SUMMARY REPORT OF THE 1970 MAINTENANCE MANAGEMENT WORKSHOP

O. Raymond Martin, Delaware Department of Highways and Transportation

A ROADSIDE sign used in one southern state makes an earnest request: "Arrive Alive." Few motorists fully comprehend that not only are safe driving habits required by these two little words, but also roads professionally maintained with maintenance that is professionally managed. Today's roads have more traffic, handle higher speeds, and move greater loads, and at the same time are wider, safer, and exist in locations never dreamed of 50 years ago.

The realization that highway maintenance needed improved management as well as techniques and procedures began to emerge 20 years ago. In June 1950, the first organized form of a maintenance management research program, a joint venture of the Federal Highway Administration and an individual state, was initiated. Between 1950 and 1967, there were numerous studies, both formal and informal, undertaken by the state, county, and municipal highway and street organizations throughout the country with and without FHWA participation.

By 1967, the Highway Research Board and in particular the members of the department of maintenance were of the opinion that the particular research projects having to do with systematizing maintenance operations that were being supported in some states would be of interest to maintenance managers in general. There was a feeling that state legislators were beginning to question whether or not the considerable funds being approved for highway maintenance operations were really necessary or were being spent wisely.

The first Maintenance Management Workshop sponsored by the Highway Research Board's department of maintenance was held during July 1968 at Ohio State University in Columbus, Ohio. Because of the enthusiasm generated by the first three-day Workshop for the purpose of delving into the field of management as it applies to highway and street maintenance, a follow-up Workshop was scheduled.

The 1970 Maintenance Management Workshop was held in August of 1970 at the University of Illinois in Urbana-Champaign. Its topic was: "The Challenge of the 70's: Meeting Change."

The meeting opened August third with the registration of approximately 140 participants. Those participating represented state, municipal, and federal agencies, and private firms from 34 states, the District of Columbia, Puerto Rico, Great Britain, and Canada. The purpose of this meeting was to probe more deeply into those maintenance management systems that were in the development and implementation phase in 1968 as well as those that were only in the formative stage.

The format of this meeting was changed from that used at the Columbus meeting in that the formal papers dealing with a specific subject were presented to the Topic Group Sessions as they met throughout the Workshop rather than to all of the participants in a mass group session during the first day and a half of the three-day Workshop. The advantage of this change in format was that the specific topic subject was fresh in the minds of the individual groups when their time for discussion arrived. The one disadvantage in this format was the limited time available for questions and discussion.

On the first morning after initial welcoming speeches, Mr. Morgan J. Kilpatrick, Office of Research and Development, Federal Highway Administration, gave a situation report on maintenance management's "State of Knowledge." He defined the theme of our second Maintenance Management Workshop, "The Challenge of the 70's: Meeting Change," as encouraging and exciting because it implies accelerating interest in new techniques to accommodate change and a recognition of future needs—need for more—need for better.
A brief look into the past and future of highway maintenance followed. The look into the past went back into the middle 20's and early 30's showing equipment then in use which gave many of the older members of the highway maintenance fraternity a twinge of nostalgia and many of the younger members shudders of horror and wonder, visualizing its use under today's conditions. His view into the future visualized change in the level of service demanded and provided; change in the methods and techniques used to accomplish the many and varied tasks; and change in management techniques to cope with the heavier work loads and greater fiscal accountability. In short, he feels that:

1. Maintenance continues to face increasing work loads which will generate more need for change;
2. Management improvement programs have been started in over half the states and in ten or more counties and cities;
3. Measurement of the maintenance work load is progressing rapidly;
4. Reporting systems along with planning and scheduling systems are being used increasingly as tools of management;
5. Progress in developing quality standards is slow and there is need for additional research and development;
6. The burden of funding maintenance management research and implementation has gradually shifted to the states as the percentage of the study effort devoted to research has declined; and
7. Attainment of maximum benefits from recent improvements in maintenance management is hampered by lack of an adequate staff.

