RESEARCH REPORT NO. SS 16.1

RESEARCH IMPLEMENTATION IN TEXAS

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PREFACE

Many of the ideas explained in this report were brought out in discussions between this writer and several persons in the Texas Highway Department in Austin. The personnel interviewed are all actively connected with the Texas research program, and, in my opinion, are well qualified to offer their experiences concerning research implementation. The purpose of this report is to describe the procedure used in Texas to implement research, and to analyze problems often incurred in the implementation process.

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INTRODUCTION

The Texas Highway Department administers an extensive research program each year. In recent years the program has grown to include 45 to 50 projects at an annual cost of approximately $2,000,000. A majority of the research is conducted through cooperative agreements with the Texas Transportation Institute (TTI), a research arm of Texas A & M University, and the University of Texas Center for Highway Research, with the remainder being conducted within the Department. The capabilities of these two research agencies, in conjunction with highly qualified people within the Highway Department, have enabled a broad spectrum of highway problems to be investigated through research efforts.

All research studies are undertaken with the intent of solving a particular problem or providing useful information. If the intent is accomplished and the results are implemented, the project has been a success. "Implementation" is the key to evaluation of a research system. Time, effort, and money are wasted when research findings are not put to use in some manner.

Unfortunately, implementation seldom occurs automatically, and it usually requires a concerted effort on the part of all concerned. The Texas Highway Department recognized the complexity of its large Cooperative Research Program in 1966 when

it established its present research organization system. The organization is designed to coordinate the research effort by involving both District and Austin Headquarters personnel in the conduct of research projects. The idea behind the system is that if all potential users are involved in the progress and direction of a research study, implementation of the findings will be more easily achieved.

Figures 1 and 2 in the Appendix show the Highway Department's research organization in flow chart form. The Research and Development Committee, composed of five Division Chiefs in the Headquarters office, operates under the direction of the State Highway Engineer in administering the Cooperative Research Program. The secretary and coordinating arm of this Policy Committee is the Engineer of Research, who is also the head of the Research Section in the Highway Design Division. All research is coordinated through him, and he plays an important role in promoting widespread utilization of all usable research results. There is an Area Advisory Committee, composed of District Engineers and Division Chiefs or their representatives, for each of the four areas of research (see Figure 3), into which all projects are grouped according to the nature of the study. The secretary of each committee, the Area Coordinator, keeps the committee informed of research developments within its area. Study Contact Individuals from the Department help

guide the Study Supervisors (the researchers) in the conduct of each study. The specific duties of each individual in the research organization will be explained in subsequent sections of this report, with emphasis on the part played by every person involved to achieve the ultimate goal of research -- "implementation of the findings."

The Texas Highway Department has an impressive record in implementing its research, and many of its research results have been adopted nationwide. However, putting research findings to use is often a long and difficult process, and some research results are never used. Problems are often involved in implementing State-sponsored research as well as research from other sources. The following context relates the manner in which implementation is attempted in Texas and the difficulties sometimes incurred.

SELECTION OF PROBLEMS FOR RESEARCH

The number of new research projects which can be begun in any fiscal year is dependent upon the funds available for research during the year. Due to fund limitations and the large number of problems submitted for research, the administrators must have a method of establishing priorities. In Texas, the research organization is set up to screen problems first at the operating level and then at the administrative level to determine which are more vital and urgent in the public interest.

Prime concern when establishing priorities are the extent and expediency to which the research solution to a particular problem will be implemented. This determination is based on the needs of the potential users. Would a solution to this problem satisfy a present need of the user and have immediate widespread application? For the findings to have direct implementability, a research project must be undertaken to solve a real and recognized problem, and not to prescribe an anticipated usage of the results. The Texas Highway Department has attempted to approach research problem selection with these ideas in mind.

The Research Section has encouraged anyone within the Department or personnel connected with a research agency to submit problems for research at any time. These Problem

Statements are referred to the Advisory Committee of the appropriate research area. Each of the four committees ranks the problems within its area in accordance with the aforementioned criteria. Representatives from research agencies are usually present at these meetings so they can get an idea of possible future research projects and evaluate their capabilities to perform them. Project proposals are prepared by the agencies, in cooperation with Department personnel, or by researchers within the Highway Department and submitted to the Advisory Committee, the Research Section, and any interested Austin Division for reviews. The Research and Development Committee screens all proposals and priority ratings and then formulates the year's Cooperative Highway Research Program. Final approval rests with the State Highway Engineer.

