HIGHWAY RESEARCH BOARD

Special Report 15

Highway Research Organizations

Description of Existing Organizational Patterns and Scope of Activities

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M. Earl Campbell, Engineer of
Economics, Finance, and Administration
Highway Research Board

1953
Washington, D. C.

Foreword

RESEARCH has been defined as: "Studious inquiry or examination; specifically and usually, critical and exhaustive investigation or experimentation having for its aim the discovery of new facts and their correct interpretation, the revision of accepted conclusions, theories, or laws, in the light of newly discovered facts, or the practical applications of such new or revised conclusions." Webster's New International Dictionary, Second Edition, Unabridged.

The questions of how to promote, organize, and plan highway research and to effectively utilize the results have been addressed to the Highway Research Board with increasing frequency since the inauguration of the Highway Research Correlation Service. The insistence with which these questions were asked prompted a nationwide survey among state highway departments and universities to determine the forms of administrative structures and functions for highway research.

Nearly a hundred engineers and educators representing both administrative and research branches have been interviewed and have given of their thoughts and experiences relating to forms of organization and the techniques for planning and operating research projects and to the utilization of research findings in highway operations.

Researchers have expressed the belief that form of organization and techniques of planning exert tremendous influence on productiveness, and administrators, likewise convinced of this, are asking for suggestions in order that highway research administration might be conducted with greater wisdom and skill.

This report reviews and discusses the information supplied by the several state highway departments and colleges and universities. It is presented with the hope that it will supply a need hitherto unsupplied; that is, the presentation of many answers which were born out of necessity, and tempered by environment, experience, and tradition. As a sequel to this presentation, it is earnestly hoped that the right answer will spring from the genius of a stimulated mind.

ACKNOWLEDGMENT

Acknowledgment is gratefully made to N. W. Dougherty, dean of engineering, and to J. C. Bridger and his associates in the Department of Civil Engineering and in the Engineering Experiment Station, University of Tennessee, for making available the material they had gathered on highway research in universities and colleges.

Appreciation is also expressed to all who furnished information during the canvass of state highway departments, universities, and colleges. Special gratitude is acknowledged for copies of legislation, agreements, and literature relating to the research function furnished by several states.

The assistance of the other staff engineers of the Research Correlation Service of the Highway Research Board in preparing this report is also acknowledged with sincere appreciation.

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Highway Research Organizations

DESCRIPTION OF EXISTING ORGANIZATIONAL PATTERNS AND SCOPE OF ACTIVITIES

M. EARL CAMPBELL, Engineer of Economics, Finance and Administration
Highway Research Board

● IN response to requests from highway engineers the Highway Research Board undertook (in 1952) a four-phase study of current highway research administration to determine: (1) the various patterns of research organizations; (2) the advantages and disadvantages of each pattern; (3) existing procedures for planning and operation of research projects; and (4) means of utilizing research findings.

As a basis for personal interviews in the states by the Research Correlation Service engineers, a questionnaire designed to obtain information for analysis in each of these four phases of the study was prepared. After the nation-wide canvass among state highway departments began, a better appreciation was gained of the many ramifications of highway research organizations. A survey similar in purpose was being made at about the same time among universities and colleges by J. C. Bridger and his associates in the Department of Civil Engineering at the University of Tennessee. Bridger was called back to active duty in the Navy before he had completed summarizing the information received from the universities and colleges. N. W. Dougherty, dean of the College of Engineering, made the information available to the Highway Research Board for incorporation in this report.

The highway department summary includes information from 48 states, the District of Columbia, the Territory of Hawaii, and the Commonwealth of Puerto Rico. The university-and-college summary includes information from 66 institutions.

This summary of highway research by state highway departments discloses five broad organizational patterns, each having various deviations and combinations in function and structure: (1) noncentralized research, (2) formal research, (3) centrally coordinated research, (4) joint research, and (5) contracted research.

In addition to these five patterns, this report discusses, under "College and University Research," highway research as conducted by engineering experiment stations. Also included is a discussion of highway research in "Regional and National Cooperative Research" showing the patterns of organization developing in these broader areas.

NONCENTRALIZED RESEARCH

Noncentralized research is that research undertaken by various units of the highway department without special organizational framework. This is the traditional type in both state highway departments and universities. The individual operating function (division, bureau, or district) initiates the project of research or investigation, securing approval and authorization of funds as necessary. Active direction of the project often resides with the initiator. The type of organizational framework employed is in no way indicative of the magnitude or importance of the work undertaken.

Often the cost of a research project is so small that a formal authorization of funds is not required. The research, in some cases, is "just a part of getting the job done," and it may be a local investigation not officially considered as research. Such investigations are expedient and usually are practical; in other words, they consist of applied or developmental research rather than basic research.[1] If this

[1]Applied research: "Applied research (also called 'service,' 'expedient,' 'programmatic,' or 'practical') is a technical undertaking aimed at solving problems of practical significance in which the scope and extent of the work are determined by the degree of likelihood that it will lead to practical rewards." Applied Research in the United States, 1952, National Academy of Sciences, National Research Council, Washington 25, D.C.

"Applied research is a search for new knowledge di-

research results in useable information it may be put to immediate use within the operating division responsible for the research. If the results are negative, perhaps only a few will ever hear of the investigations undertaken.

This research, being of a spontaneous character, may also be sporadic due to lack of communications, time and resources.

Thirty state highway departments[2] are classified as conducting noncentralized research to a varying degree. Of these states, two reported no money spent for research during 1951; one reported approximately $70,000, while the total for all 30 states was estimated to be approximately $700,000, with about $400,000 spent for physical research and $300,000 spent for planning research. The total expenditures of these states during 1951 for construction and maintenance was approximately 818 million dollars. Thus, less than 0.1 percent of this amount was spent for research.

Advantages and Disadvantages

Discussions with researchers brought out the following probable advantages and disadvantages of noncentralized research: Advantages - (1) flexibility, (2) rapid initiation and accomplishment, (3) adaptable to spontaneous problems, (4) reaches out to anyone with an idea, (5) can use research project to take up slack time. Disadvantages - (1) no comprehensive research needs program, (2) may lack thorough planning, including search of records and library for previous similar studies, (3) may lack continuity, of sporadic character, (4) may lack proper laboratory facilities, (5) possibility of incomplete recording and reporting of projects undertaken, (6) probably lack of dissemination of findings.

Since this research may be diffused throughout the organization as allowance is made for creative ability anywhere in the organization and since there is no special line of authority or assigned responsibility, it is not possible to draw a realistic chart of the structural arrangements. Each division, or district, is autonomous; in other words, "sufficient unto itself." Thus the staff and personnel of one division may be unaware of or inadequately informed of the work of other divisions.

CENTRALLY COORDINATED RESEARCH

In centrally coordinated research, the various units of the highway department conduct research which is programmed and assigned by the executive branch of the highway department and coordinated by a research director. Central coordination provides a means of assessing the relative need of each proposed project and for including the most-needful projects to obtain a balanced, continuing program. It also allows scheduling of the individual projects to take advantage of the researchers and facilities. In practice, some of the small-sized investigations and developments are done independently, although all of the larger projects requiring authorization of funds are made a part of the planned program. This type of operation does not preclude contracted research with other research agencies.

Four state highway departments[3] now operate with this type of research organization, and a fifth state is at the point of formulating this type. Some of the significant factors in this type of research organization are presented. These are drawn from the studies and directives leading to creation of this type of organization.

Ohio

The Ohio State Department of Highways, by journal entry of June 17, 1946, outlines

rectly applicable to a specific problem and the application of all existing knowledge to the practical solution of the problem." S.C. Ogburn, Jr., Op. Cit.

Development research: Development research may be considered as a subdivision of Applied Research. "Development Research includes such items as design, engineering and production of prototype models." The First Annual Report of the National Science Foundation, 1950-51. It also includes the modifications bringing evolution of processes and procedures used in operations.

Basic research: "Basic research (also called 'fundamental,' 'pure,' 'uncommitted,' or 'exploratory') has to do primarily with the discovery of new facts about nature and with finding, testing, and developing general principles." The First Annual Report of the National Science Foundation, 1950-51, U.S. Government Printing Office, Wash., D.C.

"Fundamental research is a search for new knowledge... without reference to specific application." S.C. Ogburn, Jr., in an article titled "Research Management" published in Industrial Laboratories, September, 1951.

[2]Alabama, Arizona, Arkansas, Connecticut, Delaware, Georgia, Idaho, Louisiana, Maine, Massachusetts, Mississippi, Montana, Nevada, New Mexico, New York, North Dakota, Oklahoma, Oregon, Rhode Island, South Carolina, South Dakota, Texas, Utah, Vermont, Washington, West Virginia, Wyoming, Hawaii, District of Columbia, Puerto Rico.

[3]Ohio, Colorado, Iowa, Kansas, now operate centrally coordinated research programs. Maryland is formulating this type of program.

the functions and structure of its research organization as follows:

For the purpose of stimulating and correlating research leading to improvement in Highway facilities and Highway transportation, I, Perry T. Ford, Director of Highways, do hereby establish the Highway Research Board of the Ohio Department of Highways and the position of Highway Department Research Engineer.

The constitution, duties, and operation of the Research Board and the duties of the Research Engineer shall be as follows:

A. The Board will consist of the Chief Engineer of the Department and one representative each of the following functions: Bridges and Railroad Crossings, Construction, Maintenance and Repair, Location and Design, Testing and Research, and Traffic and Safety.

B. It will be the purpose of the Board to direct the activities of the Research Engineer.

C. The Highway Department Research Engineer will operate under the direction of the Highway Research Board. For purposes of administration, the Research Engineer will be responsible to the Chief Engineer of the Department.

D. The office of the Research Engineer shall consist of the following personnel: Research Engineer, one Engineer as Assistant, one report writer, and a stenographer.

E. The duties of the Research Engineer will be to organize and carry out such research assignments as may be directed by the Ohio Highway Research Board which shall include:

1. Preparation of bibliographies and reviews of the research activities of other agencies carrying on research and investigations pertaining to highway activities, and dissemination of this information within the Highway Department.

2. Compilation of reports covering the research activities within the Highway Department and dissemination of these reports to interested parties.

3. Preparation of for approval of the Board revisions of the specifications based on research and recommendations of the operating functions.

F. The necessary research approved by the Board will be carried on by the various operating functions of the Department.

The Research Engineer will cooperate with the operating functions of the Department in carrying out the research projects approved by the Board.

Essentially, the research engineer is a staff engineer responsible to the chief engineer of the highway department and operating under the direction of a research board. It is worthy of note that a means of adapting research findings is provided in that the research engineer is to prepare revisions of the specifications based on recommendations growing out of the research of the operating functions.

Colorado

A variant of this type of organization is found in the Colorado State Highway Department. A planning and research division was created and made responsible for the broad highway program and for the research program (both economic and physical). The division as constituted was to have three sections: (1) planning section to conduct economic and traffic research, (2) physical-research section to conduct researches in materials, soils and related processes, and (3) analytical section to make use of the information developed in the other two sections in its broad planning function.

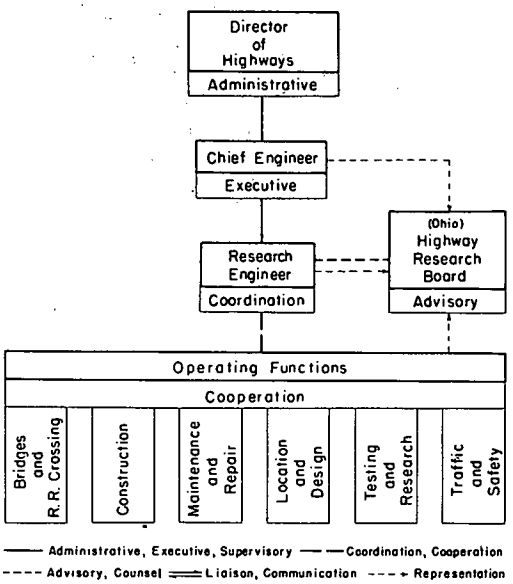


Figure 1. Ohio type of centrally coordinated research.

The materials division contributes its facilities, at present, for physical research. The other departments contribute their facilities and help as their participation is required.

The planning and research division publishes technical reports, incorporating results of research, construction specifications and disseminates within the highway department relevant research reports from other agencies.

A research board is composed of the assistant state highway engineer and headquarters staff engineers and faculty members of state engineering colleges. The

functions of the board are to: (1) counsel and advise with the research engineer, (2) plan the research program, and (3) act as steering committee.

The state highway department may also utilize the research engineer to coordinate highway research programs contracted to state institutions.

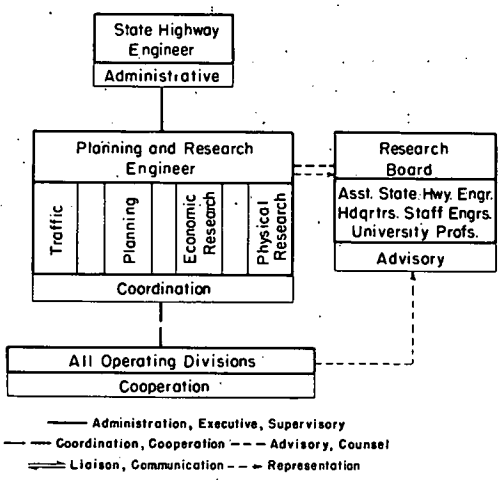


Figure 2. Colorado type of centrally coordinated research.

