IS YOUR HIGHWAY RESEARCH BEING IMPLEMENTED?

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As with most industries, the highway industry is experiencing the massive technological changes that we associate with space-age development. Contractors are building highways at unprecedented rates; the computer has become an everyday tool; nuclear gages and ultrasonic devices are routinely applied to highway inspection tasks.

These rapid changes are placing pressure on the researchers to solve related problems. With increasing problems and greater competition for research funds, and the need for "maximum return" on the research dollar, expeditious implementation is the key to success.

Implementation starts with the researcher himself. From the very inception of a project he must take action to smoothly implement his findings into the ongoing operation. He should think of himself as a salesman with a real product and seek active support and cooperation from the ultimate users. He must deal directly with experienced engineers who will want to see strong evidence before changing their operations. The researcher must not only calculate, contemplate, reason, and evaluate, but he must also inform, justify, specify, convince, and persuade if he is to observe early implementation of his research findings.

The following are some suggestions that should help the researcher's ideas survive the rigorous test of practical application.

1. Get the Right People Involved. At the very beginning, involve knowledgeable engineers who are successful and effective in the appropriate field to discuss the research. In house, the engineers should be selected from those units that are responsible for administering the activity. These people will be able to supply valuable ideas and help focus the research effort on the most acute problems. In addition, it gives the researcher the first opportunity to sell his research to the user. Every modern textbook on personnel management points out the advantages of group participation, particularly when initiating new procedures. This is certainly true in highway research, where the full cooperation of operational people is a necessity.

There is one pitfall in this approach that must be pointed out. The old cliché tells us that the camel is a horse designed by a committee. In research, this is particularly true. Every project, if it is to be effectively carried out, must be under the direction of one principal investigator who has the final responsibility for directing and reporting the work. A committee or group should serve only in an advisory and policy basis.

2. Solve Only Real Problems. If implementing research is to get the support of others, they must be convinced of the importance of the work. Often the researcher concerns himself with his own problems rather than those of the operational unit. Actual problems in highway research often boil down to a need to increase safety, cut costs, or improve quality. Other areas of study

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include driver or other citizen complaints, inconvenience to the public, unsightly conditions, contract administration procedures, etc. If one is to gain support, the problem must be well defined and expressed clearly and succinctly. Rare indeed is the researcher who can state the "problem" in one or two sentences. For example, one researcher working in the area of highway safety started out with a three-paragraph problem statement regarding skid resistance. He finally reduced it down to "Various types of pavement sometimes lose their property of skid resistance, thus creating unsafe conditions." As a general rule, if you can say it in one or two simple sentences, you have identified the problem in a manner that can be easily understood by all concerned.

3. Stick to the Objectives. Are the objectives clear and precise? As with the problem statement, the objectives can usually be stated in one or two concise sentences. The objective for the skid resistance project mentioned above has been stated as "Develop procedures, methods, and criteria for assuring adequate skid resistance during pavement surface life."

Once the objective is well defined in the work plan, do not become distracted from the initial goal. It is certainly true that many worthwhile things are learned as a by-product of research. In fact, the "spin-off" can be very important and many times should be pursued under a related project, but this should not distract from meeting initial goals and objectives, nor should it delay implementation. One method that may help in this regard is to utilize a flow diagram. On some of our research projects we have successfully used critical path charts and flow diagrams; an example is shown in Figure 1. In any case, the commitment to a schedule should not be considered complete until it has been placed in some simplified form that can be understood and followed.

4. Spend Enough Time Planning. One essential of being a good researcher is to spend enough time planning a research project. Once a researcher develops an idea he is anxious to get the work under way. The argument is often