By involvement of the researchers, the Districts, and the Central Office Divisions in a cooperative effort to determine which problems are the most significant and urgent to warrant research, the difficulties associated with implementation should be greatly reduced (provided that research does solve the problems).

A possible weakness in the system is the inability of operating people to sort out and define the major and most urgent problems when submitting them for research. Many

problems within a District or Division are small-scale organizational problems that do not warrant research. Some of these problems might possibly even be solved by utilizing existing research results. The engineer should always "look back" at what he has built and determine what his real problems are.

The Houston District has made an effort to coordinate research within their District by establishing their own Research and Development Committee. One of the functions of this group is to travel throughout the District to discuss with resident engineers and maintenance foremen any problems, questions, or new practices these people have encountered. At its semi-monthly meetings the committee members discuss problems and new developments, and aid in the selection of the most important District problems to be submitted to the Advisory Committees for research. They publish a monthly "Research Notes" in which new ideas are presented, along with a digest of research reports which may be of interest to District people in solving their problems. It is felt that this committee has done a fine job in promoting research and the use of research findings at the local level.

UTILIZATION OF EXISTING RESEARCH RESULTS TO AVOID DUPLICATION OF EFFORT

A problem is selected for research on the basis that it has not been solved by previous research or that local

conditions require further investigation for existing research results to be applicable. It is just as wasteful to duplicate research as it is to conduct research without implementation of the results. To avoid duplication of effort, all existing research findings should be screened to ensure that any portion of the problem at hand has not previously been solved. The Research Section of the Highway Department attempts to make known all available research reports to any interested individual in the Department.

The Highway Research Information Service (HRIS) listing of national research reports is available in the Research Section so that anyone concerned with a particular study can search for related published reports on the subject. If they so desire, they can request from the Highway Research Board a computerized listing of all available research reports in a certain subject area with a summary of each report. As a supplement to this, a continuous Texas research project entitled "Library Research in Support of the Cooperative Research Program" is used to make available all known publications on any proposed research study subject. This listing is generally more inclusive than the HRIS listing because it includes many foreign as well as national research reports. Together the two sources provide excellent coverage for available research findings.

In addition, the Highway Department publishes on frequent occasions a Research Digest in three forms. One digest constitutes a listing of all out-of-State research reports on file in the Research Section, and is distributed throughout the Department to Divisions, Districts, Residencies, etc. A second digest is composed of abstracts of the latest reports on Texas research studies. This digest is published whenever a sufficient number of new reports are available for their abstracts to fill approximately seven pages, the purpose being to keep the size of the publication to reasonable proportions for quick reading by busy personnel. Also, a glossy summary of a few pages is often prepared for each report listed in the digest. This digest is distributed throughout the Department, and, by being current, allows people concerned to review and evaluate the applicability of the latest research findings without having to wait for the final report to be published. A third digest contains a complete listing of all research studies conducted to date under the Texas Cooperative Research Program and every report published under each study. This digest is published frequently and is distributed nationwide as well as statewide. The digests allow any interested person within the Department to readily obtain, by simply filling out an order blank, any research reports pertaining to a particular subject that are on file in the Highway

Department. Even if results cannot be utilized directly, application of the ideas, principles, factors, etc. of existing research results to a current study constitutes, in a sense, implementation.

To determine to what extent people are using these digests, the Research Section assembles a Research Digest Request Analysis once a year. Requests by Departmental personnel for out-of-State research reports according to broad subject matter groupings is the basis for the analysis. From this analysis the Research Section can get an idea of what problems the operating people are having by what subject matter is requested most often, which, in turn, may indicate areas in which further research is needed. Figures show that 19 Research Digests were published for out-of-State reports in 1970, and the number of requests for reports within the digests was 1,083. If nothing else, these figures indicate an interest by Departmental personnel in implementing out-of-State research findings to solve their problems and, if at all possible, eliminate duplication of effort in this respect.

