

Putting Highway Research To Use

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INTRODUCTION

The total expenditure of funds, federal and otherwise, for research and development will continue to rise in 1967, although, the rate of increase will be less than the 12 percent annual average for the last decade and even less than the eight percent increase last year. Even so, expenditures will reach approximately \$24 billion this year. What happens to the results from these expenditures? Are they too immature for use? Are they so technically complicated that there will be difficulty in communicating them to others? Are they being "put" to use? These questions are frequently being asked by research sponsors and consequently there is a growing feeling that more direct methods of getting research into practice are needed.

The distribution made of these funds with respect to how much is actually being spent on research provides background as to the magnitude of the problem. In 1965 for example, 23 percent of the funds went to research and 77 percent to development. Of the 23 percent, four percent was used in basic research and 19 percent in applied research. It is the applied research, or mission-aimed research, with which we need to be especially concerned. That is, what happens to those research results emanating from the expenditure of approximately five billion dollars. (1) (†)

RESEARCH AND THE MISSING LINK

I believe that the growth of mission-aimed research has exceeded our historical methods of making use of the results. There is a widening of the gap between results and their use; even to the extent that some refer to it as a "missing-link." If this is true, and I believe that it is, there is

* The opinions and conclusions expressed or implied in this paper are those of the author and are not necessarily those of the Highway Research Board nor of the sponsors of the National Cooperative Highway Research Program.

† Numbers in parentheses refer to references listed at the end of this paper.

an urgent need to by-pass the "missing-link" by instituting new positive procedures and improving existing procedures whereby the fruits of this type research can best be realized.

Over the years much has been written on management decisions associated with allocation of research funds to obtain maximum "pay-off," but little attention has been given to management decisions needed to insure the "pay-off" through application of the research results. The general problem is apparent and is receiving attention from non-highway groups such as UNESCO (The United Nations Educational, Scientific and Cultural Organization), and now recently NASA (National Aeronautical Space Administration). For example, NASA has instituted procedures of encouraging industries outside of the space field to learn of and use their research results. Recent committee hearings on the NSF (National Science Foundation) points to the need of utilization of research findings.

Senator Jennings Randolph as chairman of the Science and Technology Subcommittee, is asking the question—"How can new technology be expeditiously and efficiently woven into the fabric of industry and thus into the products and services available to the American consumer?"—The Technical Services Act which became law 18 months ago was intended—"To promote economic growth by supporting state and regional centers to place the findings of science usefully in the hands of American enterprise—" (2)

A recent article on, *The Engineer and Public Policy* by Dr. Eric A. Walker, President National Academy of Engineering contained his views on the need for implementing research.

"And in many other fields as well, the shift of emphasis is taking place from research to engineering. Reports have been written on the needs of science in oceanography; much research has been conducted on air pollution and water pollution; research has been done on the removal of solid wastes; it is being done on highspeed transportation. In all of these areas the government has played a part, not only by concerning itself with the basic problems involved, but also by supporting much of the research being done.

Yet sooner or later, in all of these fields, the nation will be faced with the problem of putting to use the knowledge that is being gained through research. If the public is to benefit, it will be necessary to move into the area of application, of large-scale testing and production." (3)

Even with the foregoing expressions of concern some research results are obviously getting into practice as witnessed by the many tech-

nological changes that have occurred, but the expanding amount of research demands that more effort be directed towards the use of results.

Figure 1 presents the problems, pictorially, that there is truly a "missing-link" between research results and their getting into practice. This is not an uncommon picture in the mind of the mission-aimed researcher as he views the problem for he is most anxious to see his findings applied. The true fulfillment of a mission-aimed researcher's effort is the change in technology effected by his work. Such rewards are frequently slow in achievement. The "missing-link" is real to him. To be sure, there are indirect processes, but very slow, to which the researcher may look for the fulfillment of his desires; that is, through the known historical process of education, professional and technical society activities, and publications.



Fig. 1. The Missing Link.

To the sponsor of research the use of research results is also of concern and, more frequently than not, he has the methods by which they can be implemented. Except in the case of industrial sponsors, the process is frequently slow and not clearly defined. So, he too, sees this "missing-link" as a real thing.