In analyzing the functions of the research division, it is found that specific provision is made for the central coordination of both economic and physical research, thus supplying a mechanism for the programming of problems where there is an interrelation of economic and physical considerations involving interdepartmental cooperation.

As in Ohio, the Colorado setup provides that a research board program the projects and act as steering committee. A research clearinghouse is also provided.

In the Colorado procedural manual for the implementation of planning and research appears the following specifications for the Planning and Research Division:

a. To make assignments to other operating divisions for research tasks. Such assignments to be made by agreement through the Assistant State Highway Engineer or other responsible head.

b. To report to the State Highway Engineer the progress and/or results of research investigations and to include therein recommendations for use.

c. To form a research board composed of the Assistant Highway Engineer and his staff. Such board to include Engineering Faculty Members of State Institutions when possible.

These suggestions were carried out in 1948, and the Planning and Research Division has continued to operate as set up at that time, coordinating and assigning researches among all of the operating divisions. In 1952 the Traffic Division was added to the Planning and Research Division.

Iowa

Another variant of the centrally coordinated type is found in Iowa where intergovermental coordination in highway research is provided as set forth in Memorandum of Instruction No. 148, Relative to Highway Research, issued by F. R. White, chief engineer of the Iowa State Highway Commission, and dated December 20, 1949, creating the research organization. This organization was established to serve both the interests of the state's highway department and the county highway departments in "developing an orderly, efficient, coordinated highway research program."

This memorandum creates a highway research board of eleven members—six

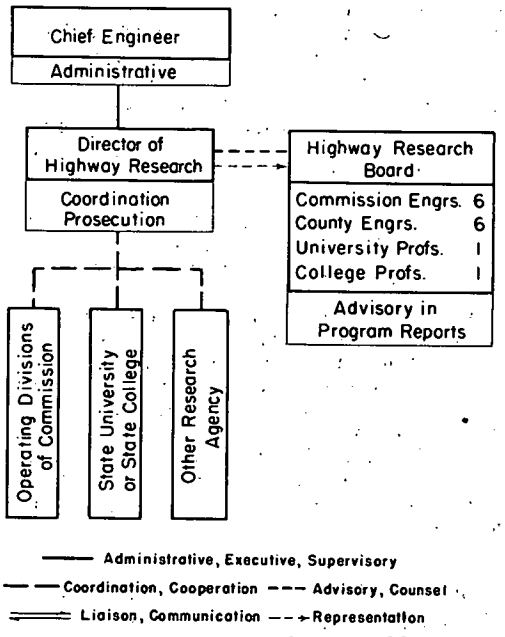


Figure 3. Iowa type of centrally coordinated research.

county engineers, three highway commission engineers, and one representative each from the state university and state college. The duties of the board are to (1) prepare a highway research program; (2) recom-

mend the program to the state highway commission; (3) recommend an appropriate agency to conduct each project (commission, university, college, or other agency); (4) follow through on each active project to its completion; (5) review and act on all research reports; (6) disseminate information; and (7) report annually.

The memorandum also provides for the designation of a commission engineer as director of highway research who shall serve as secretary and executive officer of the board. His duties shall be to (1) keep minutes and records of the board; (2) supervise and prosecute the authorized program; (3) convey to the chief engineer the recommendations of the board relative to projects proposed for the research program; and (4) formulate and negotiate agreements with other agencies for executing research projects.

In order to finance the secondary road research program the Iowa legislature authorized the highway commission to use not more than 1½ percent of the farm-to-market-road fund for secondary road research.[4] It is estimated that a pooling of the funds available for research from all sources would provide approximately $500,000 annually for research by the board.

An examination of the provisions in the memorandum discloses that the Iowa Highway Research Board has initial responsibility for the program, that the director is a staff engineer responsible to the chief engineer, and he is to coordinate, supervise and prosecute the total program, whether physical or planning research, whether of state or county interest, and whether performed by the operating division of the commission or contracted to outside research agencies.

Kansas

The Kansas State Highway Commission initiated a centrally coordinated research program in 1953. A Commission Resolution dated June 10, 1953, provided for certain administrative changes and establishing a section consisting of the Highway Planning Division and the Research Division, the heads of these respective divisions reporting to the state highway engineer. The program will include nonphysical research as well as physical research.

[4] Chapter 128, Laws of the 53rd General Assembly, State of Iowa (1949).

The director of research is to serve as coordinator of all research activities, whether by the several divisions of the highway commission or by the state university or state college.

A research board consists of section heads, division engineers and representatives from state engineering colleges. The state highway engineer serves as chairman of the board, and the director of research serves as secretary. The purpose of the board is to: (1) be responsible for instigating projects; (2) approve projects for

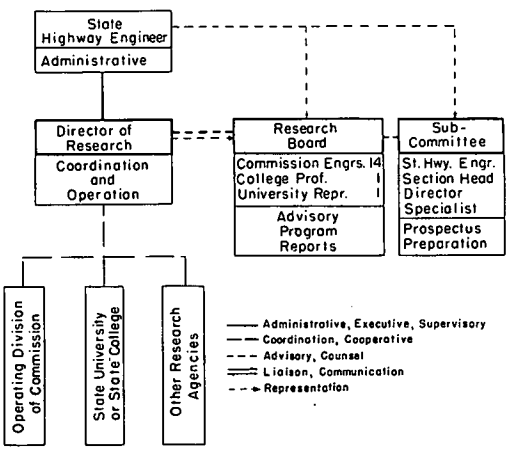


Figure 4. Kansas type of centrally coordinated research.

operation; (3) assign projects to appropriate division or engineering college; (4) review reports (both progress and final); and (5) suggest means of utilizing findings.

The board will meet quarterly.

Projects may be suggested by anyone in the organization. Suggestions to follow usual channels of comminications to the director of research. Upon receipt of a suggestion the director is to appoint a subcommittee to consider its merits and to formulate a project statement for review by the research board. The subcommittee is authorized to call on professional help, industry consultants, or other special assistance in formulating their prospectus for the board. The subcommittee is to consist of: (1) director of research, (2) pertinent section head, (3) state highway engineer, and (4) fourth man, selected by the first three, for his knowledge of subject.

The director of research will furnish the services of the several specialists on his

staff (1) in assembling back-ground material, (2) setting up projects, (3) in observing performance, (4) in keeping records, (5) in analyzing field and laboratory data, and (6) in writing reports. He may operate certain laboratory projects, but this operation will be limited in consequence of his small staff.

A continuing operation of the director of research will be that of issuing informational bulletins, or news letters, and to disseminate literature of relevant interest to each division head, and to call to the attention of individuals in the highway department articles and reports which might be of value to them.

Maryland

In Maryland another variant of this type of organization has been proposed. At present research is conducted through cooperative arrangements, one with the Johns

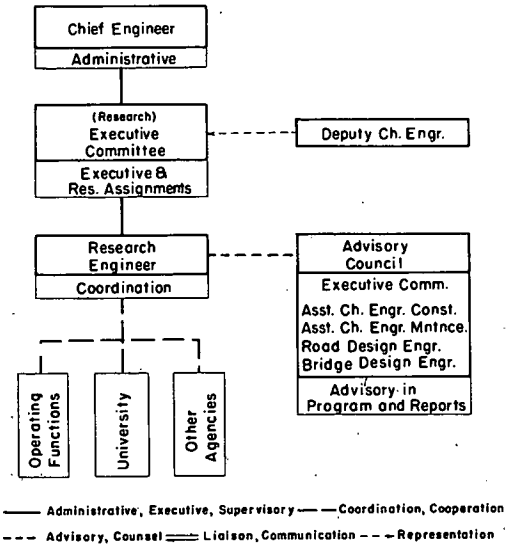


Figure 5. Proposed Maryland type of centrally coordinated research.

Hopkins University, and one by and between the Maryland State Roads Commission, Baltimore County, Baltimore City and Johns Hopkins University. However, a critical study of current forms of research organizations has been made for the purpose of providing perspective in drawing up a research organization plan, and a report submitted to the chief engineer concluding with the following "suggested form of Minute Order for Commission Approval". [5]

Whereas unsolved highway problems are just as numerous, just as baffling, just as pressing and just as frought with vast economic and social possibilities as are private industrial problems, and

Whereas the highway industry can no more survive on an economic, efficient, and intelligent basis without research than can private industry, and

Whereas improvement in highway facilities and highway transportation is in need of stimulating and correlating research, and

Whereas fundamental and applied research contributes knowledge and information for the efficient expenditure of highway funds, and

Whereas coordination between the state agencies brings forth greater savings, increased benefits and better service to the taxpayers,

Be it therefore resolved that this Commission does hereby establish a Highway Research Department of the Maryland State Roads Commission, and the position of Highway Research Engineer.

The constitution, duties, and operation of the Highway Research Department and the duties of the Highway Research Engineer shall be as follows:

1. An Executive Committee consisting of the Chief Engineer of the State Roads Commission, as Chairman of the Committee, the Highway Research Engineer, as Secretary, and the Deputy Chief Engineer of the Commission as a Member.

2. An Advisory Council consisting of the Assistant Chief Engineers of Construction and Maintenance, the Engineers of Road and Bridge Design, the Director of the Planning Division and the Materials Engineer.

3. The Executive Committee will be responsible for calling meetings of the Advisory Council, at which meetings the Committee and the Council will operate as one organization, with the Chief Engineer as presiding officer and the Highway Research Engineer as Secretary.

4. The Highway Research Engineer will work under the direction of the Executive Committee and for the purposes of administration will be responsible to the Chief Engineer.

5. The office of the Highway Research Engineer shall consist of the following personnel: Highway Research Engineer, Assistant Highway Research Engineer, and Engineer Aide, and a Stenographer.

6. The duties of the Highway Research Engineer will be to organize and carry out such research assignments as may be directed by the Chief Engineer as Chairman of the combined Executive Committee and Advisory Council which shall include:

a. Preparation of bibliographies and reviews of the research activities of other agencies carrying on research and investigations pertaining to highway activities, and dissemination of this information within the Highway Department.

b. Compilation of reports covering the research activities within the Highway Department and dissemination of these reports to interested parties.

c. Preparation of for approval of the Council revisions of the specifications based on research and recommendations of the operating departments and divisions.

7. The Executive Committee is hereby given the responsibility for determining whether research projects are to be prosecuted by the university, by university-sponsored agencies, by other governmental agencies, by private agencies, by the various

[5] From report of E. L. Worthington, Research Engineer, to W. F. Childs, Jr., Chief Engineer, Maryland State Roads Commission, 1952.

department or division of the State Roads Commission or by any combinations of the foregoing on a cooperative or individual bases.

8. The necessary research approved by the combined Executive Committee and Advisory Council will be carried on as directed by the Executive Committee.

An examination of these functions discloses their similarity to the functions of the research divisions in Ohio and Colorado. In its structural form it adds a provision for counsel in programming and in adaption of finding yet retains an executive committee to administer the program generally.

Under this proposed system the research engineer would be a staff engineer responsible for all-inclusive coordination of the research function, whether physical or planning research, and whether performed by the operating divisions or contracted to outside research agencies.

Figures 1, 2, 3, 4, and 5 illustrate the existing and proposed orgainzations used in centrally coordinated research.

Discussions relating to the probable advantages and disadvantages of the centrally coordinated research brought out the following:

Advantages of Centrally Coordinated Research

1. It retains advantages of departmental operations, in sustaining aninterest in research throughout the organization.

2. It takes advantage of opportunities for simple researches in any unit of highway department organization.

3. No elaborate research organization is required since the principal work of the research engineer is that of coordination. planning, and providing a clearinghouse and does not necessarily entail research operations.

4. The chief administrator and the heads of all operating divisions are close to all research activities and therefore are kept aware of requirements for changes in specifications and standards.

5. The advantages of noncentralized type of research are enhanced by coordination.

6. A mechanism is provided for formulating a program of all needed research, including physical or planning research and including both physical and planning aspects and for assigning projects to appropriate research units, either outside or inside of the state highway departments.

7. Research may be scheduled to use slack time of engineers engaged in operations.

8. A central clearinghouse is provided for records and reports of research done by and for the highway department and for dissemination of research reports and publications of the highway department or other research agencies to the several operating divisions.

9. An organization is provided to encourage and stimulate research.

Disadvantages of Centrally Coordinated Research

1. Responsibility for the research program and supervisory authority over operations is not always equal.

2. Research conducted in spare time by the operating divisions may result in discontinuity of effort.

Estimates of expenditures for research for these five states was not complete, but after consulting with the research engineers in these organizations, it was estimated that $450,000 would be a reasonable figure for 1951, with about two thirds for physical research. Some $178 million was spent for construction and maintenance by these five state highway departments in 1951. Thus, about ¼ percent of this total was spent for research.