The Texas Highway Department automatically sends copies of its research reports to each of the other states. However, all the other states have not been as cooperative, and most send their reports to Texas only on request. Even when requested, it is sometimes difficult to obtain a particular

report from another highway department. It is discouraging to the Engineer of Research to discover an out-of-State report that he feels would be helpful to a particular study and then either be unable to obtain this report at all or have to wait a long period of time to receive it. It appears that there would be much more widespread implementation of research findings if there was better cooperation and coordination among highway departments. The case sometimes occurs where someone in the Department is aware of a research project being conducted in another state and is anticipating usage of the results. But, due to the time lag between completing the research and publishing the approved final report, the interested person may lose sight of the new knowledge and proceed without it. Perhaps with a little more interstate coordination, interested parties could obtain copies of the draft report of the particular project of interest. If this were done, implementation of the results could occur much more rapidly and to a greater extent.

Results of out-of-State research studies are often not implementable in Texas because the problems researched are not always applicable to the Highway Department's needs.

IMPORTANCE OF SURVEILLANCE AND COMMUNICATION DURING PROGRESS OF RESEARCH STUDIES

For usable results of research to be implemented as soon as possible after they become available, the potential user

must be convinced of the merit and applicability of the results. To accomplish this end it is essential that the researchers and the operating field people establish lines of communication and understanding during the performance of research studies. There must be efficient coordination between the researcher, Austin Office Divisions, and the Districts as a project progresses so that all concerned will be better prepared to assess the implementation potential of the findings.

A Study Contact Individual from an appropriate Austin Division is assigned to every research project for the purpose of keeping close surveillance over the work regarding its progress and direction. He is responsible for directing the study in such a manner that the results will be meaningful and practical for usage by the Department. As a means of keeping appropriate officials informed, the contact representative is required to submit quarterly reports on his study which relate his evaluation as to whether the study is progressing according to the work plan and if any implementable results have been achieved.

Since a Contact Individual is the Highway Department's closest link with the researcher of a cooperative research project, it is his job to keep the potential users of the research (operating personnel in the Department) properly informed of the advancement and direction of the study as it is being conducted. By understanding the process through which a

solution was derived and the subsequent method of proof and verification of the solution, operating people will be more willing to accept and apply research findings. To accomplish this type of communication, some contact men call study meetings on frequent occasions and invite interested personnel from the Districts or Divisions, and also FHWA engineers, to attend and participate in an evaluation of the progress of the study. The study supervisor presents what he has done and what he plans to do to execute the study objective. Any guidance he may receive from the operating people in attendance should aid him in presenting the final results in a practical and usable manner. These meetings are rotated throughout the State in an attempt to provide access for all interested personnel who desire to attend. The idea of getting the users involved early in a study as a means toward facilitating implementation should not be underemphasized.

Certain studies have gone a step further in requiring involvement of the user by having field people actually participate in the performance of the study. A prime example of this is a project concerning the establishment and control of vegetation on highway right-of-way. Once the concepts had been developed they were applied in the Districts as test projects. District maintenance personnel actually performed the work under the supervision of the researcher. These experiments were run in

nearly every District because of varying soil conditions, etc. throughout the State. Conducting research in this manner practically ensures that the results will be implemented without effort because the user was directly involved in surveillance of the study.

The Area Advisory Committees are composed of highly qualified personnel from District and Austin Headquarters Divisions. The Area Coordinator maintains lines of communication with the Contact Individuals for the projects within his research area. When problems are encountered in a study, or when results of a project are available for implementation, the Area Coordinator, in conjunction with the committee chairman (usually a District Engineer), will call a meeting of the Advisory Committee to discuss these developments with the study supervisor. Since the potential users of research are members, the committees are well equipped to help solve any problems and to guide a study in the proper direction to produce usable results. If the group is convinced that certain findings are ready for implementation, they submit a report to the Engineer of Research with recommendations concerning the applicability of the findings.

This system is thus designed to eliminate the time lag between availability and implementation of results provided by research. Maintaining the interest of the potential user

through personal contact is an important duty of the Contact Individuals during the surveillance of their studies. If this is adequately accomplished, early implementation of the findings usually results.

EVALUATION OF RESEARCH IMPLEMENTATION

For the product of a highway research effort to be properly implemented it must provide an obvious benefit to the user. The immediate users, in most cases, are the people connected with the planning, design, construction, or maintenance of a highway system. The ultimate beneficiary of research is, of course, the traveling public.