It is apparent to both, however, that the most direct way to utilize research is to change practice, and *to change practice one must change the media of practice*. These media being design handbooks, manuals, policy guides, etc. (4)

Historically, and in the future, the indirect ways of skirting the "missing-link" will continue to be through education, professional and technical societies, and publications.

IMPLEMENTING RESEARCH

Education

One of the more significant historical means of implementing research, although slow and indirect, is through education (Figure 2). Where researchers also teach, they have an opportunity to by-pass the “missing-link” by educating the future users of research. Through association with a researcher, a laboratory assistant or student, may gain an appreciation for the value of research and an insight into how it may be applied. “Mission-aimed” research, conducted at colleges, universities, and campus located institutions, should have as one of its recognized objectives that of exposing our future engineers to research—its meaning and value.

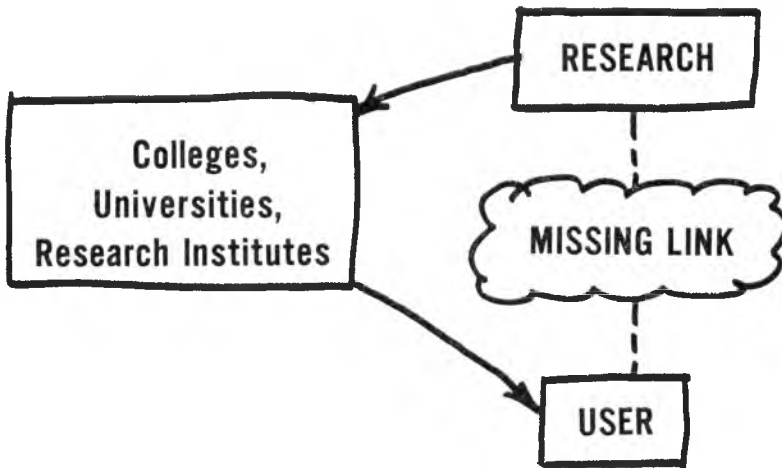


Fig. 2. Implementing Research Through Education.

Societies

In professional and technical societies (Figure 3), I find that the results of research permeates most of technical committee activities. For example, the scope of many of the ASTM (American Society for Testing and Materials) committees and subcommittees either directly or inferred provide for the encouragement and sponsoring of research. The society’s work directed to standards and recommended practices, is predicated on sound research results. In many instances, where research reported in the literature is not adequate for the facts needed in the development of standards, an ASTM committee will have its members conduct “round-robin” tests to provide the information. The ACI (American Concrete Institute) works similar to ASTM in the development of design media for the practicing engineer—the user of research. There

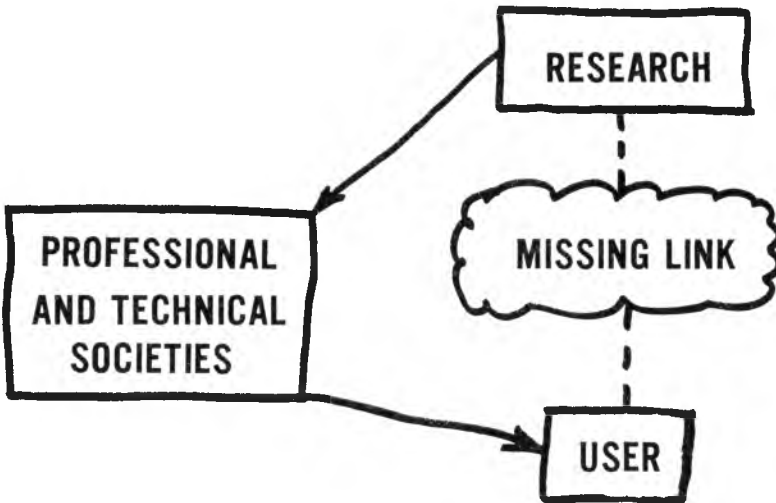


Fig. 3. Implementing Research Through Society Activity.

are many other societies and professional groups working in the interest of the practicing engineer by effecting changes in design media based on research. The Institute of Traffic Engineers, for example, has cooperated with the American Association of State Highway Officials, the National Committee on Uniform Traffic Laws and Ordinances, the National Association of County Officials, and the American Municipal Association in the development of the *Manual on Uniform Traffic Control Devices for Streets and Highways*. Many other such instances could be cited.