FORMAL RESEARCH

This discussion deals with research by these formal, self-contained, centrally operated units officially designated or recognized as research units (or divisions) in the state highway departments. This type of unit is sometimes responsible for the whole program but may assign parts of it to outside agencies. It has its own director and conducts its own operations, performing research and investigations for other operating divisions as occasion may require. This type of unit is distinguished from the joint research projects by pattern of top management, although each operates formally, with its own staff and facilities.

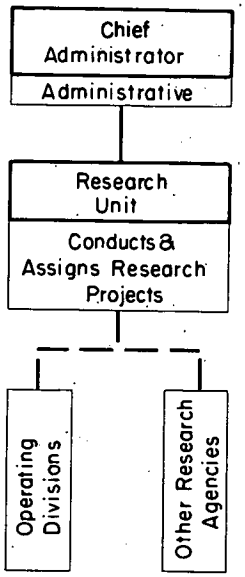
Formal research organizations in the highway department may exist for physical research, or for planning research, or for both. Ten state highway departments[6] report formal research units in the physical sciences. Some few report research engi-

[6] California, Illinois, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, North Carolina, Pennsylvania, Wisconsin.

neers without benefit of laboratory or authority to coordinate research. These were not included in the ten with staff and laboratories. Of the state and territorial highway departments 51 report formal planning units.

Physical Research[7]

Generally, the physical-research divisions have at their disposal research laboratories or share the laboratories of the materials and tests divisions. An attempt is made to coordinate all physical research, although some is still performed in other operating divisions or outside research agencies (see Fig. 6). Dates when these several research divisions were established are listed by 10-yr. periods in chronological order: one in 1914, one between 1920 and 1930, two between 1930 and 1940, five between 1940 and 1950, and one since 1950.



Administrative, Executive, Supervisory
Coordination, Cooperation
Advisory, Counsel
Liaison, Communication
Representation

Figure 6. Typical formal unit.

The research engineer has division status in most cases, but in some cases reports to a division engineer.

[7]Physical research: Research in the physical science; for example, highway research involving materials, test apparatus and equipment development; and construction and maintenance methods. It may be basic or applied in nature. Routine testing to determine compliance with specifications is not regarded as research.

The operating procedures tend to be formalized, since staff members are, in many cases, professionally trained researchers devoting full time to this work. Furthermore, the staff may represent the various physical sciences and form a "research team." Functionally designed laboratories with specialized equipment permit wide variety of research. The possibilities for organizing personnel and processes in these modern laboratories expedite production and reduce the cost of conducting research.

Michigan

The Michigan State Highway Department Laboratory is cited as a formal research unit. The functions and objectives are set forth in its Report No. 132, dated June 1949, as follows:

FUNCTIONS

The functions of the Research Laboratory are manifold, diversified, and of vital importance to the development of all phases of highway work. These functions may be broadly outlined as follows:

1. To visualize the problems of highway technology, to determine which of the many phases involve further research, to formulate and execute a definite program of research.
2. To perform experimental and developmental researches directed toward the solution of technical problems arising in the various divisions of the Department, or to the development of new procedures and methods and the improvement of existing ones.
3. To participate in theoretical researches directed toward the solution of certain major problems of interest in the general field of highway engineering.
4. To engage in cooperative research programs with educational institutions, agencies of the federal government and certain manufactureres on problems of mutual interest.
5. To provide specifications and standards for materials, make specialized analyses and research tests on new materials, and render assistance in regard to construction difficulties.
6. To accumulate, analyze and distribute to the Department technical and research information from outside sources pertaining to highway problems.
7. To prepare technical reports for members of the Department outside of the Research organization.
8. Through membership take part in committee work of the various technical organizations and thereby represent the Department in their activities.
9. To act in a advisory capacity to the Department on problems of a technical nature or on

matters of policy in regard to design, construction and maintenance practices.

OBJECTIVES

Organization of research within the Department is directed toward the accomplishment of the following objectives:

1. Achievement of a sound research organization in terms of administration, Staff and facilities for the conduct of a research program commensurate with the growth and responsibilities of the Department.
2. Encouragement of these now actively engaged in research and provisions of opportunities in research work for interested and capable employees of the Department not now doing research.
3. Promotion of cooperation in research within the Department, and between the Department and educational institutions, agencies of the federal government and industry, in order to secure concentration of effort, minimize duplication and stimulate progress.
4. Formulation of comprehensive projects of research and the development of effective means of utilizing the scientific and technical resources of both the State and the Nation for dealing with these projects.
5. Effective cooperation with the Highway Research Board's newly created Correlation Service which has recently been established. With this new functional responsibility the Highway Research Board plans greater emphasis on highway research in the future with the thought of utilizing all available research agencies and facilities to develop an integrated national program of highway research.

It appears that only two of the ten research organizations were created by administrative order or written agreement. And only two have a formal highway research board, although others indicated that division heads were called together informally to advise in project selection and prosecution.

Illinois

A recent development in formal research organizations is the creation of the Bureau of Research and Planning in the Illinois Division of Highways[8]. This bureau is divided into three main sections: Economic Research, Physical Research, and Planning and Programming. In addition, two other services were proposed: a technical library and an information-digest service.

[8]a. A Proposal for the Re-organization of the Illinois Division of Highways, Feb. 1951; b. Bureau of Research and Planning, Detailed list of Activities, Illinois Division of Highways, May 1951; c. The Illinois Highway Research Council, July 26, 1951; d. Minutes of Council Meeting, October 4, 1951, Illinois Highway Research Council.

The engineer of research and planning is responsible to the chief highway engineer. A highway research council was established to serve in an advisory capacity. The council consists of not less than 12 members composed of: (1) three representatives of the division of highways, (2) three representatives of the University of Illinois, (3) two members of the Bureau of Public Roads, (4) two county superintendents of highways, and (5) two city engineers.

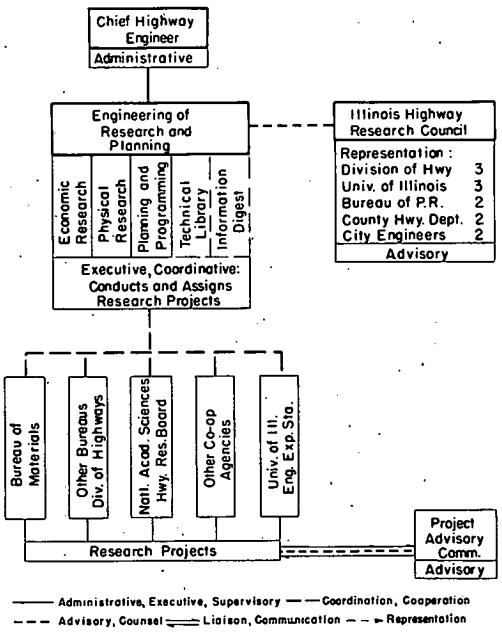


Figure 7. Illinois type of formal research.

Among the duties of the council are the following: (1) stimulate interest in research; (2) solicit suggestions for research projects; (3) suggest research projects; (4) develop a tentative research program; (5) recommend research agency to execute each project; (6) follow up on prosecution of research; (7) review final reports, suggest appropriate action; (8) recommend methods for dissemination of information; (9) explore, and recommend ways and means of financing, developing and conducting the research program; and (10) report annually.

The council will hold semi-annual meetings.

A project advisory committee is also set up to provide the project supervisor with advice and help in scheduling work. It consists of not less than five members on state-financed projects and not less than

seven members on federal-aid participating projects. The chief highway engineer will appoint other than ex-officio members with consent and approval of agencies concerned. The membership will include; (1) two representatives of the Illinois Division of Highways, one from the bureau most directly affected by the research objective and one from the district organization; (2) two representatives of the unit, university, college, or other agency conducting the research project; (3) two representatives of the Bureau of Public Roads (if a federal-aid participating project); (4) the engineer of physical research of the Bureau of Research and Planning; (5) one representative of such other unit or units of the Illinois Division of Highways, highway agency, or research agency directly affected by the objective of the research project, when deemed advisable by the chief highway engineer; and (6) two representatives of any other agency or agencies contributing funds for the research project.

The duties of the advisory committee will be to: (1) investigate and recommend procedures for obtaining the objective of the project; (2) investigate and prepare the annual work program; (3) review the progress of each project toward attaining the objective established in the prospectus, and bring the investigation to a conclusion as promptly as possible; (4) review annual progress reports and final reports for the project prior to submission, with recommendations, to the Illinois Highway Research Council for its review and consideration; (5) recommend additional research projects suggested by discoveries made or knowledge gained during the current investigation. (6) suggest methods and procedures for dissemination of information; and (7) stimulate interest in highway research and foster and encourage the use of engineering information gained through the highway research program of Illinois and other agencies.

The project advisory committee will be furnished such information as is available and pertinent to the research assignment, and may confer with such members of the highway department specially qualified to give advice.

The project supervisor is to be the chairman, and the secretary is to be selected by the committee. Meetings will be held as required. No compensation will be allowed members by virtue of service on committee.

An examination of the provisions for this bureau in Illinois would lead to the conclusion that it might be classed as a centrally coordinated research type quite similar to the Iowa type. It appears, however, that the engineer of research and planning in Illinois has a line function and that his authority includes not only the coordination but also the control of research for the Illinois Division of Highways (see Fig. 7).

Discussions of probable advantages and disadvantages resulted in the following listing: Advantages of formal research units (1) direct supervision of research personnel by the research engineer; (2) central coordination and state-wide programming of highway research; (3) functionally designed laboratories provided with specialized equipment, effective use of library, professionally trained scientists employed on full time basis which promotes efficiency in planning, executing and reporting research; (4) places emphasis on the research program and thus sustains the interest of the administrative branch of the highway department; and (5) provides for a continuing and long-range study with proper records and reports. Disadvantages of formal research units (1) usually (though not necessary) a division of responsibility for physical and planning-research; (2) poor communications between research division and operating divisions, no special liaison between researcher and operating engineer; and (3) a general lack of a formally constituted advisory council to assist in suggesting projects and to assist in getting the findings put to use.

A summary of expenditures for research for the ten states which have formal research programs shows nearly a million dollars was spent in 1951 on research, approximately 70 percent of which was for physical research. About $655 million was spent for construction and maintenance by these same states in 1951. Thus about 0.15 percent of this figure was spent for research.

Highway-Planning Research[9]

Five states (Colorado, Kansas, Illinois, Iowa, and Pennsylvania) have organizations

[9] Planning research: This is a broad term and herein denotes research usually conducted by the planning division. It may

for purpose of planning and coordinating all types and phases of research relating to highway engineering.

Identified by various names[10] planning survey units are found in all of the 51 highway departments. These units are similarly organized and generally conduct formal research. Procedures include problem statements, library research, formalized methodology, preparation of reports, and dissemination of findings through appropriate channels.

Most of these planning units have division status, but some operate as bureaus or sections of a major division. In several states, the planning unit reports to the chief administrative office of the state highway department, since this division often performs studies dealing with program and fiscal considerations and other matters of administration.

In quite a few states the planning function has been linked to the traffic and operations function in units called "traffic and planning" or "planning and traffic" divisions. While both traffic units and planning units conduct some traffic research, their objectives do differ. The traffic unit deals with the management of traffic operations through regulation and control, whereas the planning unit deals with traffic planning (system and route selection, traffic assignment, project justification, motor-vehicle use and related studies and then correlates these with fiscal studies).

Of the federal-aid allotment to the state 1½ percent may be set aside for the program of the planning division. The proposed projects to be included in the program of the planning division are set forth in a budget for approval by the Bureau of Public Roads and becomes a part of the agreement. The state may, and often does, carry on additional research projects not covered in agreement.

The typical planning survey division has three sections, inventory, traffic and fiscal. Many have added a fourth section commonly called the "special studies" section. The larger part of planning division expenditures is for the continuing, routine studies in the inventory, traffic, and fiscal sections. However, in some states, substantial amounts go into the studies of the special studies section. In the latter section is found the highway planning research (economic, finance, administration, and traffic research). If the planning division is operating a program satisfactory to the Bureau of Public Roads and is not using all of the 1½ percent funds, the unused portion may, by agreement, be used for physical research, either conducted by the highway department or contracted to outside research agency.

In the canvass of the highway departments, an arbitrary definition of planning research ruled out routine continuing operations and studies made by conventional methods. The definition regards as research only those studies pursued towards discovery of distinctively new knowledge or towards modification of present methods or development of new ones. It was indicated by some of the highway planning engineers that about 10 percent of the funds provided to the planning division was spent for planning-research.

An examination of budgets submitted by the planning survey divisions to the Bureau of Public Roads showed that they spent about $600,000 in 1951 for all types of research in which the 1½ percent funds were used, $400,000 of which was spent for physical research and $200,000 was used for planning-research. Additional planning research was conducted by highway planning survey divisions out of state funds, in the amount of approximately $200,000. Thus, a total of approximately $400,000 was spent forplanning-research, according to the budgetary analysis.

JOINT RESEARCH

(With Engineering Schools)

Joint Research is that research conducted by organizations established and operated by joint effort and for the mutual benefit of the state highway department and

consist of studies pertaining to improved administrative and fiscal practices, traffic studies, and related activities.