Benefits accrued from research implementation may be in terms of cash savings. This may take the form of reduction in initial cost through an improved construction procedure, elimination of unnecessary expenditures, reduction in maintenance cost by use of an improved and more lasting product, or savings through decreased travel time for the motorist. Safety and convenience are other important benefits in preventing accidents and saving lives. Improving aesthetics and environmental features is yet another way in which research can improve our highways.

The researcher must realize the potential benefits and assess the application of the findings of his study, such as

changes in specifications, design procedures, standards, construction and maintenance practices, etc., when he formulates his work plan. To obtain the expected results in usable form and have immediate implementation requires a concerted and enthusiastic effort on the part of everyone involved in the research organization.

The Texas Highway Department has had considerable success with its research system in accomplishing early implementation of research results. Findings of several current studies have already been integrated into the production scheme of the Department. Preceding sections of this report have described the research procedures used in Texas, with main emphasis on achieving implementation. However, immediate implementation does not always occur, and it is true that some research results are never put to use. Obtaining widespread implementation is sometimes a long process. The problems and obstacles that often hinder implementation of research findings will now be discussed.

PROBLEMS ASSOCIATED WITH RESEARCH AGENCIES AND CONTACT INDIVIDUALS

Since the beginning of its Cooperative Research Program the Highway Department has dealt primarily with two university-oriented research agencies. Over the years these agencies have conducted some very productive research studies. Difficulties in communication and understanding concerning research projects

are lesser today than in the past but still do prevail to a limited extent. By not being involved in the day-to-day operations of the Highway Department, the research agencies do not always fully understand the problems incurred by operating personnel in the Department. Their position as non-profit organizations with no competition is not conducive to a complete understanding of the Department's needs. As a result, in the process of awarding contracts, researchers sometimes have the misconception that the research money is a grant, when, in reality, it is to be used to solve a particular problem.

At times the researcher has not been highway-oriented and had only passive interest in his project, resulting in a non-productive, wasted study. This deficiency has been virtually eliminated by having the researchers submit proposals for projects they wish to perform. Research projects concerning construction and maintenance practices are not usually conducted by university research agencies as they generally have limited experience and facilities for conducting research in these areas.

Even when useful findings are the result of a research project, the manner in which they are presented plays an important role in achieving implementation. Researchers that are highly educated university employees often tend to become

too involved in the technical aspect of a study, and their presentation of results is frequently in technical terminology. When operating field personnel are confronted with using these results their first response is to completely reject them. Therefore, to eliminate this problem, the researcher must be apprised of the need to present his findings with popular language to enable field personnel and busy executives to quickly comprehend the applicability of the results. As a further measure to make certain that the usefulness of his results are understood by all, the researcher should keep close ties to the project until implementation is actually accomplished.

The Study Contact Individual is responsible for keeping the thoughts and actions of the researcher oriented toward satisfying the Department's needs. His close surveillance of a study is essential to obtaining a practical solution and promoting early implementation. The success of a project is largely dependent upon how well he performs his duties. The difficulty involved in this respect is that being a contact representative is a secondary job, a supplement to the normal workload of the individual. Hence, these men sometimes cannot devote as much time to their projects as is needed for proper surveillance. When this occurs, adequate three-way communication between the researcher, contact man, and user is not maintained, and implementation becomes a greater selling process.

PROBLEMS WITH DECENTRALIZATION

Decentralization of production is the concept under which the Texas Highway Department operates in administering its highway system. Each of the State's 25 Districts operates rather independently, with many important decisions left to the District Engineers. Headquarters Divisions act as coordinators and offer guidance, but have no responsibility for action taken by the Districts. This decentralized nature creates a competitiveness among the Districts which results in a strong desire by each to create a better product. Though this concept works well in producing quality highways, it can be an obstacle to widespread research implementation. Operating personnel in the Districts cannot be forced to apply a new finding, only encouraged.

The four Area Advisory Committees were set up to bring the District people into the research organization structure. This type of involvement has helped further the interest in research by District personnel. However, due to the extremely busy schedules of the District Engineers, the committees' effectiveness is not always what it was designed to be. The frequency of meeting is down to once a year for some committees, and this meeting is primarily for the purpose of formulating problem priorities for the coming year's Cooperative Research Program. Thus, these committees are sometimes too distant

from the research work to be very effective in aiding implementation of the results.