Although publication of research results is a passive way of skirting the "missing-link," there is much to be said for publications. An adequately documented research paper will provide information useful to those persons involved in the development of standards, recommended practices, etc. as well as aiding the direction for future research.

Publications

Published results, if clearly presented, will be studied by the user. The results of "mission-aimed" research should be presented in a manner readily useable by the user as well as future researchers.

Three important ingredients are needed to make a report on "mission-aimed" research successful. They are shown on Figure 4 as findings, application of results, and recommendations for further needed work. The findings should be presented early in the report with documentation relegated to the appendices. In this manner, the user may quickly study

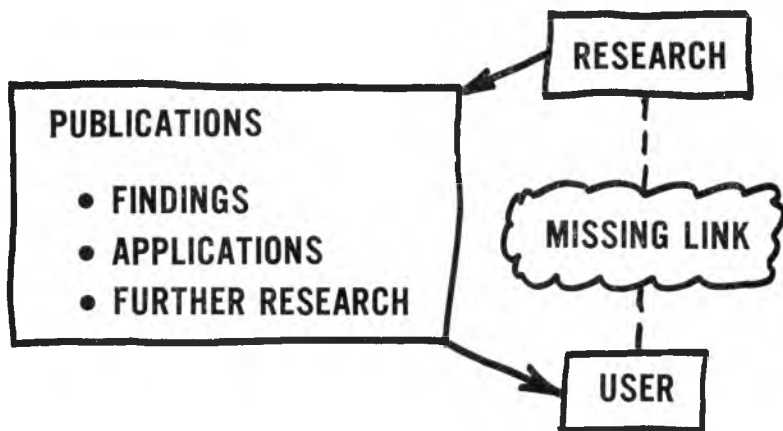


Fig. 4. Implementing Research Through Publication.

and evaluate the findings in light of his problem without wading through reams of documentation. In “mission-aimed” research, the researcher obviously has in mind during the conduct of the work an idea as to the *application* of the results and therefore he should express his views to the sponsor. A researcher is never better prepared than at the time of writing his final report to provide an insight into the need for further research to fill the gaps. It would be unfortunate for the sponsor not to receive this information from one who is currently “tuned” to the problem—that is from one who has just completed the research. The researcher should also hazard a guess as to the “pay-off” of future work. This will aid the sponsor in his decision for providing additional funds or terminating the work.

Effects of Documentation

As earlier mentioned, the documentation of research whether published or unpublished is a significant factor in not only the effectiveness of utilizing research, but in the direction for future research. For example (refer to Figure 5), suppose that researcher ‘A’ completes a study that is neither well designed nor documented; then, researcher ‘B₁’ must, of necessity, make a thorough check of ‘A’s’ conclusions before he can proceed. Consequently, within the time and funds available, researcher ‘B₁’ can only push the frontier of knowledge a relatively short distance beyond that of ‘A’. On the other hand, if ‘A’s’ study is designed by acceptable experimental procedures and his work is well documented, then researcher ‘B₂’ may make a cursory review of ‘A’s’ conclusions and can therefore proceed to significantly push the frontier forward. Every researcher has the responsibility of designing his experiment and docu-

menting his finds so that they will stand the test of time. Such efforts will aid the user of his work.

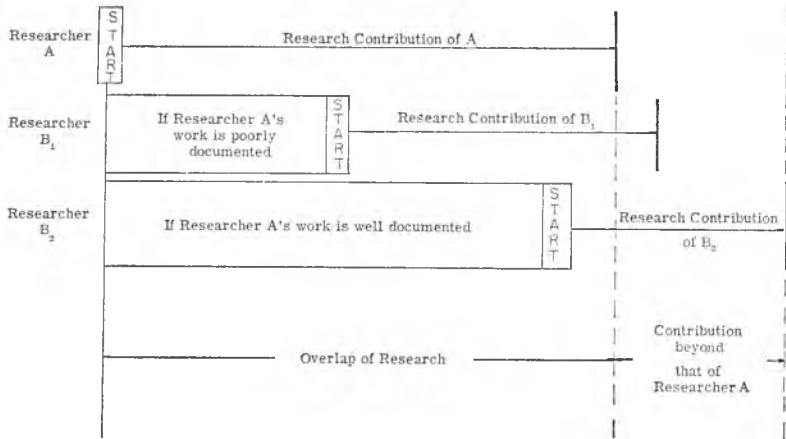


Fig. 5. Effects of Research Documentation.