For the purpose of this particular study, routine operations of the highway planning divisions are not defined as research. Routine operations include the continuing inventory and mapping surveys, continuing program of traffic counting, and the collection of fiscal data for annual reports. Origin-and-destination studies and parking studies conducted by conventional techniques are likewise excluded. However, any work done to modify the present or develop new methods for such studies is regarded as research. It is difficult to draw a sharp line between research and nonresearch in planning. In requesting cost information on planning research, the planning engineer was asked to draw his own line. The resulting cost data from the states are not precisely comparable but furnish an "educated guess" on amount of money spent on planning research.

[10] These units were originally commonly called the highway planning survey. After accomplishing the initial step of inventorying the roads, making a traffic census and obtaining fiscal data, some of these units dropped the word "survey." Others assumed names including the words "economics," "statistics," "analysis," or used simply "planning."

the state university or college. Joint research does not preclude the operation of other highway research, either inside or outside of the state highway department, but the joint research program may constitute a major highway research endeavor within a given state. The projects undertaken so far have been largely those of physical research; nevertheless some economic, traffic, and administrative research is being undertaken.

Authorization of joint research has been through permissive legislation, administrative agreement (written and verbal), and by combinations of these means. Six states reported joint research units: Indiana, Kentucky, Florida, Virginia, Tennessee, and New Jersey. The State of Texas has permissive legislation and an administrative memorandum authorizing the preparation of a working agreement.

An examination of these six joint research units discloses the variations in their structure and function and aims of the initiators.

Indiana

The first of these joint research endeavors, the joint highway research project in Indiana resulted from efforts of members of the Indiana State Highway Commission and Purdue University. It was initiated in 1936 through an agreement between the director of the Engineering Experiment Station at Purdue University and the Highway Commission. On March 11, 1937, it was authorized by an act of the Indiana General Assembly. The project now operates under the act as amended in 1949 by Senate Bill No. 219, which permits the commission to allocate to the university a maximum of $150,000 a year.

The 1937 act provided for the operation of the project with offices and laboratories situated in the Civil Engineering Building (as a function of the Civil Engineering and Engineering Mechanics School through the Engineering Experiment Station of Purdue University, a land-grant institution).

The act also provides that a portion of the funds may be used for the annual Purdue Road School, and for the dissemination of information and for highway extension[11].

[11] Ten Years of Highway Research, K. B. Woods, Associate Director, Joint Highway Research Series No. 99, The Engineering Experiment Station, Purdue University, Lafayette, Indiana.
The Pay-off in Highway Research, K. B. Woods, Associate Director, Joint Highway Research Project, Highway Research Reprint No. 62, The Engineering Experiment Station, Purdue University, Lafayette, Indiana.

The joint highway research project is financed chiefly by the commission and is operated by the university. Coordination of the commission's and the university's interests in the program is achieved through an advisory board composed of five engineers from the commission and six members of the staff of the School of Civil Engineering and Engineering Mechanics.

The state highway commission is represented by: (1) chief engineer, chairman of advisory board; (2) engineer of roads; (3) engineer of bridges, (4) superintendent of maintenance; and (5) engineer of materials and tests.

Purdue University is represented by: (1) head of School of Civil Engineering and

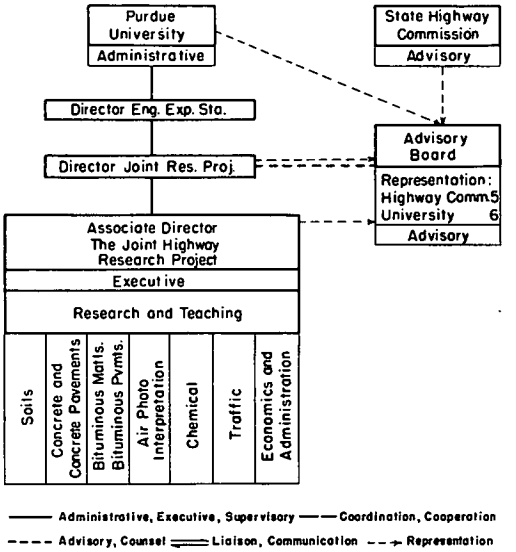


Figure 8. Indiana type of joint research.

Engineering Mechanics, vice chairman of advisory board and director of project; (2) professor of highway engineering, secretary of advisory board, associate director (and administrator) of project; (3) professor of highway engineering (undergraduate) and chairman, annual Purdue Road School; (4) professor of testing materials; (5) professor of sanitary engineering; and (6) professor structural engineering.

The advisory board functions are to: (1) outline policy relating to research activities; (2) recommend research projects; (3) review reports on research projects; (4) recommend release of research findings; (5) recommend the allocation of funds for research.

The associate director has direct administrative responsibility of the project. He acts under the authority of the director of the joint highway research project, and of the director of the experiment station.

"The functions of the project are as follows: to make basic studies of materials used in highways; to facilitate economical design, construction and maintenance of county and state highways; to investigate traffic, safety and other items as desired and agreed upon; to provide advanced instruction in the fundamentals of highway engineering and related research; and to provide practical experience in construction and maintenance expenditures and in the u se of highway materials." - Ten Years of Highway Research.

At the present time, the research organization is divided into seven departments, namely, soils, concrete and concrete pavements, bituminous materials and bituminous pavements, airphoto interpretation, chemical, traffic, and economics and administration. Each department head administers the graduate work in his area, teaches graduate courses, and supervises research projects. The J oint Highway Research Project at Purdue is operated by university staff members as both a teaching and research institution.

The State Highway Commission of Indiana has a research engineer on full-time basis operating under the Bureau of Materials and Tests. Research is also undertaken occasionally by the engineer of special assignment and by the staff of other departments on a part-time basis.

Kentucky

A second joint research endeavor was started in Kentucky in 1942. It resulted from an informal agreement between the state highway engineer and the dean of engineering, University of Kentucky. In accordance with the agreement the Kentucky Department of Highways built and equipped a research laboratory on the campus of the university of Lexington.

A research committee acting in an advisory capacity coordinates the research program (which is chiefly physical), and meeting as a group to suggest needed research and to receive reports on work accomplished and recommend appropriate action. The composition of the committee is as follows:

For the state highway department: (1) state highway engineer; (2) assistant state highway engineer; (3) director of design; (4) director of planning survey; (5) director of construction; (6) director of maintenance; (7) director of rural highways; (8) director of materials; (9) director of traffic; (10) bridge engineer; (11) nine district engineers; (12) commissioner of highways, ex-officio; (13) commissioner of rural highways; and (14) assistant research engineer, secretary.

For the university; (1) dean of engineering, director research laboratory; (2) two professors from the Department of Civil Engineering.

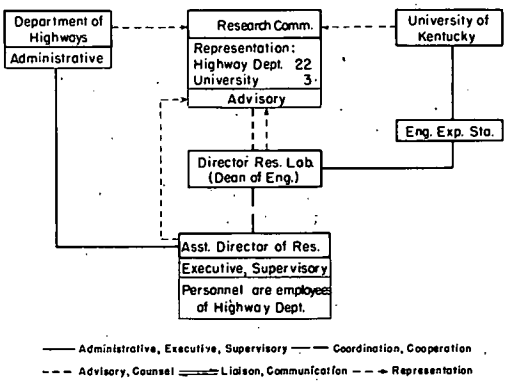


Figure 9. Kentucky type of joint research.

The dean of engineering serves as director. This is considered by Kentucky a desirable arrangement as it provides a responsible administrator in the College of Engineering as the administrator of highway department research activities at the university, thus affording a top-level administrative link between the highway department and university.

The assistant director of research, a full-time executive, is an employee of the highway department responsible to the state highway engineer. The staff members are also employees of the highway department (in contradistinction, the staff members of the Purdue Joint Highway Research Project are employees of Purdue University).

The Kentucky Department of Highways has entered into a cooperative arrangement with the university by which selected high school graduates are employed in the research laboratory for certain periods of time and attend the university during alternate periods, thus completing the required units of work for a degree in engi-

neering. Some of the engineers visited expressed the hope that the students so trained would "graduate into the department of highways." The staff of the research division also cooperates in the engineering extension work of the university.

The research division in the beginning reported to the director of design, but in 1949 acquired full division status and reports to the state highway engineer.

All of the physical research of the department of highways is conducted by the research division, under the direction of the assistant director of research with headquarters at the Highway Materials Research Laboratory, Lexington, Kentucky.

Florida

Florida initiated the third joint research project. This project was established by an act of the state legislature of 1947. The law is contained in Chapter 2434, Laws of Florida, Acts of 1947. The act is carried into Florida statutes 1941 as Section 241. 87, Cumulative Supplement.[12]

The organization is known as Joint Highway Research Project. It is operated by the University of Florida, at Gainsville. It is similar in its organization to the Purdue Joint Research Project. A feature of the management is the assignment of a "counseller" from the faculty of the university to the researcher in charge of each work project. The 1947 Legislation set a limit of $20,000 per year for expenditures. Funds are to be derived from the Florida State Road Department, supplemented from other sources.

Virginia

A fourth joint endeavor, the Virginia Department of Highways, in November 1948 executed a written agreement with the University of Virginia (at Charlottesville) "to establish and operate by joint effort and for their mutual benefit" the Virginia Council of Highway Investigation and Research.[13]

A board of administration was established composed as follows: (1) chief engineer, department of highways, chairman; (2) dean of engineering, University of Virginia; and (3) director of research, executive officer.

The duties of the board are to: (1) coordinate the interests of the two cooperating agencies; (2) develop with the assistance of the advisory committee a research program; (3) establish council policies in all matters pertaining to personnel, finances, and facilities; and (4) meet the first Friday of each month. Provision is made for employment of staff members of the department of highways as employees of the university, and by the university as employees of the university, both groups reporting to the director of research.

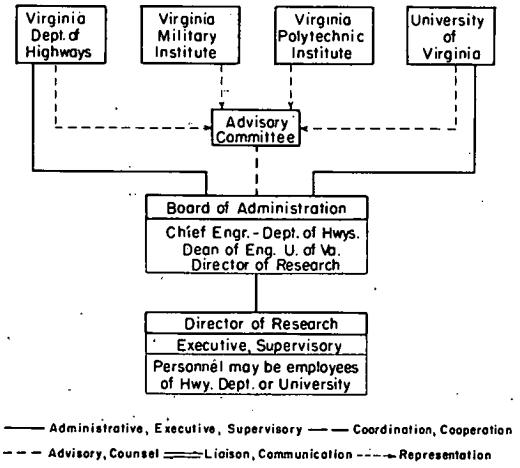


Figure 10. Virginia type of joint research.

A Highway Research Advisory Committee consists of: (1) the three members of the Board of Administration; (2) heads of the Civil Engineering Department of Virginia Polytechnic Institute, and Virginia Military Institute; (3) an additional representative from the department of highways; and (4) an additional representative from the University of Virginia. The duties of the advisory committee are to: (1) suggest research projects and investigations; (2) review outlines of working plans before work is started; (3) review progress reports; and (4) recommend publication of reports.

The agreement further provides for a nominal amount of teaching by staff members on approval of the council, and for highway conferences and short courses.

Aims and objectives of the council are to: (1) train men in the fundamentals of highway engineering and related subjects; (2) carry out research programs for the

[12] Copies of the law may be obtained from: Secretary, Florida State Road Department, Tallahassee, Florida.

[13] The Virginia Council of Highway Investigation and Research also Highway Research for Virginia, both by Virginia Council of Highway Investigation and Research, Thornton Hall, University of Virginia, Charlottesville, Va.

purpose of facilitating the economic design, construction and maintenance of highways; (3) maintain relations and to cooperate with the Highway Research Board, Research Divisions of various highway departments, universities and other agencies performing research; (4) report and publish findings that are of general interest and value and which add to fundamental knowledge; and (5) hold joint meetings and conferences of men interested in the development and improvement of all phases of highway engineering.

In addition to the research conducted at the University of Virginia, some work is contracted to the Virginia Military Institute and considerable research in traffic and economics is performed by the Traffic and Planning Division of the Virginia Department of Highways, at Richmond.

Tennessee

The fifth joint endeavor, the Tennessee Highway Research Program, was established at the University of Tennessee in October 1951 by a written agreement between the highway department and the University of Tennessee. The agreement implements Chapter 127 of the Public Acts of 1951 of the General Assembly of the State of Tennessee, and provides that: (1) the work will be performed by the University of Tennessee under the general direction of the Engineering Experiment Station; (2) an advisory council will be established composed of three members appointed by the university and three members appointed by the highway commissioner. The council will select its own chairman and secretary; (3) the council will meet quarterly to recommend programs and budgets for approval of the commissioner and university; (4) technical direction of the program shall be exercised by a program director appointed by the director of the experiment station subject to approval of advisory council. (5) all persons working on the program, including program director shall be employees of the University of Tennessee.

The act authorizing the program permits the commissioner to expend not to exceed a total sum of $25,000 a year from funds belonging to the Tennessee Department of Highways and Public Works.

In addition to the research work conducted under this program additional research may be undertaken by the Division of Materials and Tests and the Division of Traffic and Finance Studies.