The next presentation was made by Mr. L. G. Byrd of Tallamy, Byrd, Tallamy and MacDonald. Mr. Byrd spoke on the "External Influences on Maintenance." He recognized that many of the changes we are experiencing today are internally generated, responding to needs and problems within maintenance organization and operations. But as he pointed out, many are externally developed, displaying economic, sociological, technical, or political trends and phenomena completely apart from highway maintenance. Some of them are major influences and quite obvious, like inflation, which has resulted in substantial increases in the cost of labor, equipment, and materials. Thus budgets also must increase or programs must be reduced. Another is population growth which results in increasingly greater vehicle population and travel on our highways. This increase in traffic is further complicated by ever-increasing vehicle speeds. Aging of highway systems is a difficult-to-measure factor influencing increases in maintenance expenditures. That this factor is a significant external influence was graphically shown recently by the controversial GAO report on the Interstate system's deteriorating pavements issued June 30, 1970. The growing use of studded tires is also acting to decrease service life of pavements in the northern states. The fact that approximately 403,000 of our 563,000 bridges were constructed prior to 1935 and are requiring major maintenance and rehabilitation in ever greater numbers places an added strain on already overloaded maintenance budgets. There are sociological influences bearing steadily on the maintenance manager which are not readily translated into costs such as those previously mentioned. These include pollution not only of the air from vehicular exhaust emissions, but also of soil and water from use of snow and ice-control chemicals. Ecological concerns are questioning the use of soil sterilants, herbicides, insecticides, and growth inhibitors.

The present trend toward noise abatement and more emphasis on aesthetics along highway rights-of-way can result in extensive use of trees and shrubbery for noise barriers and increased plantings for beautification purposes. Increased use of our highways brings on increased problems of litter removal as the public's demands for clean, attractive roadsides continue. Traditionally, engineers have been guilty of ignoring or denying the political influences that are a fundamental part of every public works program, but they have been and will remain with us as long as our present democratic system of government exists.
As Mr. Byrd noted, the changes and challenges facing maintenance managers today can be readily documented, as can external influences in this era of protests, pollution, population increase, inflation, integration, and confrontation. These external influences may not be controllable but we can control our capability to cope with them and to utilize or modify them, which, after all, is what management is all about.

The paper presented by Mr. Charles W. Beilfuss, Director, Systems and Computer Applications, Engineering and Architectural Services Division of Control Data Corporation, entitled "Management Utilization of Data Processing Systems for Field Control" touched a sensitive spot for maintenance managers. He listed three major problem categories into which their disappointments, in general, fall. They are:

1. The use of data processing did not of itself bring better management to the operation (i.e., costs were not reduced because reports were generated by a computer). This disappointment has occurred when the relationship of the role of data processing to management was misunderstood.

2. The use of data processing in place of mutual methods has often been less timely and, at least apparently, has often produced results that have been less accurate.

3. The use of data processing has not always provided useful management information for particular problems or for particular inquiries which are unusual in nature.

Other problems than these can probably be cited, but the above are considered to occur most generally and to be most critically in need of solution. He cautioned against the misconception that a data processing system can adequately handle the role of decision making. Seldom can a decision be reached solely on the basis of data without the use of experience and judgment. A data processing system is only a tool to be used since decision making always has been and always will remain essentially the responsibility of management. He then outlined two concepts for overcoming the major problems frustrating management today which are: (a) the problems of timeliness and accuracy of data processing systems in producing management information; and (b) providing more satisfactory information to management. Use of these two concepts, described in detail in his paper, will overcome the major problems involved in allowing data processing to live up to its potential for management information systems, he believes.

For some years work has been carried on with systems that have had weak links that he feels are about to be strengthened. He is not optimistic that other weak links will not show up once these concepts are successfully employed. However, he does feel that many of the managers who have had the greatest disappointments in data processing systems of the past can now begin to have these disappointments overcome.

