

Local Expenditures - 1921

Construction all classes .....	354,991,560	.....	53.7 %
Maintenance .....	174,065,423	.....	27.9 %
Engineering and administration .....	17,149,493	.....	2.8 %
All other items ... (a) .....	97,156,629	.....	15.6 %
Total, local .....	\$623,346,110	.....	60.1 %
Grand total expenditures, 1921 .....	\$1,036,587,772	.....	100 %

(a) Includes payments of interest and principal of highway bonds, purchase of gravel pits, quarries, etc.

Remembering that on the basis of a billion-dollar highway program the division is 40 per cent expended by the State and 60 per cent by the local authorities, note the division of income for all highway purposes.

Total Income for all Rural Highway Purposes - 1921.

Bonds .....	\$438,109,273 ...	38.1 %
Taxes .....	415,680,010 ...	36.2 %
Motor Fees .....	118,942,706 ...	10.3 %
Gas .....	3,683,460 ...	.3 %
Federal aid and forest funds .....	*79,333,226 ...	6.9 %
All others .....	93,689,221 ...	8.2 %
Grand Total	\$1,149,437,896 ...	100. %

\* From State reports.

Property taxes contribute direct 36 per cent. As closely as can be estimated, this is about ten or eleven per cent of the total annual tax bill, local, State and Federal.

Therefore, if there had been no highway program, State or local, property taxes would only have been reduced by say eleven per cent.

Examine now the division of income for State funds only.

Income to State Highway Funds - 1921

State bonds and special assessments ...	\$114,825,637 ...	28.3%
State taxes, direct .....	46,206,593 ...	11.4%
State appropriations from general funds	20,817,354 ...	5.1%
Funds from counties, etc.....	29,302,653 ...	7.2%
Motor vehicle fees .....	101,284,479 ...	25.0%
Gas tax .....	3,273,988 ...	.8%
Federal aid and forest funds.....	79,333,226 ...	19.6%
Miscellaneous sources .....	10,494,479 ...	2.6%
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	\$405,538,399 *	

\* There is an apparent discrepancy between State income and expenditure, but it should be remembered that in the conduct of public business, the two are ordinarily not exactly coincident or correlated. The discrepancy here is less than 2 per cent, a most excellent record.

Crediting general property tax with both State taxes and funds from counties, the total is 18.6 per cent. The items of Federal aid, forest funds, motor vehicle and gas tax, total 46. per cent, and State bonds 28.3, i.e., 73.7 per cent outside direct property taxes. The information is not available to divide the bond retirement and interest between property taxes and motor vehicle and gas taxes.

This is the real truth. The local roads are the cause of property taxes for this purpose being higher. This clamor about taxes is directed at the wrong cause.

from this source, including Federal taxes, were more than \$350,000,000, equal to 85 per cent of the income to State highways. It exceeds the entire tax bill of the railroads.

The Federal Government has received in taxes on the motor vehicle and repair parts more than double its entire expenditure for Federal aid.

The greatest danger we face in completing the Federal aid system or the State systems, are the drives against these funds for local roads, and even for purposes having not the most remote relation to highway improvement. The very life of the highway departments and major highway program depend upon these revenues.

This is the stern fight ahead. Property taxes can and should pay for the local program until the major one is complete, and if property taxes are too high the local program of new construction can be smaller for the time.

From this general discussion of the present situation, and from the experience in each State, the conclusion is certain that the improvement of the Federal aid highway system is the most important big task ahead, not because it is the Federal aid system, but because it comprises the most important interstate and intercounty highways of the nation - the very frame work of the whole structure, and that with its improvement heavy traffic will more and more concentrate on it, thus relieving other roads. But that no matter how important this may be, there will be determined efforts to divert the necessary funds to roads of lesser traffic importance, but totaling a much larger aggregate mileage. Even though well begun, the big work of the State highway departments and

the Bureau has only just begun. There must be established closer and more sympathetic understanding, and in this the Bureau desires to meet the States more than half way. The public is impatient. It is demanding increased highway service, and this service can only be rendered by better maintenance, by as large an annual program of construction of roads suited to the needs as the funds will permit, by better construction, and by reducing costs. These objectives can only be accomplished by more efficient administration and engineering, now made possible by the great advance in the science of highway engineering. Each State has its particular problems. If some States have larger available revenues, they too have the heaviest traffic problems. There are plenty of thorns with the roses in all the States.

#### MAINTENANCE.

Sometimes questions that come to me indicate a feeling that the Bureau is inclined to deal narrowly in approving Federal aid projects, but such is not the case. The Bureau desires to meet the States on the broad basis of faith that the expenditure of Federal appropriations for road purposes is an investment which will return many fold in measurable benefits. Objections are raised if the proposed construction appears unsuited for the traffic service demanded or that the maintenance will be difficult or impossible, and the costs will be unnecessarily high.

Under the law the Bureau cannot participate in the expense of maintenance. This expense ought to be met from the revenues from the motor vehicle license fees and the gas taxes imposed now by 36 States, i.e., it should be paid by the road user. Proper original construction

will do more to decrease maintenance costs than any other factor, and the Bureau will meet the States to the fullest extent compatible with the law to secure such construction.