New Jersey

The sixth joint endeavor was entered into by the State Highway Department of New Jersey and the state university of New Jersey (Rutgers) by agreement dated May 20, 1952. The name of the research unit is the Joint Highway Research Project.

The agreement provides for a committee to advise in planning and operation of approved studies. This committee consists of an equal number of representatives and sponsor and others appointed by mutual agreement. The functions of the research committee are to: (1) receive verbal or written reports from the university; (2) advise on technical and scientific aspects of the several projects; and (3) advise on the future program of work and its support.

The committee is to meet at least quarterly for the exercise of these enumerated functions.

The term of the project was to be from July 1, 1952, to June 30, 1953, and the consideration for the fiscal year 1952-1953 was set at $61,251, payable in quarterly installments for work done.

Administration and operation of the program is assumed by the university in accordance with university statutes and policies. The several projects are supervised by the research director of the Bureau of Engineering Research (engineering experiment station), under the general jurisdiction of the dean of the College of Engineering. A three-man executive committee administers the joint interests. This committee is composed of a chairman from the state highway department, the dean of engineering, and the director of the project, who acts as secretary.

Progress and final reports are given to the sponsor according to arrangements mutually agreed upon before a project begins. Publication is the prerogative of the university.

Figures 8, 9, and 10 illustrate the types of joint research organizations.

Discussions of probable advantages and disadvantages of joint research brought out the following: Advantages of joint research —(1) provides the benefits of the complementary functions of research and teaching; (2) enlists interest of student assistants in

highway employment; (3) provides training in the scientific method and advanced education; (4) provides necessary full-time researchers for a continuing program; (5) provides environment conducive to highway research, with specialized equipment, facilities, and the scientific resources of the university; (6) affords the combined technology of the scientist and the engineer both in planning and in operating the project; (7) divorces research from operations and avoids conflicting interests; (8) provides the advantages of traditional university research with the added advantage of the feeling on the part of the staff of being a part of the highway enterprise; (9) facilitates reporting and recording; and (10) provides a stimulus for basic research. Disadvantages of joint research—(1) the possibility that the research organization may lose its identity as a real part of the highway department with resultant lack of utilization of research findings by the highway department; (2) full-time researchers may lose touch with highway department operations; and (3) limitation on program scope, university may not be able to undertake a complete program of research for the highway department.

A summary of estimated expenditure for research in 1951 by the six states operating joint research programs shows a total expenditure of approximately $460,000 of which $50,000 was for nonphysical research. This includes research by the highway departments. During this same period these same six states spent approximately $249 million for highway construction and maintenance. Thus the research expenditures amount to 0.08 percent of the figure.

CONTRACTED RESEARCH

Contracted research is research let to other agencies by the state highway department. It is sometimes called "sponsored" research, the state highway department being the sponsor. From the standpoint of the state highway department it is extramural research, usually being conducted outside of the properties of the state highway department, as distinguished from the intramural research in facilities owned and manned by the state highway department. The research projects let to other agencies are usually called "cooperative projects," and where contracted research constitutes a continuing activity from year to year, the arrangement is sometimes referred to as a "cooperative program." Cooperative projects are not limited to extramural research, however, since in many instances other agencies are cooperating in intramural research work of the state highway departments. Contracted research usually supplements research conducted by the state highway departments and seldom constitutes the whole program, nor is it substituted as a distinctive program.

Arrangements for contracted research vary. In its simplest form research is contracted project by project as circumstances dictate. A project agreement is executed covering what is to be done and

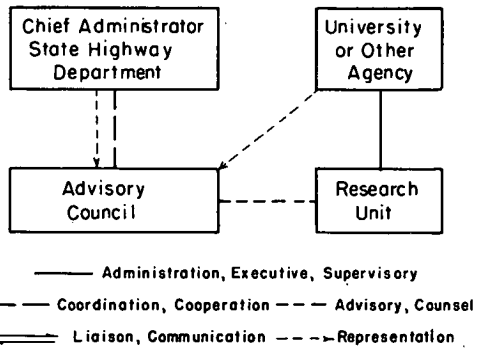


Figure 11. Typical cooperative arrangement for contracted research.

how it is to be financed. In some instances the contractual arrangement consists of a letter agreement and in some instances only a so-called gentlemen's agreement. The initiation of such a project may be either by the state highway department or by the research agency. When the research agency initiates the work the usual preliminaries consist of the submittal of a prospectus by the research agency outlining research work proposed.

Contracted research has evolved from the single-project type to planned, long-range research programs in some states. It would require but little modification in organizational arrangement to be converted to joint research.

In the administration of contracted research, the single-project type is usually administered by the chief administrative officer of the state highway department or by a member of the engineering staff. Administration of these projects ordinarily

consists of preparing and executing an agreement, providing liaison between the technicians of the operating divisions of the state highway department and the research agency conducting the research, and paying the bill. Methodology, supervision of operations, and publication of reports are usually the responsibility of the research agency.

Where this type of research has developed into a long-range cooperative program, a joint advisory council frequently plans the contract program, advises on precedures, and gives other assistance as may be desirable. Nine states now employ advisory councils to assist in contracting research. The members of the advisory council are selected both from the research agency and state highway department. Members are sometimes drawn from contracting and manufacturing firms and from consulting engineering firms. Administrative responsibility for the state highway department is usually reserved for its chief administrative officer and supervisory responsibility delegated to the director of the research agency, while the advisory board exists in an advisory capacity.

Research is occasionally contracted to industrial laboratories, but more often to the research organization of the state university or college. These research organizations in the land-grant colleges are commonly known as "engineering experiment stations" but have usually adopted some other name in non-land-grant institutions.

Thirty-one state highway departments report research work contracted to other research agencies, chiefly to state colleges and universities. (This does not include the six states having joint research units.) Of these 31 states, 19 use contracted research to supplement noncentralized research, nine use contracted research to supplement their own formal research programs, and three use it as a part of their centrally coordinated research activities. Figure 11 illustrates the organizational arrangement for contracted research.

No separation of costs was obtained for this type of research, except as reported earlier in this report, for research work conducted by engineering experiment stations. The expenditures for contracted research are included in the expenditure totals except in those cases where appropriations of grants for highway research are made directly to the educational institution by government or industry and do not pass through the highway department. (The Institute of Transportation and Traffic Engineering, University of California, Berkeley, is such an exception).

Discussion of probable advantages and disadvantages disclosed the following: Advantages of contracted research—(1) obtains specialized staff, laboratory, and equipment; (2) relieves highway department of work load involved; (3) provides research theses for graduate students; (4) gives students an appreciation of scientific method; (5) engages the interest of students in highway engineering and aids in recruitment; (6) provides an objective research; and (7) provides formalized procedures and reports. Disadvantages of contracted research—(1) may scatter the research among two or more agencies; (2) educational institutions prefer fundamental research to complement their teaching and may not accept some applied research projects; and (3) the "how", "where" and "why" of the research are often reserved to the research agency.

COLLEGE AND UNIVERSITY RESEARCH

Highway research in the colleges and universities is usually conducted as sponsored research. The sponsoring agent may be industry, government agency, or professional institution. At the moment the state highway departments are principal sponsors, federal government second, and industry third. The colleges and universities, themselves, provide some financial assistance to highway research.

The state government usually sponsors highway research through one of the following arrangements: (1) direct legislative appropriation; (2) specific enabling legislation authorizing the state highway department to sponsor research at state colleges or universities; or (3) implied permission in the broad powers of the state highway department to sponsor research at state college or university.

The federal government's sponsorship of highway research includes the following arrangements: (1) grants, loans, scholarships and fellowships of the National Science Foundation[14], and (2) contracts of the

[14] Grants for Scientific Research. A guide for the submission of Research proposals. National Science Foundation, Washington 25, D.C., December 1951. Also, Public Law 507 – 81st Congress, Chapter 171 – 2nd Session.

several departments, particularly those of the Bureau of Public Roads of the U. S. Department of Commerce.

Industry sponsorship is provided through contracts, grants, and fellowships. Government, technical associations, and industry have, on occasions, provided funds to be used by the Highway Research Board of the National Research Council in grants and fellowships for highway research.

An example of state sponsorship through legislative appropriation is provided by the Institute of Transportation and Traffic Engineering at the University of California. A state law, enacted in 1947, provided for establishment of the institute and resulted in a direct grant of funds for initial facilities and first year's operations. Since then, funds have been made available as a part of the university budget.

This California institute is specifically charged with both research and educational responsibility. It is also designated to operate within the College of Engineering of the state university. As a result, it is able to organize and pursue broad, continuing programs of research and to augment its own staff and facilities by drawing upon the extensive laboratories, equipment, and staff services of the university at large.

To facilitate statewide service, the institute maintains offices at the two principal University of California campuses (at Berkeley and at Los Angeles). Normally, to make efficient use of staff and facilities, research in the fields of traffic safety, traffic instrumentation, and driver behavior is centered at Los Angeles, while that relating to materials, structures, operations, design, etc., is centered at Berkeley.

Management of the institute is provided by an executive committee, consisting of the institute director, the assistant directors for Berkeley and Los Angeles, and the deans of the Berkeley and Los Angeles engineering colleges. An institute's advisory committee provides the executive committee with guidance as to the nature of current problems. The following partial list of organizations with top-executive representatives actively participating on the committee indicates the nature of this advisory group: County Supervisors Association of California, California Road Commissioners, State Public Utilities Commission, State Division of Highways, State Chamber of Commerce, Highway Research Board, U. S. Bureau of Public Roads, League of California Cities, National Safety Council, Automotive Safety Foundation, California Highway Patrol, Associated General Contractors, and various automobile clubs.

The institute's technical staff consists of some 25 specialists with experience in teaching, research, and practice. Several of these individuals are engaged jointly by the institute and other engineering divisions of the university, the latter paying a substantial portion of their salaries. While staff groups specialize in particular phases of education and research, all are concerned with the general problem of efficient transportation.

Besides research, the institute carries on a college program comprising an undergraduate transportation option in the civil engineering curriculum, and graduate seminars and courses in transportation engineering. Education for those at work in the field is provided through a variety of extension services — classes, short courses, conferences — in which some 3,000 Californians enroll each year. Administrative assistance in these offerings is provided by university extension. Supplementary services include publications, visual aids, and a transportation library. The last, situated at Berkeley, now consists of some 3,000 books, pamphlets, and reports, and 600 periodical titles, as well as slides, photographs, and microfilms.

Research plans of the institute are laid out in close cooperation with the California Division of Highways and city and county agencies. Broad research objectives are reviewed by the advisory committee twice a year; specific projects are approved by the executive committee. While many institute research activities are carried out with its own funds, others are cooperative, some involving joint financing, some merely involving coordination of separately financed investigation.

The previous chapters discussed certain joint cooperative projects in Indiana, Florida, Iowa, and Tennessee, which were made possible by legislative enactments. In addition to these, at least three other states have special laws authorizing or permitting cooperative research with state colleges or universities.

Altogether, 31 states (not including Indiana, Kentucky, Florida, Tennessee, Virginia, and New Jersey, which have joint

programs) report cooperative projects being performed by their state college or university. Some of these cooperating state highway departments entered into these arrangements through implied legal authority and reported that written agreements were executed, while several reported letter agreements were the basis for proceeding with the work.

Fifty-five colleges and universities (not including those six with joint research organizations) in 41 states reported highway research work being undertaken, and 20 of these 55 report definite and continuing programs, while the remainder report occasional projects (see Summary of Highway Research Programs at Colleges and Universities). Sponsorship of research by state highway departments was provided in 36 of the 41 states where colleges and universities were conducting highway research with some of the 36 state highway departments sponsoring research in more than one institution. It may be assumed that industry, federal government, and the colleges and universities, themselves, are responsible for research not sponsored by the state highway departments.

Administrative arrangements are quite generally made with the engineering experiment stations of the land-grant colleges[15] for the research work. Forty-four states report active engineering experiment stations in the engineering colleges and universities. In addition to the engineering experiment stations of the landgrant institutions, there are the several research units in non-land-grant institutions, usually called by some other name than "engineering experiment station."

Member institutions of the Engineering College Research Council numbered 91 in 1951[16]. This number, including most of the engineering experiment stations, indicates the available potential for research. Only three states (Idaho, Vermont, and Wyoming) do not have member institutions in the Engineering College Research Council, but these three states do have active engineering experiment stations.

[15] Engineering Division Record. Bulletin of the Engineering Division of the Assoc. of Land-Grant Colleges and Universities. Issued three times annually. Dean N. W. Dougherty, secretary and editor, University of Tennessee.

[16] Review of Current Research and Directory of Member Institutions. Engineering College Research Council of the American Society for Engineering Education. John Matill, Secretary, Massachusetts Institute of Technology, Cambridge 39, Massachusetts (published annually).

Engineering experiment stations differ in character. Some have only office space and part time directors who serve to coordinate the research undertaken by the station, arranging for research and for laboratory space in the available laboratories in the institution. On the other hand, there are units having their own laboratories and full-time staffs of specialists conducting continuous research work.