With a centralized research program and a decentralized production scheme, research administration must be recognized as a science in itself. Communication between the researcher and user is the key to the success of such a research program. As previously mentioned, the Contact Individual is not always successful in maintaining this communication. A definite aid to this situation would be appointment of a full-time individual in each District who is solely responsible for dealing with research and implementation. He would be the District's link with the researcher and Contact Individual and would be able to assess the applicability of research results to satisfy the needs of his District. By having one responsible individual in each District to coordinate with the Austin Office on research matters, the decentralization "gap" would partially be closed. At present, one District has made an attempt to have a man responsible for research, but the laboratory engineer is the principal research contact in most Districts. The District Research and Development Committee in Houston has done much to promote implementation at the local level, but has no formal procedure in coordinating with the Engineer of Research in Austin. Although operating people in the Districts seem to be receptive toward research, personnel

shortages are apparently prohibiting the assignment of a full-time research individual.

In line with communication, perhaps more research should be conducted within the Department to enact greater involvement with the Districts. These studies eliminate the third "party" (i.e., research agency), and keep lines of communication among Departmental personnel only. There may even be a trend in some Districts to request funds for research. Some are now performing small research studies with their own money, but most Districts don't have enough manpower or time to conduct their own research. Providing funds for District research projects would be beneficial in solving small organizational problems within the Districts that were ranked low on the state-wide research priorities list, and would show District Engineers that Austin officials are concerned with their particular problems.

IMPLEMENTATION AS A SELLING PROCESS

When they are not involved in the direction of a research study, practicing engineers are sometimes suspicious of the findings and are hesitant to take the lead in implementing them. They would prefer to "see how well it works for the other guy," and then take appropriate action. If the research findings are proven to be of benefit when applied in one

District, other Districts that were hesitant at first don't want to be last in utilizing these findings either, due to the competitive aspect of decentralization. The initial reluctance to change is gradually faded out as the research results tend to "grow" in popularity.

A selling process is also required when a project produces seemingly valid ideas, but documentation and evaluation of these ideas have not been pursued thoroughly enough to convince the users of their applicability. Results of this nature present a problem in that they cannot be implemented immediately. For example, a certain project produced a new design for structural footings, but did not test the design adequately enough to be utilized under various conditions throughout the State. The same is true with a project that resulted in ideas concerning the amount of air to entrain in concrete. In this case, not enough materials were examined to apply the concept statewide. Thus, if widespread acceptance of a research finding is to be obtained, the solution must be verified by testing it under various conditions that exist in different parts of the State. This can be more easily accomplished during the progress of a study by getting the user involved to help direct the study.

OBTAINING THE TOTAL SOLUTION

Research sometimes furnishes a solution where there is no problem, in which case little benefit is provided to the intended user. This is the case when a computer program is produced as a faster way to do the calculations, when, in reality, what the user needs is a better theory. Also, it sometimes occurs that research results cannot be applied by the user because they're not in the same units, so to speak. For example, if research conceives a new and better way to calculate stress in a pavement, this is virtually unusable by field personnel who are concerned with how to determine pavement performance. Although these findings cannot be implemented directly, they do advance knowledge in the subject area. If these types of research solutions are to be of potential benefit to the user they must form a significant part of an overall objective. There are many different problems being tackled by research, but there is too much work done on one little block of a problem. To achieve implementation, the pieces must be tied together to solve the user's problem. A way to overcome this fragmentation of effort is being attempted in two current Texas research studies. One is designed to incorporate several pavement design developments into an operational pavement design procedure. The other is attempting to interrelate all the factors affecting vehicle skids toward

the common goal of preventing skidding accidents. Another procedure that enables a broader look at an overall problem is the pooling of research money and effort in multi-state studies. The multi-state approach also permits more widespread implementation of findings. At present, the Texas Highway Department is involved jointly with other states in two research studies, one on the breakaway sign concept for overhead sign structures and the other concerning driver communications. Regardless of the manner in which it is accomplished, the subsystems must be tied together to yield a workable system.

OTHER IMPLEMENTATION PROBLEMS

There are other reasons for not utilizing the findings of research. In some cases, research results require special equipment to implement them. This is true more often in out-of-state studies than Texas studies. The Districts seldom have this equipment on hand, and have no funds set up for its purchase. Research which determines that a certain idea is not valid, a particular method cannot be used, etc. has provided pertinent information only. Eliminating from consideration something that has proven undesirable is called "negative implementation" by some. Another possible hindrance to implementation occurs when research produces a maximum or

minimum value to be used. An example would be the setting of a minimum friction value for construction of pavements. Litigation is a factor considered by the Districts when encouraged to use this value. They become concerned with the liability for skidding accidents that could occur on a pavement with an above-minimum friction value. In addition to these mentioned, there are many other possible circumstances that sometimes retard or prevent implementation of research findings.