Although the historical methods of implementing research will continue to be effective, they are indirect and time consuming. More direct steps need to be taken to fill the “missing-link” gap between the research and the user. In this respect, the roles of research sponsors and research administrators can play an important part and make a significant contribution.

Administration

The role of the research administrator (Figure 6), whether he is acting on behalf of the sponsor of the work or associated with the same organization as the researcher, is varied and sometimes not clearly defined, but in my opinion he can aid the researcher in a positive way and thereby contribute to circumventing the “missing-link”. He should be ever aware of the need for the work and its potential use. Where possible, he should generally follow the conduct of the work, through succinct reports from the researcher, in order that he may provide the broad perspective of the research goals. In the event that the work is faltering, or the mission is becoming vague, he should take appropriate action. The usefulness of his role may be measured in terms of benefits derived by the sponsor.

Sponsors

The sponsors of research (Figure 7) have an obligation to see that the results are put into practice whether it be in-house or contract

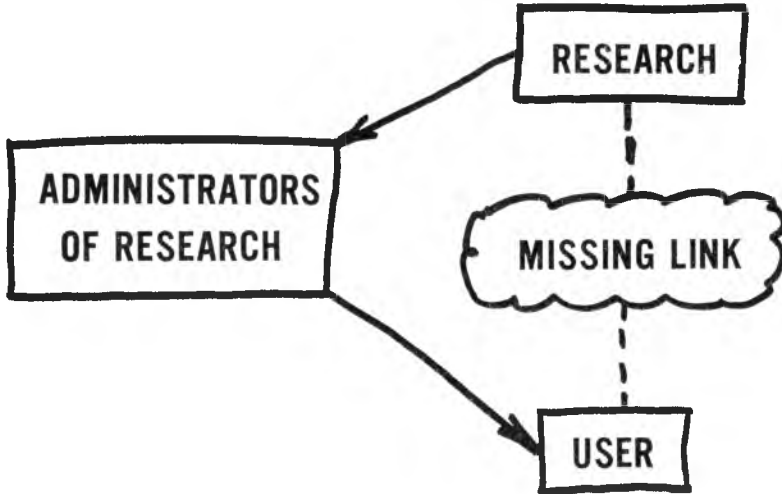


Fig. 6. Implementing Research Through Administration.

research. This is not so much a problem with profit motivated industries as it is with the nonprofit groups such as government. It is this latter group that needs to use more positive methods of implementing their research findings. One effective method used by industry is that of having a research-practice staff (committee or office) with the continuing responsibility of reviewing published works and keeping abreast of active inhouse or contract research. As useful information about a particular

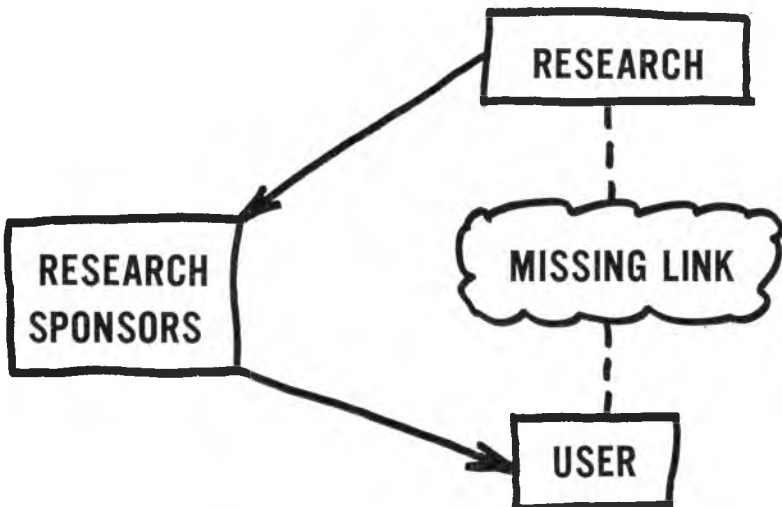


Fig. 7. Implementing Research Through Sponsors.