Administratively, the engineering experiment stations are usually, both functionally and structurally, a part of the engineering college, with the director of the station reporting to the dean of engineering or to a research council. In some cases where joint research units have been established by state highway department and university, the director of the engineering experiment station becomes the administrative agent with respect to business and financial arrangements, although there are some exceptions. From the standpoint of the university, sponsored highway research fits into its traditional type of departmentalized research.

Discussions during the survey brought out that the major purposes of research in colleges and universities are to support and promote graduate training in basic research and to complement and stimulate the teaching program and, in doing this, make available for research studies the diversity of engineering training, experience, and equipment of the faculty and laboratories. Applied and developmental types of research are accepted by many institutions, if they do not interfere with the major emphasis. Gilman's statement was called to the attention of the writer in connection with the purpose of the university: "I take it that the prime purpose of the university is education; its secondary object is research."[17]

In the more-elaborate foundations or institutes, full-time research scientists are employed and work by student help consists more of "leg work" than of research, but in many of the institutions graduate students with faculty members as counsellors perform the research for theses in partial fulfillment of requirements for graduate degrees. In others, the individual faculty members perform or supervise the research. These institu-

[17] Daniel Coit Gilman, the first president of Johns Hopkins University in a speech before the American Philosophical Society, Philadelphia, March 15, 1880.

Summary of Highway Research Programs at Colleges, Universities

NAME OF INSTITUTION	RESEARCH PROGRAM		EXTENT OF PROGRAM										SOURCE OF FUNDS (Percent)						COOPERATIVE PROGRAM					TYPE OF RESEARCH (Percent)		
					PERSONNEL																			FUNDAMENTAL		
	DEFINITE AND CONTINUING	OCCASIONAL	APPROXIMATE TOTAL ANNUAL EXPENDITURE	VALUE OF PHYSICAL PLANT	PROFESSIONAL	SUB PROFESSIONAL	CLERICAL	STUDENT UNDER GRADUATE	STUDENT GRADUATE	OVERHEAD CHARGES	SPECIAL EXPENDITURES	FEDERAL	STATE HIGHWAY	COUNTY HIGHWAY	MUNICIPAL STREET	STATE UNIVERSITY	OTHER	FORMAL OPERATIVE	INFORMAL OPERATIVE	ADMINISTRATIVE AUTHORITY	SPECIAL LEGISLATION	SPECIAL JOINT BOARD	BROAD SCOPE	NARROW SCOPE	SUPERFICIAL (See Text)
Alabama, Polytechnic	Yes		5,000	25,000	1			1	2	10%		0	100					Yes		Joint	No	Yes			100
Arkansas, University of	Yes		15,000	20,000	1	1	1	5	2	3,000		35	35			5	25	Yes		Univ.	No	No	75	25	
California, University of (Berkeley)	Yes		350,000	Not Available	12					Not Available		0	0	0	0	100	0	Yes		Univ.	Yes	No	75	25	0
Colorado, University of	No	Yes	Indeterminant		1.2				4			0						No	Yes			No			
Connecticut, Yale Bureau of Highway Traffic	Yes																								
University of	Yes		40,000	15,000	4	8	5	0	0			20	80					Yes		Univ.	No	No	70	10	20
Delaware, University of	Yes		12,000		1	1	$\frac{1}{4}$	1	$\frac{1}{2}$			0						Yes		Univ.	No	No	75	25	
Florida, University of	Joint with S.H.D. (See Highway Department Report - Chapter IV)																								
Georgia, Tech	No	Yes																							
Idaho, University of	Yes		1,500	100,000	1	$\frac{1}{2}$	$\frac{1}{2}$	1	0			0				90		Yes		Shared	No	No	50	25	25
Illinois, University of	Yes	Yes	220,000	All Facilities Available	12	2	4	7	8	62,000		20	45	0	0	55	0	Yes		Both	No	Yes	80	20	0
Northwestern University		Yes	(Indeterminate)									0	0				Univ.	No	No				(Varies)		
Indiana, Notre Dame University	No	Yes	400	20,000	$\frac{1}{4}$	0	$\frac{1}{10}$	Var.	$\frac{1}{4}$	0	0	0					Univ.								100
Purdue University	Joint with S.H.D. (See Highway Department Report - Chapter IV)																								
Iowa, Iowa State College	Yes		42,500		$3\frac{1}{2}$		2	1	6	4,500						33		No		No	No	Yes	56	28	16
University of	Yes																					Yes			
Kansas, University of	No	Yes																No	Yes	S.H.D.	No	No			
Kansas State College	Yes		20,000	32,000	3	2	1	2	3			0				15	85	No	Yes				80	20	0
Kentucky, University of	Joint with S.H.D. (See Highway Department Report - Chapter IV)																								
Louisiana, Louisiana State University	No	Yes	1,000	100,000	$1\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{1}{2}$	2			0	0	0	0	100		No	No			No	50	35	15
Maine, University of	No	Yes										100										No			
Maryland, University of	No	Yes																							
Massachusetts, M.I.T.	No	Yes	0					Some		0								Yes			Yes	No			
Michigan, Michigan State	No	Yes	0	0	0	0	0	0	0	0	0							No				Yes			
University of Detroit	No	Yes	Negligible					Some									Univ.	Yes						100	
Minnesota, University of	No	Yes	10,000									50	50	0	0	0	0	No	Yes				50	50	0
Mississippi, Mississippi State College	No	Yes	500	50,000								0						No				No			
Missouri, University of (Columbia)	Yes	Yes	3,000	50,000	$\frac{1}{2}$	$\frac{1}{2}$		$\frac{1}{2}$	$\frac{1}{2}$							100		No	Yes	Univ.	No	No	50	50	0
School of Mines (Rolla)	No	Yes	750±	50,000	1	0	0	0	2	0		0	25	0	0	50	25	No	Yes		No	No	0	50	50
Washington University	No	Yes	500		1			2				0	0	0	0	0	Univ.	No							
Montana, Montana State College	No	Yes	Negligible	50,000	$\frac{1}{10}$	$\frac{1}{5}$			$\frac{1}{2}$			0	0	0	0	0	0	No	Yes			No	100		
Nebraska, University of	No	Yes	150±		$\frac{1}{12}$	0	0	0	0			0						No	Yes			No			100
New Jersey, Princeton University	Yes		Variable	50,000					3			0	0	0	0	0	Univ.	Yes					100		
Rutgers University	Yes		70,000		8	5	1	3										Yes		Univ.	No	No	85	12	3
New Mexico, University of	No	Yes	500	50,000	2	1	1	2	2			0				100		No	No					67	33
New York, College of the City of	No	Yes																							
Cornell University	Yes		15,000	80,000	4	4	3		4			70				25	5	Pending	No			No	50	50	0
Columbia University	No	Yes	Variable																						
North Carolina, North Carolina State College	No	Yes	2,800	60,000±	$1\frac{1}{2}$	$\frac{1}{2}$						0	0	0	0	100		No	Yes			No	50		50
North Dakota, University of	No	Yes	Variable	50,000	2			1	1			0	0	0	0	100		No	No						100
Ohio, State University	No	Yes																No	Yes			Yes			
Oklahoma, University of	Yes	Yes	11,000	6,000	2		$\frac{1}{4}$	1	2	8,000		0	30			20	40	Yes		Univ.	No	No	30	20	50
Oregon, State College	No	Yes	25,000		3							15	85					No	Yes		No	No		50	50
Pennsylvania, University of	No	Yes																No	Inf.	Univ.	No	No	60	30	10
Pennsylvania State College	No	Yes	1,200	10,000	$\frac{1}{4}$	0	0	0	1	0		0	0	0	0	100		No	Yes			No	0	100	0
Lehigh University	Yes		2,000		$\frac{1}{8}$				1	600		50	50							Univ.	No	No		100	
Swarthmore College	No	Yes																							
Villanova College	No	Yes	0	15,000	1							0	0	0	0	0						No			
Rhode Island, State College	No	Yes																No							
South Dakota, State College	No	Yes																No							
Tennessee, University of	Joint with S.H.D. (See Highway Department Report - Chapter IV)																								
Texas, A and M College	Yes		44,500		4	4	1	9	0			50					50	Yes		ExpSt.	Yes	No	50	25	25
University of	Yes		4,500		$\frac{1}{2}$			$\frac{1}{2}$	$\frac{1}{2}$	600						100		No	No			No	80	20	
Utah, Utah State Agricultural College	No	Yes	Varies	50,000								0				100		No	No						
Virginia, University of	Joint with S.H.D. (See Highway Department Report - Chapter IV)																								
Virginia Military Institute	Yes	Yes	3,600	20,000	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$					100						Yes		Council	No	Yes	100		
V.P.I.	Yes	Yes																				Yes			
Washington, University of	No	Yes																No							
State College of	No	Yes																							
Wisconsin, University of	No	Yes										0	0	0	0	90	10	No	Yes		No	No	50	25	25
Wyoming, University of	No	Yes	3,000	20,000	$\frac{1}{4}$			1	1							60	40	No	Inf.			No	100		
Total Number of Institutions Reporting			29	21																					
Totals for Institutions Reporting			$905,400	$923,000																					

Prepared by Dougherty and Bridger - 1951

tions generally prefer to receive the research assignment as a problem statement so that they can, themselves, conduct the complete research operation, including library research, methodology, operation, analysis and interpretation, and publication of report.

The financing of research in colleges and universities is arranged through fellowships or grants in aid. Large projects and cooperative programs are more adaptable to financing through grants in aid. Highway departments cannot readily provide endowments but can contract for specific work at agreed cost.

The table facing this page, entitled "Summary of Highway Research Programs of Colleges and Universities," shows the status of highway research in these institutions as provided in replies to questionnaires sent to them by J. C. Bridger, of the University of Tennessee.

REGIONAL AND NATIONAL COOPERATIVE RESEARCH

Most of highway research problems are of a nature that they can be effectively studied by an individual or small group of researchers; however, there are some mutual problems of large proportions in which the greatest promise of accelerated progress lies in a cooperative endeavor.

Procedures for formulation and administration of research projects to be financed jointly by two or more states were suggested in a report to the Executive Committee of the American Association of State Highway Officials by a special committee of the association's Committee on Research Activities. The procedures as approved by the Executive Committee on September 24, 1948 are as follows:

1. A Committee of the American Association of State Highway Officials desiring to recommend a research project for joint financing by two or more States, with or without use of Federal-aid 1½ percent funds, should submit a project statement and estimates of cost to the Committee on Research Activities. The project statement should show the need for the research, the scope of the proposed work, and list the States that might be expected to take part.

2. The project statement should be referred for comment to the chairman of other appropriate committees of the Association. On due consideration thereafter the Committee on Research Activities should transmit a report of its findings with recommendation for action to the Chairman of the Committee on Standards of the Association.

3. If recommended by the Committee on Research Activities, the Chairman of the Committee on Standards should submit the proposed project to the consideration of the States that may be concerned in its financing and of the Public Roads Administration and ascertain which of the States are willing and able to participate. The Chairman of the Committee on Standards should thereupon notify the Highway Research Board of the proposed project and of the interested agencies.

4. Upon receipt of this notification, the Highway Research Board should offer its Correlation Service to the States concerned and to the Public Roads Administration for the purpose of arranging, to the satisfaction of all contributing States, a scheme of joint financing.

5. If desired by the States concerned, and upon approval of its Executive Committee, the Highway Research Board should undertake supervision and administration of the jointly arranged project, proceeding as follows:

(a) To enter into agreements with the individual States for payment to it of contributions to the support of the work.

(b) To appoint a project committee to plan and direct the work, which committee shall include representatives of the Committee on Research activities and of the Committee sponsoring the project.

(c) To arrange the necessary staff and proceed with the work.

(d) To prepare and publish reports of the project in accordance with the terms of its agreements and with the approval of the Committee on Research Activities and to distribute such reports to all States and the Public Roads Administration.

Three projects have been undertaken to date, under the procedures thus outlined. These projects are described as follows:

Road Test One-MD. Road Test One-MD was a field research project designed to determine the relative effects of 18,000- and 22,400-lb. single-axle trucks and 32,000- and 44,800-lb. tandem-axle trucks on a section 24 ft. wide (two 12-ft. lanes) reinforced-concrete pavement located on US 301, in southern Maryland about 45 mi. south of the District of Columbia. The cost was borne by the cooperating agencies through cash contributions totaling $150,000 from the highway departments of Connecticut, Delaware, Illinois, Kentucky, Maryland, Michigan, New Jersey, Ohio, Pennsylvania, Virginia, Wisconsin, and the District of Columbia and through contributions of personnel, equipment, and services with an estimated value of

$95,000 from the Bureau of Public Roads, seven truck manufacturers, fourteen petroleum companies, and the Department of Defense. Traffic tests were completed in 1950, soil and strain tests in 1951, and the analyses of these data were completed and approved by the advisory committee in April 1952. The final report covering all features of the test was released in August 1952.