AIDS TO IMPLEMENTATION

Teamwork and coordination are basic to research implementation. To enact a specification change, as an illustration, requires a high degree of coordination among Austin Divisions. The specification committee is composed of chiefs of several Divisions. To incorporate a change due to the results of research, all committee members must be convinced that the change is worthwhile. Even if a change is put into the specifications, the Districts can only be encouraged, not required, to use it because special provisions can be written to bypass a specification. It is obvious, then, that communication among all concerned is essential to achieving research implementation.

Several methods are available to promote changes and encourage the Districts to use them. Since performance data is highly important when selling a new product, there must be

an effective way to prove results to the user. Demonstration projects to show how the proposed change will affect performance are very beneficial. Personnel from Austin Divisions travel to the Districts to promote usable research findings and assist in these demonstrations. This personal contact cannot be underestimated in its value toward facilitating implementation. To explain a new method or design, workshops have proven to be very useful. At these sessions the users can clear up any misunderstanding they may have had concerning the new development, and thus be more able to assess its applicability.

Presentation of results in any concise, non-technical manner to generate interest is a real aid in promoting implementation. Interim reports with a brief abstract, summary, and implementation statement have helped achieve early implementation of findings before completion of the project. Attachment of a short, glossy summary with the main report has also accomplished this purpose. Movies are a good selling tool for certain studies. Although these are not practical in many cases, research on breakaway signs and impact attenuators, for example, can vividly be displayed in a movie.

As a means of familiarizing as many personnel as possible with the achievements of research, Texas conducts an annual "Highway Short Course." The course is attended by engineers

and technicians from throughout the Department, as well as from the Federal Government and private industry. During the three-day meeting, researchers give presentations on the progress and findings of their particular studies, and relate what results are ready to be implemented. Articles on new findings are also published in Texas Highways, a magazine distributed to all employees of the Department.