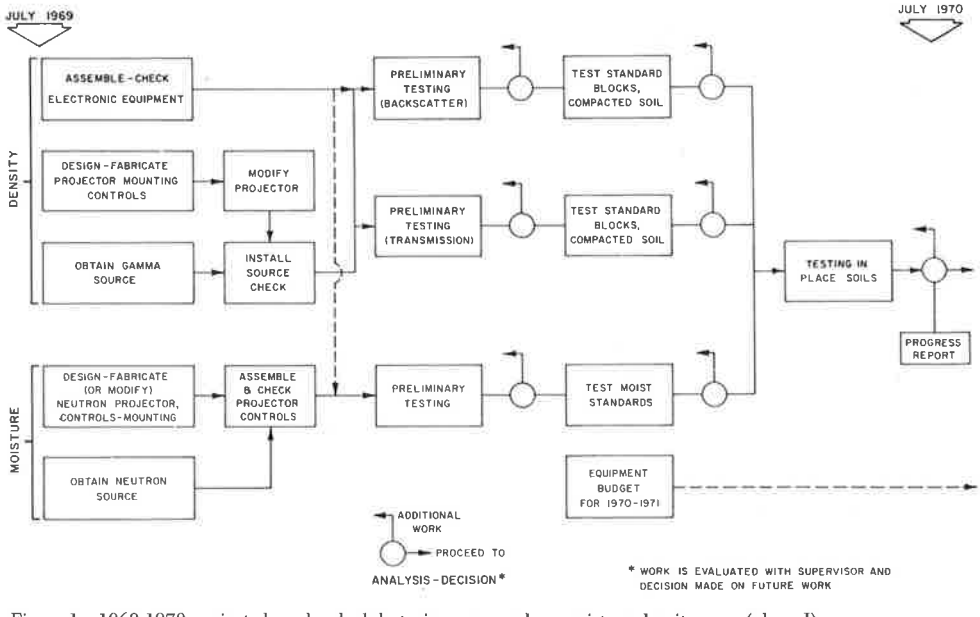

Figure 1. 1969-1970 projected work schedule to improve nuclear moisture density gage (phase I).

heard, "This is research; if I had all the answers I wouldn't have to research this subject." While there is some truth to this statement, it still holds that the researcher should carefully review all current literature on the subject and plan as many details as possible. At the very least, the researcher should know the first two or three steps that he intends to take. Research data have often been gathered without regard to how they will be analyzed and put to use. Detailed sampling plans, the number of tests to be performed, and the data evaluation process must have a sound basis and should be fully considered in the planning stage. It is, of course, expected that today's researcher in the highway field has at least a working knowledge of statistics and the ability to design an experiment.

An essential part of any research plan is a statement of steps that will be taken to implement the anticipated findings. This assures management that the researcher has given full consideration to the feasibility of implementation; it also encourages assistance from key individuals in both the research and implementation stages.

5. Expand the Laboratory. In planning a modern highway research facility we try to provide sufficient space and equipment for the researcher. In addition to this carefully planned area, we must add the highway itself to our "laboratory." To begin with, it takes careful observation and communication with those in the field to clearly understand and define the problem and to adequately plan the work. As the research progresses, the experienced researcher finds no substitute for the hours of tedious field work that are needed to ensure the validity of his results. After data analysis and evaluation, the implementation or field trial period provides the researcher with an invaluable opportunity to sell his product to the field men as well as the designers. By soliciting both the field and design engineers' criticism of his work, the researcher can generally be sure that all facets of the problem are considered. Sometimes it may be necessary to challenge and initiate controversy to really develop the problem.

6. A Research Report Is an "Implementation Tool". Research reports are too often written for "the ears" of other researchers rather than for the engineer. Most engineers are not interested in the volumes of data and the clever research methods employed. They want to know the significance of research findings and how to apply them. At the very front of the report, there should be an abstract or a concise summary, a list of conclusions, and recommendations. The operating engineer has neither the time nor the inclination to dig out information applicable to his work which is buried under "mountains" of detail (or "mountains" of words burying insufficient detail).

7. Make Sure the Work Is Finished. This is an area where even the best researchers have been guilty of dropping the ball. Even though they may have completed the research, they do not always follow through on the operational phases to assure that the user has all the necessary instructions, forms, etc. to implement the findings. Often the final product of a research effort is a change in specifications. Even specific recommendations to those responsible for specifications will probably not be sufficient to assure full implementation. Researchers should plan for special presentations before the group of engineers or individuals responsible for implementation. Sometimes this must be done in a dramatic manner. A good example of this is told of Mr. Francis Hveem, former Materials and Research Engineer for the California Division of Highways. Under his direction, the laboratory developed a Sand Equivalent test which is used to quantitatively determine the presence of detrimental clays in fine aggregates. Mr. Hveem was experiencing considerable difficulty in getting the test accepted by the field engineers. In order to demonstrate its value, he selected a concrete sand containing a high percentage of clay-like fines and also one from a clean source, both then in regular production. At a group

meeting, Mr. Hveem presented each construction engineer containers of the dampened materials. The engineers worked the sticky clay between their fingers and also the clean sand and then were asked which they really wanted in their concrete. Needless to say, the test was soon accepted.

Subsequent reviews of performance throughout the service life of the highway product (as that product is affected by research implementation) should also be considered as a vital part of research evaluation. As a matter of good practice, such reviews should be a part of an agency's overall Quality Assurance Program.

Careful attention to the foregoing points can help researchers do more meaningful research and ensure implementation of their findings, but they must also have strong management support if the implementation is to be successful. An AASHO committee on the utilization of research findings in their first interim report issued on April 1, 1968, noted that there is an unnecessary time lag between the conclusion of research work and the actual widespread utilization of the information. This group strongly recommended that each state highway department appoint a high-level professional engineer with a strong research background to assist researchers in implementing their findings. This AASHO committee also noted, "It is important that the professionals appointed to such positions be persons who have the respect of the division chiefs in the department." In my opinion this latter attribute should take precedence over the first. There is no substitute for management support; experience has shown that if the support function is delegated at too low a level, the work will lack stature and importance in the eyes of other busy people.

If management provides strong support, as is done in the California Division of Highways, the researchers can more readily and effectively find answers to highway problems and implement their findings into a better highway product, thereby assuring a maximum return on the research dollar.