There are supplementary practices which we consider desirable, for example, the seeding of embankments and side slopes of grades, and other work calculated to protect and thus decrease maintenance costs.

It is our judgment that the limitation now imposed on the allowable participation per mile should be removed to enable participation on paved roadways on heavy traffic roads not less than 20 feet wide. While 18 feet is regarded as sufficient for two way traffic, the 20 foot widths are already indicating a lessened maintenance cost and a more usable width.

#### STAGE CONSTRUCTION.

The proper balance between maintenance and construction costs is one which each State may not always determine on its merits. Many States have been forced to build roads of lower types because of lack of funds and a demand for a larger mileage than is justifiable from the maintenance standpoint but necessary from the standpoint of traffic service to the public.

The stage construction policies of the Bureau seem not to be understood in some States. The Bureau is willing to approve stage construction and the most economical types or processes that it is possible to devise, whether these are regarded as standard or not. The stage construction policy is sound and practically all of the road work in the United States may be regarded on this basis now, since it has been definitely proven possible, assuming the original alignment

and grades are adequate to build up existing types to meet increased traffic. We need to extend this policy and to develop new designs. Processes ought to be simplified, and we are ready to meet economies of this character even to the extent of extending project agreements to cover more than one construction season. For example, there are many roads which for lack of funds have been only graded and drained which would be greatly improved by the addition of sand where the traffic is not too heavy and where the soil is of the clay and gumbo types. There are many miles of such roads in the great agricultural States of the Mississippi Valley. This material could be applied in thin layers through say two construction seasons until a maintainable surface is built. The same policy could be followed in building gravel roads where the material is of the fine type and where water and rolling add undue expense. The stage construction policy must be carried out in good faith. The Bureau regards as real contracts the grading projects approved for later surfacing. There is a real danger in extending grading and draining too far ahead of the final construction, and already this situation exists to a limited extent. Lack of funds to build as original construction a suitable type for the traffic is the only possible reason for the use of the stage construction where the improvement does not extend beyond grading and draining unless there is difficult clearing or time is needed to allow the settlement of high fills. The greatest danger in stage construction lies in the possibility of not being able to secure funds for higher type surfacings where actually needed.

SUBGRADES.

The character of the subgrade has a very large effect upon the stability of the road surface. The difference between good and poor subgrade materials has long been recognized. It is a more difficult matter to decide where the boundary line exists between a bad soil and one that will provide adequate supporting power under any moisture condition. Recently the Bureau has placed a memorandum before the district engineers calling for subgrade treatments of plastic soils, such as the clays and gumbos, before placing high type surfaces. The practice already exists in some States of stabilizing the subgrades where bad soils are encountered before building the surface, and this practice should be adopted generally.

There is need for cooperation between the Bureau and the States in establishing the relation between field behavior and laboratory analysis. It is believed that very simple tests will determine the soils which should be modified before surfaces are placed and that the treatment itself can be of a simple, economical type. Silt and sand are both effective. Recently the Bureau tested the effect of the addition of Portland cement to a clay subgrade with marked results. One part of cement was mixed with 28 parts of soil to a depth of one foot. Concrete slabs six inches in thickness were laid on this subgrade, and corresponding concrete slabs were laid on an untreated subgrade. The slabs were then tested under impact simulating truck action. The slabs on the cement treated subgrade broke under loads which created a pressure under the wheel of 18,000 pounds, while the slabs on the untreated subgrade broke under a pressure of about 12,000 pounds. The bearing values of the



treated soil showed great improvement, and when mixed with water had apparently lost its plasticity, while the untreated soil was plastic. Similar results can be obtained with the use of other materials.

It appears that with very simple but intelligent methods, the stability of bad soils may be materially increased at an expenditure very small relative to the results that may be secured in the addition to service life of the completed roadway.

#### RAILROAD CROSSINGS.

Generally speaking, the States are fully cooperating in the elimination of grade crossings on new construction. From the records of the Bureau, out of a total of 753 crossings which have been eliminated, 467, or 62 per cent have been eliminated by relocation, 286, or 38 per cent by grade separation. In spite of the progress along this line in the work that has already been done to bring about a separation of grades, there still exist many grade crossings on important traffic routes. It appears reasonable and advisable that each State should adopt definite policies fixing an annual program of crossing elimination or of improvement providing for more adequate protection and safeguarding of the public.

In dealing with a problem of this kind it is always better to secure adequate data for each crossing. The Bureau will very gladly cooperate with each State in the examination of the crossings now existing on the Federal highway system to the end that a proper classification of these crossings might be made and a program of improvement or elimination set up. The railroads constitute a third party which should be taken into consultation since they must participate in such a program. It is

difficult to fix upon an annual program which would, within a reasonable length of time, eliminate this source of danger from our principal highways without definite information as to its full extent. There is no reason why such a determination might not be made independently of the progress of the construction program, as there is no reason why the improvement of such crossings should not be taken up as single projects without waiting for the construction of the roads on which they occur. Unless a policy of this character is established it is more than likely that the most dangerous crossings will not receive prior attention.