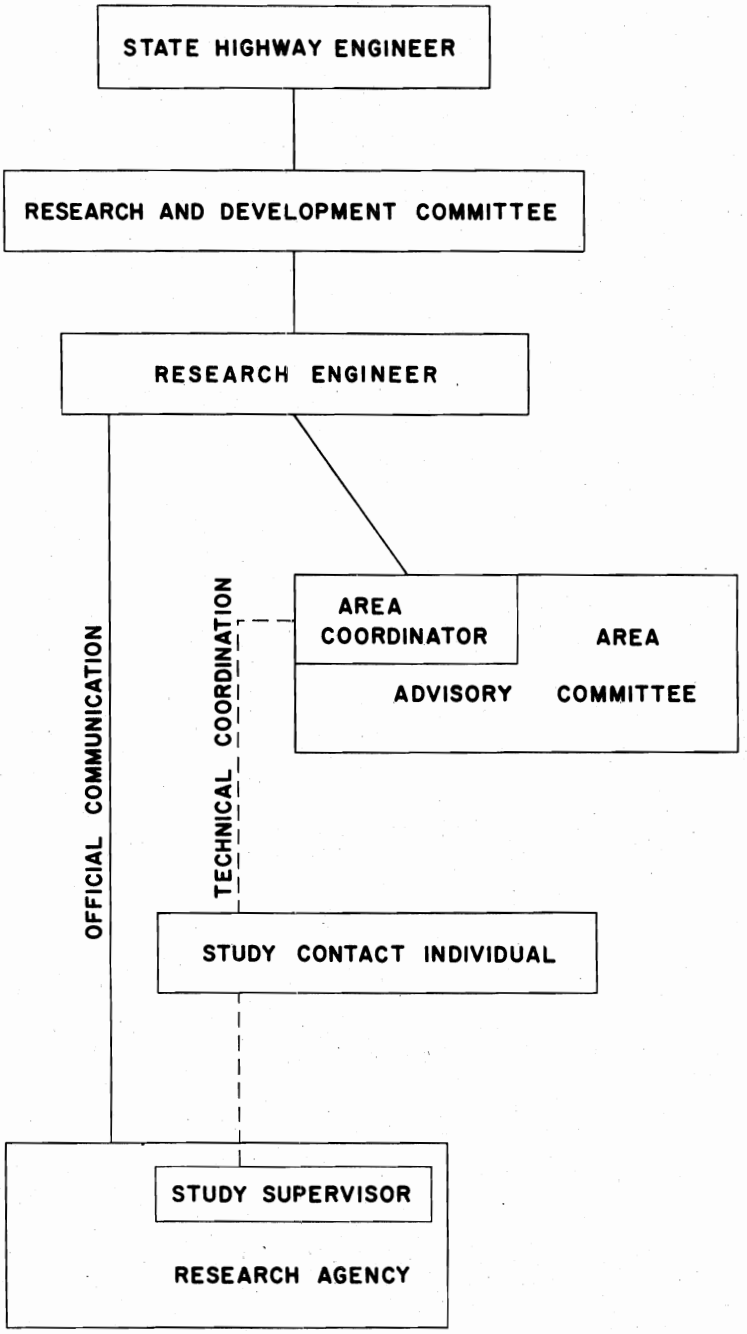
CONCLUSION

The problems often associated with research implementation are generally recognized by research personnel in the Highway Department, but exact solutions to these problems are not always obvious. Analyzing the causes of the problems is often a difficult process because many causes may be compound. When research results are not immediately implemented, it is difficult to ascertain whether this is due to fallacies in the structure of the research system, a letdown on the part of personnel involved, or a combination of these and other factors.

There seems to be a great deal of enthusiasm on the part of Departmental personnel toward their research program. Many of the problems and possible solutions described in this report were, in fact, offered in discussions with these people. This awareness of the problems involved, coupled with an enthusiastic

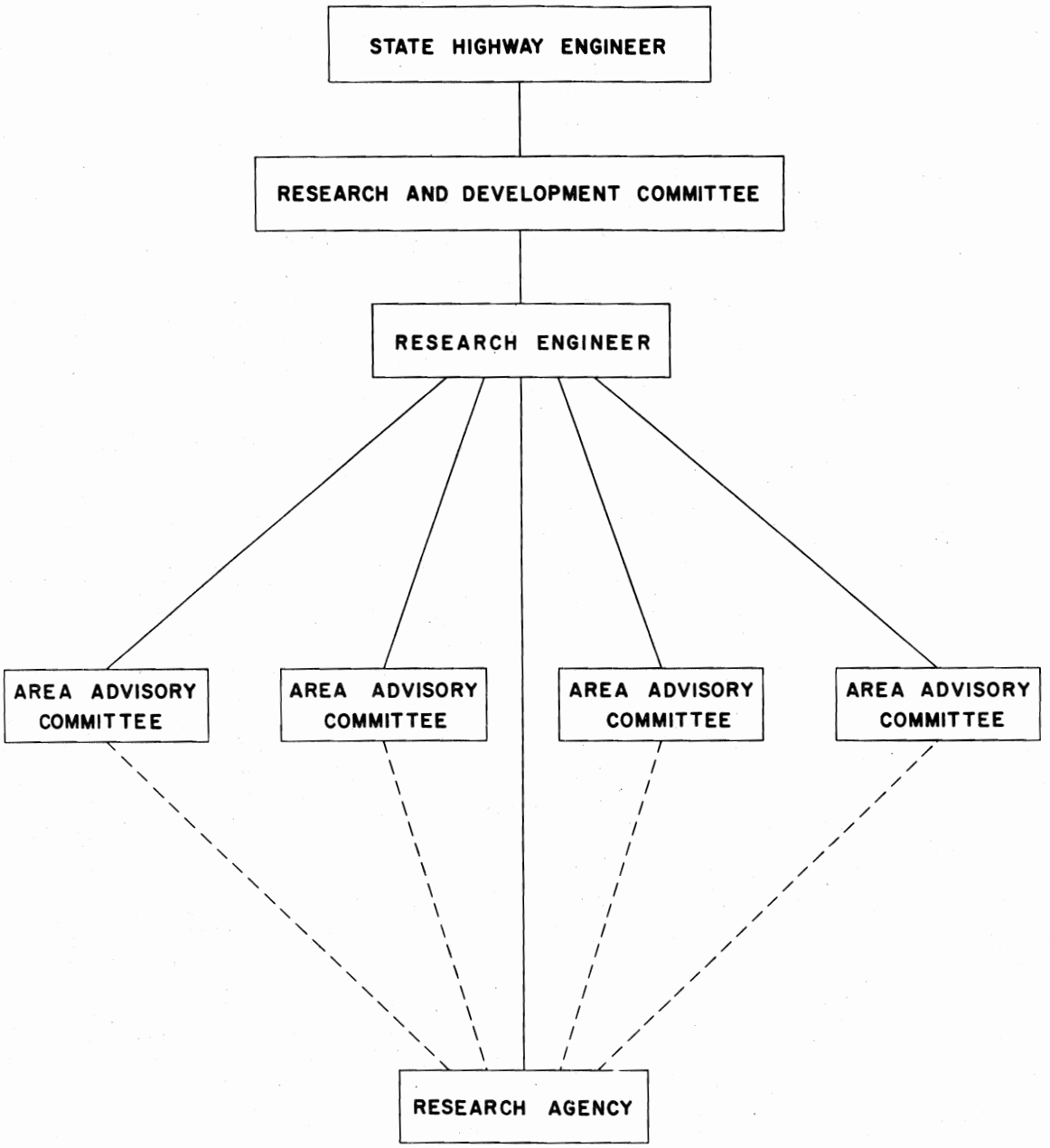
effort to overcome them, is the key to the continued success of the research program in Texas.