WASHO Road Test. This field research project was designed to determine relative effects of 18,000- and 22,400-lb. single-axle loads and 32,000- and 40,000-lb. tandem-axle loads on flexible pavements with thicknesses ranging from 6 to 22 in. A special pavement section for the test was constructed by the Highway Research Board on a relocation of Route 191 in southeastern Idaho about halfway between Pocatello, Idaho, and Ogden, Utah. California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming have contributed $315,000 to defray the cost of construction of the road and part of the testing cost. The Bureau of Public Roads is furnishing certain personnel, equipment, materials, etc. estimated at about $70,000. Truck manufacturers, truck trailer manufacturers, and petroleum companies are contributing vehicles and fuel valued at about $150,000 for the test.

Construction was completed in the early fall of 1952 and instruments to study the effects of the test traffic were then installed and controlled truck operations were started in the fall of 1952 and resumed in June 1953. Traffic will be discontinued in November 1953 and started again during the spring breakup period in 1954. A report of the construction, general plans, and instrumentation will be released during 1953.

Effect of Wind Stress on Bridges. A special cooperative research project to investigate, by means of wind-tunnel studies, the effects of wind forces on models of various designs of bridge spans. The project, which was initiated by the Bridge Committee of the American Association of State Highway Officials, is being financed by monetary contributions totaling approximately $14,000 from Colorado, Connecticut, the District of Columbia, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Missouri, New Jersey, Ohio, Oregon, Pennsylvania, Virginia, Washington, and Wisconsin. Further support to this project is being given by the Bureau of Public Roads. Studies were completed during the past year at the U. S. Navy's David Taylor Model Basin Laboratories near Washington, D. C., on model bridge spans under different wind forces and various other considerations. A comprehensive report on the investigation was distributed in September 1953.

Another procedure has been used to obtain comparative test and design information on a regional or national scale, and to promote identical research in a number of states under a variety of conditions. Since the work is to be done in the individual states and the results correlated, a committee of the Highway Research Board, or of the American Association of State Highway Officials, or other highway research agency invites participation of selected states with the understanding that the resulting data submitted will be analyzed and reported. Several cooperative projects have been undertaken in this manner. The cooperative work of the Committee on Load Carrying Capacity of Roads as Affected by Frost Action, conducted by ten states, is an example of this type.

The Bureau of Public Roads provides still another means for cooperative research. To furnish guidance to highway engineers, the Bureau is cooperating in as well as conducting researches in finance, taxation, administration, economics, highway transport, hydraulics, highway materials, methods of construction, and related highway functions.

This research is supported in the highway departments and colleges through federal aid grants. Cooperative research has also been arranged with several nongovernmental organizations which are actively interested in highway research and development. Support for research has been provided in the form of financial and technical assistance, and materials and equipment.

A development in the regional aspect of research is the formation of the Western Interstate Committee on Highway Policy, which resulted from discussions at a meeting of the western regional division of the Council of State Governments in 1949. The Western Interstate Committee is composed of two legislators and the

highway administrator from each of the 11 states in the Western Division. A subcommittee on research was appointed with the following duties:

1. Consider needed areas of research bearing upon the economically healthy development of transportation systems and facilities in the 11 western states, with particular reference to highway transport.
2. Secure information and recommendations on specific items of study of regional value or interest, as a basis for recommendations for action to the Western Interstate Committee.
3. Devise ways and means for stimulating and fostering needed research developments of regional significance, whether the research is conducted as regional activity or by State or national agencies.
4. Suggest a general policy concerning appropriateness of research activities and of regional support thereof.

An example of a method of financing research of the nature suggested by the subcommittee is provided in the laws of Washington. The legislature of that state provided by law for a small highway research fee to be levied on vehicles of over 4,000-lb. gross weight. Revenues for highway research derived from these fees amounts to approximately $90,000 per year and is spent at the joint discretion of the state highway department and the legislative joint fact-finding committee on highways (p. 881, Sec. 48, Chapter 264, Laws of 1951 of Washington).

Regional cooperation in research has been suggested from time to time by which special equipment and selected personnel could be diffused through a region of several states, or concentrated in a single laboratory, to serve the research interests of the whole region under the guidance of a regional research committee.

A number of national agencies[18] serve the state highway departments in their research work. Since this survey was only intended to explore the research organizations directly in and among state highway departments and state colleges and universities, the functions of the national agencies will not be discussed, except for brief review of the functions of the Highway Research Board, which has the function of providing a research correlation service to the state highway departments. The June 30, 1952, Annual Report of the Highway Research Board to the American Association of State Highway Officials says:

Since its inception seven years ago the Research Correlation Service has been developing a practical pattern of usefulness for the highway engineering profession. The utility of the Research Correlation service is now well recognized — the State highway departments have found that this program renders not only the regular service through publications, through personal contacts at Committee Meetings and through periodic visits by the Staff, but provides special help on request. This special help includes assistance in the formulation of research projects and compilation of background reference material, assembly of practices and procedures in the various fields of operations by the several States, and response to requests for up-to-date information on all phases of highway research. Many of the requests are in this form: "We have this problem. Has any other State solved a similar problem? Is anyone working on such a problem? Can you furnish literature on the subject?"

Again this year staff engineers visited all the subscribing highway departments in this country and responded to numerous requests for special information. In addition to this they participated in several lecture courses at road schools and training institutes, prepared critical reviews of research developments, and assisted in the outline of methods of research.

The Board's staff engineers are in the fortunate position of being able to ascertain what is going on throughout the country through their personal visits. Thus the engineers and administrators in each State can draw on the best experience of all other States before attempting to solve a particular problem or before setting up a research program.

RESEARCH PROGRAMS AND OPERATIONS

Several distinctive processes are involved from the inception to the completion of a research project. Certain questions were asked to discover how these processes were accomplished and to see if there were any evident patterns in the methods used. A brief of the questions and answers follow:

Certain questions asked during the canvass related to how these processes were accomplished and the desirable extent of each process.

"How are projects conceived" was one of the questions asked. Answers most frequently given were that projects: (1) grow out of problems; (2) are conceived

[18] Among the National Agencies the National Science Foundation sponsors and encourages basic research in the sciences, including the highway field.

from needs; (3) stem from questions; and (4) come from ideas.

Concisely stated, projects derive from sensitivity and response to problem experiences and the desire to determine the cause of the problem, and also from the desire for expanded understanding of nature's laws.

"How are projects suggested?" Replies to this question were unanimous in advising that anybody could suggest research projects. Suggestions are ordinarily funnelled through the usual channels of communication to the chief engineer or research engineer. Projects growing out of problem experiences are suggested, in large part, from the operating divisions, but projects arising from questions and ideas come from all divisions. A research engineer summed it up by saying: "Submitting projects for research is everybody's business."

"What are the programming processes?" In answer to this question, 18 states reported that programming was the function of a research committee, either formally constituted or of ad hoc type. These committees (variously called "boards" or "councils",) screen suggestions and formulate a working program in light of overall objectives. In some cases the committees serve only in formulating joint or cooperative programs for state highway departments and engineering colleges. In other cases the committee programs all research activities sponsored or operated by the highway department. In nearly all cases the committee serves in an advisory capacity in the formulation of a suggested program for the approval of the chief administrator or an executive committee.

Where no advisory committee exists various persons are responsible for the programming function. In physical research the names most frequently mentioned were: (1) chief administrator, (2) materials and tests engineer, and (3) research engineer.

In nonphysical research, the persons noted as responsible for programming research included: (1) chief administrator and (2) planning engineer.

It was noted that several state highway departments coordinated physical and nonphysical research through a central research committee or chief administrator.

"How much basic research is programmed?" Replies to this question disclosed that a substantial number of highway departments programmed little or no basic research. Those which did include basic research advised that it amounted to about 10 percent in physical research and up to about 25 percent in nonphysical research. The joint research projects, as a whole, reported a higher proportion of basic research than other research units.

"How are project assignments made?" Answers to this question disclosed that the research committees (where existing) suggested appropriate agencies or division of the highway department to operate the research project. Where no committees exist the chief administrator, research engineer, or division engineer makes the assignment.

"How does the individual researcher become orientated with respect to the problem from which the project derived, and how does he obtain service of specialists in diverse fields of science?" This question brought the answer from several states that the instigator of the project or some representative of the division from which the problem came was designated as a consultant or counsellor. It was also brought out that certain college professors were designated to research projects to give the research the benefit of a specialist in a related science. Nearly all of the researchers noted the importance of correlation and communication through consultation and conferences.

"How are the results of research translated into 'findings'?" It was found quite commonly that assistance was given the researcher in analysis of data and in the determination of findings. Conferences are had with the instigator of the project to see if the findings provide the answers he sought, and conferences are also had with counsellors and other members of the staff to make sure that the findings are valid and adaptable.

"How are the reports approved for publication and utilization?" Replies to this question disclosed the research committee as a reviewing board. Where none exist the chief administrator, or sometimes an ad hoc committee reviews the report of findings.

Forms specially designed to aid in keeping records of the individual project are incorporated in the appendix to this report.

UTILIZATION OF RESEARCH FINDINGS

It has been said that there are three major steps to research, namely, scheduling, operating and reporting. But there is another step which is essential if the research is to be of any value: putting research findings to work.

A director of highway research had this to say: "The matter of putting into practice the findings of research is most important. Research is fact finding, and not policy making. So often the research organization is limited as to effective means of putting latest techniques into practice."[19]

How can findings be put to work? This question was asked of all highway departments. The following methods were indicated:

(1) direct responsibility of chief engineer; (2) committees established to handle findings and to recommend their disposition; (3) conferences and staff meetings; (4) memoranda, circular letters, and informational circulars distributed; (5) most of those highway departments having research boards or advisory committees indicated the review and recommendation of disposition of findings as one of the functions of these bodies; and (6) ten reported no formal method of putting the findings to work, but did indicate various informal methods.

To disseminate research reports, 24 highway departments reported research clearinghouses of varying degrees of effectiveness, and 35 reported libraries of varying extent. Nine departments reported full time librarians, and 17 reported systematic routing of current technical periodicals.

Communications were recognized as a vital factor in adaptation of findings as in all other previous steps in research. Therefore provisions should be made for adequate communications.

It was pointed out that responsibility for the function of adapting findings to the various operational fields needs to be defined clearly, whether resident in chief administrator or delegated to a deputy or to a committee. After adaptation of findings in the modification of policies, standards, specifications, or procedures pertinent, dissemination of these adaptations is in order. A committee sometimes has the added function of making a check to determine the results and effectiveness of putting the findings to work.

[19] Excerpt from letter dated October 17, 1952 of Tilton E. Shelburne, director of research, Virginia Council of Highway Investigation and Research.

SUMMARY

Table 1 provides a recapitulation of research expenditures compared to construction and maintenance expenditures as related to pattern of research organization (see also Fig. 12).

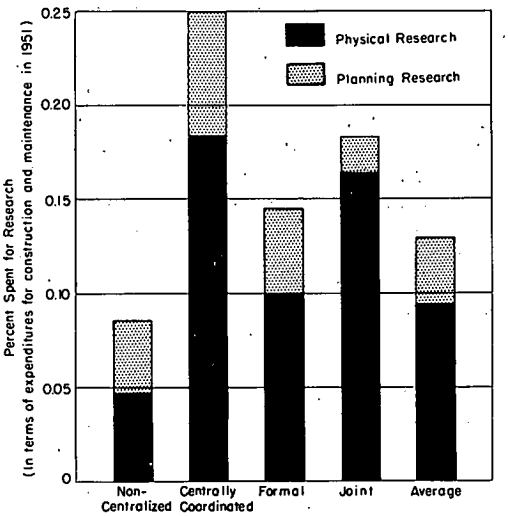


Figure 12. Estimated percentage of construction and maintenance expenditures spent for highway research by type of research organization.

A comparison of estimated expenditures for physical and planning-researches is given in Table 2.

A comparison of the expenditures in Table 2 for planning research, with the expenditures determined in the analysis made of expenditures of federal-aid funds for research, indicates that the expenditures for research reported by the planning engineers may have included some physical researches. The inexactness of breakdown because of this possibility added to the inexactness of estimates, due to the lack of a rigid demarkation between planning researches and planning studies, will explain the seeming conflict between the reports of the planning engineers and the analysis of the Public Roads budget of the 1½-percent funds.

TABLE 1

Pattern of Research Organization	No. of States	(1951) Approx. Research Expenditures	(1951) Approx. Construction and Maintenance Expenditures	Amount for Research
		($1,000)	($1,000,000)	%
Noncentralized	30	700	818	0.09
Centrally coordinated	5	450	178	0.25
Formal	10	950	655	0.15
Joint	6	460	249	0.18
Total	51	2,560	1,900	0.13

The greatest amount spent for highway research in any one state was 0.7 percent (in Iowa).

Basic research, as near as could be determined, constitutes about 10 percent of the total money spent for highway research.

Forty of the 51 highway departments reported an estimated total of 400 researchers (mixed staff of scientists, engineers, aids, and clerks) for physical and nonphysical research. Thirty of the 56 colleges and universities reported 200 researchers (mixed staff of professional, subprofessional, clerical, and graduate and undergraduate students) conducting physical research for the most part.