At the close of his presentation, he reiterated that we should beware of the data processing man or the manager who expects that a data processing system should manage. Until we all recognize that data processing systems provide information and managers manage, we cannot expect to achieve our management goals.

After Mr. C. G. Prahl, Vice President, General Construction Company, formerly Director, Washington Department of Highways, presented his "Charge to Participants" which stressed the need to put highway maintenance on a more businesslike basis, the participants were divided into four groups. These groups met individually and successively with the four topic teams for a series of three-hour periods of formal presentations and discussions covering the following topics:

- Topic 1 "Problems Encountered Implementing and Utilizing Reporting Systems."
- Topic 2 "Maintenance Levels."
- Topic 3 "Implementing and Utilizing Performance Standards."
- Topic 4 "Organizational Structure and Training."

Since all of the papers given in the topic sessions are published in this record, only the highlights of papers and discussions, which seem to have the most bearing on the theme of the Workshop, will be emphasized in this Summary.

Mr. James A. Murchie, Assistant Commissioner—Maintenance, Minnesota Department of Highways, presided over Topic 1 sessions which dealt with the reporting systems required to produce an effective maintenance management system. The participants heard the following four excellent papers:
The reporting systems currently in use have one thing in common—they must be changed almost continuously to satisfy different needs. None of the input data nor the output seems to satisfy many managers over an extended period of time. Flexibility of the systems must be incorporated to prevent the whole effort from bogging down in stagnation. It is significant that the State of Virginia has practically nothing left of its original management system developed in 1965.

The problems encountered in implementing the systems are of our own making. Maintenance managers must recognize the need to sell the concept of the system to both upper-echelon and working-level people. Unless the management system is accepted as a team effort, it cannot be made to function. Maintenance people basically do not understand computer people nor does the computer technician have a working knowledge of maintenance variables. It is essential, therefore, that these two groups be brought together in a common understanding if they are to make meaningful contributions to the program. Of the 27 states currently in the process of developing maintenance management systems, 16 are developing comprehensive programs. The similarity of the problems they have encountered is outstanding. The major problem has been with computerization and actual application of the systems.

Currently, each organization seems to be developing a management system tailor-made to its own specific needs. This makes it difficult to judge who has the best system or what systems can really be called management systems. The reporting in management systems must include those data and criteria which make it possible for management at any level to make meaningful decisions so that the necessary actions can be initiated. Since this has long been recognized as a goal of management systems, future workshops could well be directed to the development of this concept. It was also recommended that the HRB undertake to define the problems, establish criteria, and design a reporting system which will implement valid decisions.

One outstanding problem with any reporting system seems to be in the turn-around time needed to process the data into a meaningful report. Every echelon of management should have available to them timely reports on which they can act to keep the plan on schedule and to see that the program is completed within its prescribed limitations. Currently, only one state has such a system in the making, from which it appears that on-line remote computer consoles are almost essential to rapid data processing.

Simplified reporting systems incorporating fiscal as well as accomplishment data must be developed if reporting is to be meaningful to more than one individual in an organization. The confusion in reports currently developed results from finance people superimposing data on accomplishment reports so that the dollar value and fiscal responsibility overrides the work performed report. Maintenance managers then have difficulty in interpreting the information reported to them. Simplified source reports, such as used in Illinois and Virginia, have much merit in reducing field paper work and satisfying requirements for both the dollar accounting and the work accomplishment data.

It was evident from the enthusiasm of the participants that there is a general need by all of the states represented for meaningful reports. There is a general feeling of uneasiness among those who are not well along on their management systems and even those who have developed relatively sophisticated systems recognize they are not yet complete and will have to develop through an evolutionary process.

Topic 2 was presided over by Mr. George M. Briggs, Director of Maintenance, New York State Department of Transportation, and dealt with the need for determining maintenance standards and some of the pitfalls in the establishment of levels of maintenance. The following papers were presented:
"Legal Aspects" by David C. Oliver, Highway Research Board.