APPENDIX



ORGANIZATION AND FLOW CHART

Figure No. 1

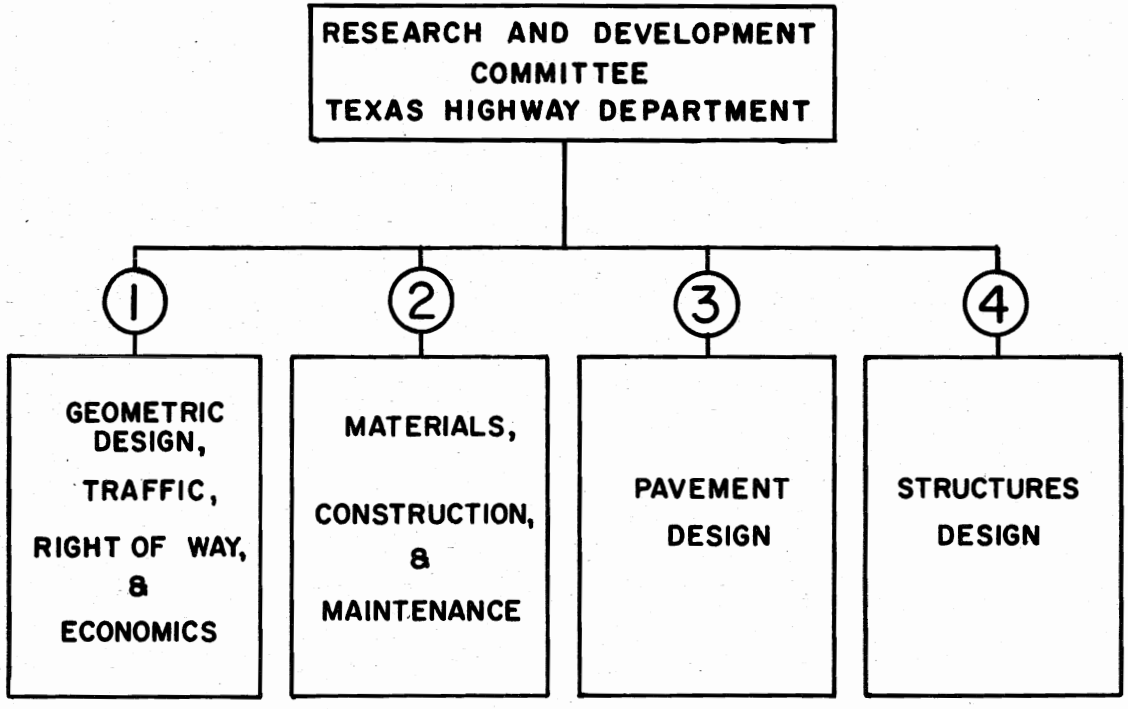


ORGANIZATION AND FLOW CHART

FOR

COOPERATIVE RESEARCH PROGRAM

Figure No. 2



AREAS OF RESEARCH

FIGURE NO. 3