problem is obtained, the sponsor's research-practice staff would discuss the possible use of the idea, technique, or specification change with the appropriate operations man—the sponsor's so-called "man on the firing line." Between them, they could institute a change or maybe even a small pilot study or test section. Once a change is in effect, the research-practice staff would, where appropriate, observe the effects of the change and report whether or not it could be made generally useful throughout the system. If not, and more research is indicated, then the research-practice staff would determine the nature of the additional work, have it accomplished, and return to the field with the improvement. The conduct of the additional research would be undertaken as an in-house project, if the needed research involves only local factors, or as a regional or national project if of broad scope. In either event, the sponsor's research-practice staff, with the operations man, determine the usefulness of the research and its application. By having a staff that is research "minded" and "mission-aimed," a sponsor of research can be extremely effective in putting research to use.

The research being administered under the Highway Research Board of the National Academy of Sciences serves as a good example of how research can be put to use by skirting the "missing-link" through the research administrator and publications.

NCHRP Publications

The role of the program administrator and staff of the NCHRP is one in which a continued awareness of the research mission is mandatory. They are in frequent contact with the researcher as a measure of helping him keep the research mission clear and on target. To aid in performing this role, the structure of the program has been devised to insure maximum exposure of the research while in progress. In addition to the liaison with the Highway Research Board committees, and the Bureau of Public Roads research, there are nineteen technical advisory sections composed of knowledgeable persons throughout the transportation field operating under six broad advisory panels. There are also four special project committees. Membership on these groups now total over 260 with representation from thirty-five states, the District of Columbia and Canada. It is estimated that these men donate over 2,000 man-days per year to the program. Since they select the agencies, follow progress of the research, and ultimately recommend acceptance of the research report, they are continually being exposed to the research underway, and can keep the staff advised as to its direction and potential use. As a consequence, they benefit from their participation by being better able to

utilize the results since they will have had a direct knowledge of the research in progress.

The results of the work are published in a special series of the board. The publication format and editing is accomplished by an editor on the NCHRP staff. The principle organization of the reports consist of two parts. The first part contains the findings, applications, and future work (Figure 8), whereas the second part contains the documentation. A Foreword is also prepared by the staff. It is directed to the administrative officer of the sponsoring states. If he reads the foreword he will immediately know the group within his organization that can benefit most from the report. In addition, he will receive an insight into the research findings and how they fit into the overall problem.

The NCHRP reports are distinctive in format and are directed to achieving the maximum usage by our sponsors.

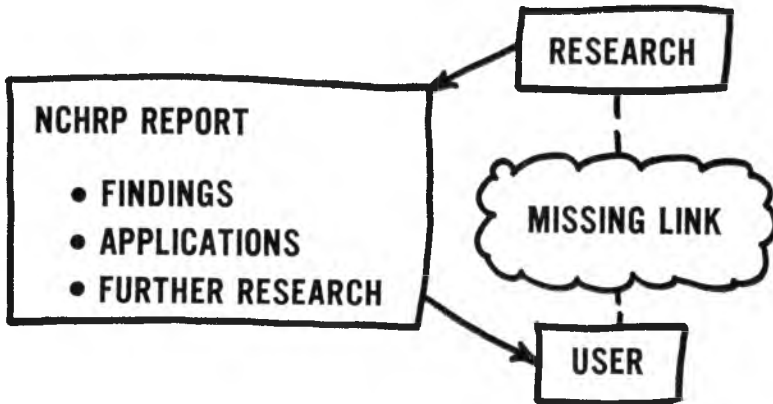


Fig. 8. Implementing Research Through Publication.

SUMMARY

The “missing-link” between research results and their use is real but there are processes, both active and passive, that are effective and can be made more effective in putting research to use.

More effort is imperative by research sponsors and research administrators in taking an active role in providing for the utilization of research; also the passive historical methods need continuing positive support. I believe that, if necessary, *funds equal to or even exceeding those used for the research* should be allocated to assuring the acceptance and use of the results. One should keep in mind that to help the practicing engineer one must change design media and guides for practice. This can

best be done through "mission-aimed" research coupled with continued effort by direct and indirect means of getting the results to the user in a useful form.

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