"Economics of Maintenance Levels" by Carl E. Forbes, Maintenance Engineer, California Division of Highways.

"Organizing and Directing a Standards Panel" by Rodney A. Pletan, Maintenance Methods Engineer, Minnesota Department of Highways.

"Statistical Approach to Establishment of Maintenance Levels" by Max A. Ross, Deputy Director, Division of Highways, and Edward L. Miller, Road Engineer, Ohio Department of Highways.

Two papers, those of Messrs. Oliver and Forbes, did deal directly with levels and the problems inherent to them. Mr. Pletan's paper dealt more with methodology of setting levels while Mr. Miller's paper detailed a proposed method of statistically evaluating existing roadway levels of service.

We were given an insight into the legal ramifications of formalized maintenance levels that affect safety. The problem areas appear to be the opposing forces of legal responsibility due to the establishment of standards and the obvious need for such standards. While there is not a large body of precedents on which to base exact rules, and while it is desirable to set well-documented and planned maintenance levels, we must be prepared to meet them or face possible law suits. It is suggested that lawyers be included in our process of establishing standards of maintenance.

The relationship of maintenance levels as a variable to the other fixed components of a maintenance management system was described. We were shown how the use of alternate levels of maintenance as a tool can aid in staying within manpower and budgetary constraints. Levels must be well defined and quantified in order to evaluate alternative levels of service. Management decisions to change these levels must be spelled out specifically. The effect of changes, not only monetary, but also in regard to the expected consequences, must be understood prior to implementation. In considering reduction in levels, a good guide is that appearance can be sacrificed first, investment in the facility second, and safety never. Public acceptance is one of the very important considerations that must be determined in establishing standards, yet it is the one that is the hardest to assess. The use of considered opinions of knowledgeable maintenance men should be used in the initial attempts; however, ultimately only the trial-and-error technique will clearly determine public acceptance.

One method for overcoming the extraordinary manpower requirements of maintenance management studies is by the skillful use of committees composed of interdisciplinary experts. Despite the so-called pitfalls of the "design by committee" concept, committees can be used to significant advantage in the development of quality and productivity standards for highway maintenance. Besides expediting the completion of a task itself, committees consisting of knowledgeable people from the field serve to improve communications between those responsible for setting standards and those required to use them, involve more people in the decision making process, and capitalize on the talents and experience of those directly involved with the work itself. In addition, results are more acceptable and the "resistance-to-change" factor is much less of a problem. In order for a committee to function in an efficient and effective manner, however, it must be carefully organized and directed. Before a committee begins work the members must clearly understand what is expected of them. A timetable must be established so they know when results are expected. The committee members must be capable of contributing to the task at hand. Each committee should have a strong leader as chairman who plans the meeting ahead of time, is able to motivate the members and guide the committee's work. Once the committee's job is complete, the committee should be disbanded.

A statistical approach to the method of measuring the quality of highway maintenance and level of service to the highway user appears to have merit. The use of this tool, once it is perfected, could result in substantial savings of time and money in the development and continued use of directing efforts, programming of remedial action, and requesting additional capability.

Once the necessary parameters and their relationships have been established, a computer program can be implemented so that data can be processed. Once each year a
random selection of sample highway sections will be generated using these computer facilities. A "Recordable Condition" survey will then be made on the sample sections. Data collected from these surveys will be processed by the computer and a determination made on the quality of maintenance on the highways. By this means a more consistent quality of maintenance will be possible throughout a state and a means will be available for deciding the type of maintenance activity to emphasize in order to maximize the utility of the maintenance investment.

Few states indicate that they have a complete set of quality standards, but more indicate they are in the process of developing them. Though none seemed opposed, the consensus seemed to be one of watchful waiting. There was a general feeling that additional research is called for into the legal aspects of standards nationwide and the development of guidelines. This would assist organizations in setting standards efficiently and perhaps in making a beginning toward more uniformity of maintenance for comparable highways that cross state lines such as interstate roads.