#### SAFETY AND ACCIDENTS.

While the grade crossing problem is one of the most serious, there are many accidents occurring which are not a product of this cause. Upon inquiry, the Bureau finds that only eight States attempt to keep a complete record of accidents occurring on the highways.

These States are:

Connecticut	Rhode Island
Indiana	Vermont
Maryland	Virginia, and
Massachusetts	Wisconsin.

In these States the automobilist is required by law in case of an accident to make a complete report to either the Commissioner of Motor Vehicles, the Commissioner of Highways, the Secretary of State, or to the nearest judicial official. In general, the laws also provide a penalty for failure to make such a report. In some of these States the report forms include typical sketches of the location where the accident occurred, and information as to its occurrence on a curve, reverse curve,

tangent, road intersection, etc. In certain States additional information is obtained from highway patrolmen and from maintenance men, and from other local highway employees.

It appears to be very important for the States to have complete data covering this matter of accidents so that it will be possible for those in authority to take the proper steps to eliminate causes which are directly attributable to the physical condition of the highways. In the main, accidents should be classified as to their results (number dead, number injured) - time (daylight, darkness) - location (railroad grade crossing, intersecting highways, tangents, curves, grades, detours) and cause (faulty operation, faulty equipment, weather condition, highway condition). These elements of the cause of accidents can be split up into greater details. For instance, under the heading of highway conditions, there should be a notation of lack of sight distance (forward or horizontal), a narrow highway, a narrow bridge or culvert, inadequate, irregular or improper wording or spacing of signs, lack of guard rail to outline roadway and warn motorists, unnecessary obstacles to view, failure to make prompt repair to holes or depressions in the pavements, excessive crown. There may be other elements of the physical condition of roads which should be inquired into in case of highway accidents.

#### FIELD INSPECTION.

It appears that preliminary engineering and designing have moved far ahead of the field control of actual construction operation. The

importance of adequate and competent field inspection cannot be overstressed. This should extend to field tests of material which can be checked by the headquarters laboratory. There has been a great improvement during the past three years, and most of the States recognize the importance of competent field inspection, but there is still a tendency to economize on personnel to such an extent that adequate engineering inspection is not always given.

This inadequate inspection extends to bridge construction. Both the Bureau and the States should strengthen their work in this regard, and should resort to new methods of inspection that will more adequately secure a compliance with the plans, specifications and contracts. The use of a light sounding hammer for testing reinforced concrete bridge construction has proven the presence of poor concrete where surface indications were reasonably good. The profilometer developed by the Illinois Highway Department provides a possible means for testing the surface secured in pavement construction and its proper use will result in higher standards of workmanship. The use of coring machines should be greatly extended. The general use of this machine to check the compliance with contracts in North Carolina is highly commended, and the results secured should lead to the universal adoption of this plan of determining not only the adequacy of the engineering control in the field, but of providing a method for settling with contractors on the basis of actual work done. The Bureau will cooperate with the States in helping to operate this equipment to any extent desired.

LABORATORY CONTROL OF MATERIALS.

Undoubtedly each State should establish its own testing laboratory. There has been such a demand upon material sources that too often the laboratory examination of materials has been only a paper compliance. That is, the information secured has had too little effect upon the materials actually going into the construction. The responsibility for the use of proper materials extends beyond the program under State control. Local authorities would be assisted if the results of tests were made known. For example, on one Federal aid job a sand was rejected which had already been used on over 500 miles of county roads. The plan of having the testing done at university laboratories cannot be relied upon for any considerable paving program, nor can a commercial laboratory compete with the service rendered by a properly equipped testing division. Just half of the States are now operating State laboratories, the others being dependent upon the commercial or university laboratories. The inspection of materials at their source is highly desirable, and this plan is used by some States. There is no reason why cement, for example, should not be tested at the manufacturing plant, and cooperation between adjoining States purchasing from the same mills might well be established with resulting economy. Material surveys would develop new sources of materials, and if these surveys are followed by testing of the materials, the State has at hand the information on which to base its construction program. The Bureau has established in each district a material engineer, and we

hope to develop a helpful service to the States in this manner.

#### DETOURS.

Traffic service must be maintained during construction. It must be given greater attention. The policy of maintaining parallel routes by the State, depending on the contractor to maintain drive-ways only when on the right of way under construction, as used in North Carolina and other States, is probably the most satisfactory practice. The maintaining of detours is a proper expenditure from Federal aid funds.

#### TRAFFIC REGULATION.

This Association should undertake at once leadership in developing uniform traffic regulations.

#### DEVELOPING THE ORGANIZATION.

One word in closing about personnel training. Fundamentally, the highway problem remains one of education. The men who come after us must be better trained. The organizations must be fed from the bottom with keen, intelligent young men. They must have a chance at broad development in the various branches of the work. They must at the same time get their minds in tune with the spirit of public service.

The record so far is clean. Let us each in his own heart resolve to pass it on, without tarnish, and to the everlasting credit of this Association and its individual members.