Topic 3 with Dr. Lawrence Mann, Jr., Louisiana State University, presiding had for its theme "Implementing and Utilizing Performance Standards." This session consisted of the following three separate presentations:

"Assessment of Productivity" by P. J. F. Wingate, Principal Scientific Officer, Road Research Laboratory of Great Britain.

"Performance Standards as a Tool in Preparing the Maintenance Program Budget" by Joel S. Katz, Maintenance Engineer, Minnesota Highway Department.

"Case Study on Performance Budgeting" by R. E. Jorgensen, President, Roy Jorgensen Associates, Inc.

A description of the method used in Great Britain to measure productivity was given the participants, which emphasized the use of performance standards. Some of the measures of productivity described were actual hours divided into standard hours, actual hours divided into wages, standard hours divided into wages, budget standard hours divided into standard hours work, and budget unit cost divided into actual unit cost. The direct assessment of productivity is cumbersome to make and not very effective for controlling labor forces used in highway maintenance. However, the modified approach through performance standards to determine effective performance was considered indispensable for a proper control of labor utilization.

Setting up the control system involves a considerable effort, but once installed it is easy to run and has a number of side benefits including a valuable means of preparing annual programs by providing accurate information on which estimates of labor and financial resources needed could be based. The system could be incorporated with an incentive bonus scheme where desired, but it is preferable for the bonus scheme to be a side benefit; otherwise, the real object, that of monitoring labor productivity in the organization, becomes obscured.

Program budgeting in maintenance can be made into a practical management process if performance standards are used. Standards controlling quality, quantity, and productivity are essential features of a program budget in maintenance. Quality standards control how well the maintenance is accomplished. Quantity standards, when combined with the road and equipment inventory, define the work load required to meet the quality standards. Productivity standards define how much manpower, equipment, and materials are required to meet the work load. Maintenance managers must be aware that maintenance program budgeting requires a commitment of personnel and there are several pitfalls that must be avoided. In general, program budgeting using performance standards can give maintenance managers a method of cost control not otherwise available to them.

Yet another approach to performance budgeting is being developed through NCHRP Project 19-2(4) based on the use of a unique card system for controlling allocations of resources in conjunction with the use of a work order form to control expenditures. This appears to be the first attempt to develop a standard maintenance management system that will be applicable to all state, county, and municipal maintenance management needs.
Topic Session 4's theme was "Organizational Structure and Training" with Professor Emmett Karrer, Ohio State University, presiding. There were five papers given on the following subjects:

"Impact of Improved Communications on Hierarchical Organizational Structures" by Charles E. Diehl, Assistant Vice President and Assistant Treasurer, George Washington University.


"Maintenance and Wisconsin's New Department of Transportation" by William J. Buglass, Chief Maintenance Engineer, Wisconsin Department of Transportation.

"Reorganizing From Patrol to Gang-Type Maintenance by Edward J. Kehl, Illinois Division of Highways.

"Pennsylvania's Reorganization to Crew Specialization" by Louis G. O'Brien, Assistant Chief Engineer, Pennsylvania Department of Highways.

The organization for highway maintenance in most states has more or less just grown up without much formal planning. A look at the history of highway usage makes evident why this has been so. Early roads in the horse and buggy era were built purely for local travel. Roads were mostly only graded and drained earth with possibly some stabilization of surfaces with gravel or crushed rock. A very common practice was to require that each landowner spend a certain number of days per year working on maintenance of the road in front of his property or furnish a team of horses and a wagon for a certain number of days.

As the "tin lizzie" appeared and travel increased in both volume and speed, more work was required for maintenance. The farmers then logically asked the local unit of government, county or township, to hire men to do the maintenance work and the landowners paid taxes to cover these costs. This was probably the beginning of the patronage system of road maintenance wherein the maintenance workers were appointed by politically elected officials.

As traffic increased in volume and in speed, an ever smaller percentage of the traffic passing any one point was of local origin, and maintenance became ever more logically a governmental responsibility. The building of better roads and the development of better maintenance equipment also made many changes. Trucks replaced horses and wagons, and then with the harnessing of steam, gasoline, and diesel power there has gradually been developed ever more sophisticated and expensive equipment, but equipment which can do a better job of maintenance. This modern equipment can be used efficiently, however, only if there is enough volume of work assigned to one piece of equipment to keep the machine busy, and if it is run by a skilled operator.

Team play requires two-way communication—instruction and response. If our instructions are poor or wrong, the coach has to accept responsibility. Maintenance communication must be such that it not only instructs, but also recognizes a response. Too often, communications have been one way. We establish cost control reporting up the line. No information is ever fed back to the field to encourage change. We send down work methods from headquarters and never check up on the efficiency of the method with the man in the field. If our communication is not looped through feedback, it is not a true communication; it is just information.

It is being proven that the number of maintenance employees can be reduced while at the same time the quality of maintenance is improved. The net result is better maintenance at lower unit cost. One reassuring aspect is the fact that reduction of the number of men on highway maintenance payrolls can be made through the normal process of attrition.

There appears to be a trend by some states that are still forced to operate under a system of patronage-appointed maintenance personnel to solve this problem by reorganizing maintenance forces into more specialized units that are responsible for larger areas of work. Another answer to this problem is to institute programs to educate and train employees similar to that being tried in Louisiana which involves canned instruction, i.e., a series of slides and an accompanying tape. Comprehensive training programs must include inspectors who determine what maintenance work is needed to cor-
rect any particular situation, as well as machine operators, maintenance supervisors, and so forth. Ways must be found not only to employ competent people but to improve the skills of all employees. A procedure is needed to determine the qualifications of persons responsible for making decisions on what maintenance work is to be done. Such a person must understand the engineering principles involved, and must be able to determine what has caused a maintenance failure in order to determine properly what corrective measures need to be taken.

In a number of states, the department of highways and transportation as an institution is entering into a period of change. Following the federal lead, states and even cities have or appear about to reorganize into comprehensive, unified departments of transportation that will approach transport issues and problems using all the tools of modern management theory. The need for this type of change or reorganization is becoming a necessity in most areas because:

1. We need increased operating efficiency to handle greater workloads without proportionate increases in staff.
2. We must make government as understandable and responsive to citizens as possible.
3. We face a growing complexity of problems which frequently involve several agencies.
4. In order to aid and abet the new efficiency required in the entire industry, government needs to perform in new areas and in a coordinated fashion.

On all governmental levels it is increasingly recognized today that our transportation policy cannot remain segmented. The day is past when each transportation mode could successfully be treated in isolation, without reference to the total transport system of which it is a part. It is no longer valid, if ever it was, to plan and construct highway, air, rail, or water facilities without reference to the transportation regulatory climate or knowledge of the interplay of transport investment, economic growth, and social change. Over the years, our nation has seen rapid technological change in all fields of endeavor and simultaneous development of a vast and complicated transport network. As we increasingly recognize the complexities of our transportation system and its interrelationships with all aspects of our interdependent society, we are forced to develop new public policy approaches to transportation and more sophisticated methods of analysis. Much study is needed.

In closing, my impression is that the 1968 Workshop attempted to bring to the attention of the participants the need for improved maintenance management and to interest them in initiating development and implementation of such a system in their states. The 1970 Workshop shows that in the interim many states have instituted such a system. The original goal of interesting states in maintenance management systems appears to have been attained.

The comments and questions at the past Workshop indicate that we have moved from the what and why phase of maintenance management to the how phase. We need to know much more about the details of the operation of such a system. We appear now ready to move into the refinement and standardization of these systems. This opens up a whole relatively untouched field that we, as managers, need to explore, such as random sampling activities, establishment of realistic uniform quality standards, methods improvement seminars, and other subsystems of the total maintenance management system. We have but scratched the surface and have much work to accomplish before we reach our ultimate goal.