This review has not attempted to single out any one of the current patterns of organization and administration or combinations thereof as the most desirable for all states. Each pattern has been successfully used. The environment, personalities, and resources will be a determinant and will suggest modification of organizational pattern to secure as many advantages and eliminate as many disadvantages as possible.

TABLE 2

Pattern of Research Organization	No. of States	(Approximate) Research Expenditure Physical	Planning-Researches
Noncentralized	30	$400,000	$300,000
Centrally coordinated	4	295,000	155,000
Formal	11	675,000	275,000
Joint	6	410,000	50,000
Total	51	1,780,000	780,000
%of construction and maintenance		0.094	0.041

REFERENCES

The following references are provided as supplementary reading in the field of research organization. The publications by industry, although discussing methods developed in industrial research, provide information relevant to the highway field.

1. "Review and Directory." Published in alternate years. Engineering College Research Council of the American Society for Engineering Education, Room 7-204, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

2. "Engineering Division Record." Bulletin of the Engineering Division of the Association of Land-Grant Colleges and Universities. Issued three times annually. N. W. Dougherty, Secretary and Editor, College of Engineering, University of Tennessee, Knoxville, Tennessee.

3. "Annual Reports." National Science Foundation. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

4. "Science and Public Policy." A Report to the President by John R. Steelman. U. S. President's Scientific Research Board. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1947.

5. "Research in Industry." C. C. Furnas, Editor. Industrial Research Institute. Van Nostrand, New York, 1948. 574 pp.

6. "Applied Research in the United States." Report of the National Academy of Sciences-National Research Council. Edited by Eugene W. Scott. National Research Council, Washington 25, D. C., 1952, 90 pp.

7. "The Theory and Practice of Industrial Research." David B. Hertz. McGraw-Hill, New York, 1950, 385 pp.

8. "Report on Space Requirements for Scientific Research Laboratories." J. Lorne Gray. National Research Council of Canada, Division of Building Research, Technical Report No. 3, January, 1949. Ottawa, Ontario, 8 pp.

9. "General Electric Creative Engineering Program." L. W. Guth. Educational Service News, January, 1950.

10. "Management of the Well-Developed Research Program." Chemical Engineering, July, 1946.

11. "A Well Founded Research Program: What are the Elements in it?" W. W. Heusner. Sales Management, July 1, 1945.

12. "Research Management." S. C. Ogburn, Jr., Industrial Laboratories, September, 1951.

13. "Putting Research Data to Work." Chemical Industries, December, 1948.

14. "Research: Who, Where, How Much." Chemical Week, October 27, 1951.

15. "University Research Potential."

16. The Surveyor and Municipal and

Engineering College Research Council of the American Society for Engineering Education, Room 7-204, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, July, 1951.

County Engineer, Carlisle House, 8 So. Hampton, London W. C. 1. England, published weekly.

APPENDIX

Forms and Agreement

NO. _____

DATE _____

SUGGESTION FOR RESEARCH

The following research project is suggested:

Brief descriptive title _____

_____

_____

Statement of problem or idea _____

_____

_____

_____

Need for solution _____

_____

_____

Other remarks: _____

_____

_____

Copies as follows:

Signed _____

Title _____

Address _____

_____

_____

Form No. ___

PROJECT IV

APPLICATION OF THE WASHO TEST DATA TO WASHINGTON ROADS

REQUESTED BY: *Washington Highway Users Conference*

APPROVED BY: *Washington State Highway Commission*
Joint Fact-Finding Committee on Highways, Streets and Bridges (Sept. 1952)

RESEARCH AGENCY: *University of Washington*
State College of Washington, cooperating

THE PROBLEM

The test road being constructed at Malad, Idaho, under the auspices of the Western Association of State Highway Officials, will provide invaluable information on the relationships between load, road, and subgrade. For the people of Washington to get maximum return from their investment at Malad, it is necessary that the Idaho test data be interpreted in terms of Washington climate, soils, and traffic before being applied to the roads and highways of Washington.

THE SOLUTION

Data on precipitation, temperature range, and depth of frost penetration are to be collected for the various sections of the state and compared with corresponding conditions at Malad to arrive at relative road costs as these are affected by pavement and base design. The relative effect of subgrade bearing power will be evaluated by collecting existing laboratory test data, and supplementing these with additional tests where information is lacking. Subgrade test data will also be tied to several types of soils classiffications to make the conclusions more useful to all engineers concerned with road building. The field of application of the WASHO test data will also be broadened to include other types of bituminous surfacings and base courses in local use by comparative stability tests on various paving mixes.

PROGRESS: *Investigation started in Autumn 1952.*

A Typical Research Project Report (From First Annual Report of Washington State Council for Highway Research, 1952)

NO. _____

DATE _____

RESEARCH PROJECT PROSPECTUS
OUTLINE

(Project Title) _____

I. The Problem

II. The Objective

III. The Benefits

IV. Suggestions as to Research Procedure

V. Research Agency

VI. Probable Time Required to Complete Proposed Research Project

VII. Probable Cost of Proposed Research Project

Original Research Suggestion by:

_____

_____

Prospectus Prepared by:

_____

_____

(This outline used by the Illinois Division of Highways)

Form No. ___

NO. _____

DATE _____

SCORING OF SUGGESTED RESEARCH PROJECT

Suggestion No. _____

Title _____

Proposed by _____

Considerations involved in justification of Research Project:

1. Value to Highway Department: The proposed research should lead to discovery of laws, behavior, or information in basic or applied research:

	Point Value
a. of great value	_____
b. of moderate value	_____
c. of little value	_____
d. of no value	_____
e. of value to other agencies	_____
f. duplication of previous research	_____

SCORING OF SUGGESTED RESEARCH PROJECT (Continued)

2. Extent of Application

   a. Limited local . . . . . _____
   b. State-wide . . . . . _____
   c. Nation-wide . . . . . _____

3. Adequacy of Research Unit to Conduct Project:

   a. Availability of necessary specialized personnel . . . . . _____
   b. Availability of additional aides . . . . . _____
   c. Availability of necessary specialized equipment . . . . . _____

4. Relative Importance

   a. Adequacy of budget to complete research . . . . . _____
   b. Cost vs. benefits — reasonableness of budget . . . . . _____
   c. Relation to other suggested projects . . . . . _____
   d. Priority assignment . . . . . _____

Recommendation _____ Total Points _____

Adapted from Form developed by National Science Foundation
Form No. ___

NO. _____

DATE _____

NOTICE OF DECISION
On Suggestion for Research

TO: RESEARCH UNIT

THE SUGGESTION FOR RESEARCH NO _____ SUBMITTED UNDER DATE OF _____ HAS BEEN CONSIDERED AND THE FOLLOWING DECISION MADE:

DESCRIPTIVE TITLE _____

_____

_____

DECISION:

Approved _____

Postponed _____

Rejected _____

REMARKS _____

_____

_____

Copies as follows:

SIGNED _____

(Title) _____

Note: Approval does not constitute authorization. Requests for authorization to be made by Research Unit at appropriate time preceding starting date of research project.

Form No. ___

PROJECT NO. _____

DATE _____

AUTHORIZATION
For Expenditure of Funds for Research

TO _____
(Name of Research Unit)

Research has been authorized as follows:

_____

_____

TITLE OF PROJECT _____

_____

_____

Expenditures not to exceed _____ are hereby authorized.

To be charged to _____

_____

SUGGESTION NO. _____ DATE _____

SUGGESTED BY _____

DECISION NO. _____ DATE _____

Minute Order No. _____ Date _____

Signed _____
Secretary, State Highway Dept.

_____
Date

Form No. ___

HIGHWAY RESEARCH BOARD

STATUS OF RESEARCH PROJECT SUGGESTIONS

_____ DATE

Research Project Suggestion No.	TITLE OF PROJECT	Source of Suggestion and Date Received	Estimated Cost	Project Period in Years	Action upon Suggestion		Hwy. Commission Research Project No.	Agency to Conduct Project
					By Board and Date Taken	By Commission and Date Taken		

(This form prepared and used by the Iowa State Highway Commission)

NO. _____

RESEARCH PROJECT REPORT

State _____ Date _____

Title of Project _____

Date started _____ Date of Completion _____

Sponsoring Agency (Name) _____
(Highway Department, College, Industry, Federal Government, other)

Operating Agency (Name) _____
(Highway Department, College, other)

The Problem _____

Scope of Investigation and Method of Solution _____

Present status _____

Reports issued, Titles and Date, Medium of Publication _____

Have reports been published in other media? _____

Will subsequent reports be issued? Titles and Dates _____

Permission to circulate or abstract reports: Yes _____ No _____

Personnel in charge: _____

Remarks: _____

Information furnished by _____

_____
Title

(H. R. B. Form)

BASIC AGREEMENT

for

ILLINOIS COOPERATIVE HIGHWAY RESEARCH PROGRAM

Illinois Division of Highways and University of Illinois

I. Parties to Agreement: This Agreement is made by and between The Board of Trustees of the University of Illinois, a public corporation, Urbana, Illinois, party of the First Part, hereinafter called the UNIVERSITY, and the State of Illinois, Department of Public Works and Buildings, Division of Highways, Springfield, Illinois, party of the Second Part, hereinafter called the STATE.

II. Character of Agreement and Program: (A) This is an agreement to establish and provide for the operation of a continuing program of cooperative highway research by the STATE and the UNIVERSITY which shall be known as the:

ILLINOIS COOPERATIVE HIGHWAY RESEARCH PROGRAM

Illinois Division of Highways and University of Illinois

hereinafter referred to as the PROGRAM. This agreement shall be referred to as the BASIC AGREEMENT.

(B) Except for the general administration of the PROGRAM which is indicated in various sections of this BASIC AGREEMENT, the PROGRAM shall consist of individual research projects, each a cooperative investigation in a particular field of highway engineering, with sufficiently defined limits to permit a clear determination of the overall objective of the project.

III. Purpose: (A) The general purpose of the PROGRAM is to secure and analyze data and to develop facts and information which will define the governing principles and will advance the science of highway engineering for practical application in using in the most efficient and economical manner the public moneys now available for highway improvement purposes.

(B) The specific purposes of the PROGRAM are:

(1) To provide the administrative facilities and to establish the procedures necessary for the proper coordination and planning and the efficient execution of the individual cooperative highway research projects under the PROGRAM.

(2) To provide a medium for the exchange of pertinent information with other highway research agencies and to provide methods for the prompt dissemination to practicing highway engineers in Illinois of any useful knowledge acquired.

(3) To provide a balanced and reasonably uniform program of cooperative highway research projects on a continuing basis which will permit proper scheduling and efficient use of UNIVERSITY personnel, space, and equipment.

IV. Project Agreements for Cooperative Investigations: (A) No cooperative investigational work shall be undertaken on any individual research project under this PROGRAM until a prospectus which assigns a project title, clearly states the objective, and outlines the general plan for the project has been prepared and approved, and until a project agreement has been properly executed, by the STATE and the UNIVERSITY authorizing the particular project.

(B) (1) Each project agreement for a cooperative investigation, hereinafter referred to as a PROJECT AGREEMENT, shall be executed in writing as a supplemental agreement to this BASIC AGREEMENT and shall follow the general form shown on the attached sheet marked: Sample Form, Enclosure No. 1 to BASIC AGREEMENT; and entitled: PROJECT AGREEMENT for COOPERATIVE INVESTIGATION.

(2) PROJECT AGREEMENT shall be for fiscal year periods, July 1 to June 30, or any portion thereof.

(3) By an agreement in writing executed by the STATE and UNIVERSITY a PROJECT AGREEMENT may be extended for additional fiscal year periods or portions thereof under the same terms or under such other terms as may be mutually agreed upon, provided such terms are not in conflict with any provisions of this BASIC AGREEMENT including any subsequent amendments thereto. The University of Illinois form for: RENEWAL OF AGREEMENT FOR COOPERATIVE INVESTIGATION (copy attached hereto and marked: Sample Form, Enclosure No. 2 to BASIC AGREEMENT) may be used for the renewal of PROJECT AGREEMENTS.

(C) All existing agreements and renewals of agreements between the STATE and the UNIVERSITY in effect for the fiscal year 1951-52 shall be considered to be a part of the PROGRAM effective July 1, 1951. Where the terms of existing agreements or renewal agreements are in conflict with the provisions of this BASIC AGREEMENT, the terms of the existing agreements shall govern until July 1, 1952. At that time all agreements and renewals shall be made to conform to this BASIC AGREEMENT.

V. Program and Project Funds: (A) No specific fund will be provided for the general administration and supervision of the PROGRAM since the costs of such administration and supervision are to be borne directly by the STATE and the UNIVERSITY respectively, as specified in Section VI.

(B) (1) A project fund to cover expenses incurred by the UNIVERSITY and to be paid by the STATE according to the terms of Section VI for the period of each PROJECT AGREEMENT or RENEWAL AGREEMENT, shall be made available by the STATE for each separate cooperative investigation in the amount stated in the PROJECT AGREEMENT or in the RENEWAL AGREEMENT. The procedure for transferring the project funds to the UNIVERSITY and for the accounting for these funds to the STATE shall be determined from time to time by agreement between their respective authorized representatives and shall be evidenced either by formal written agreements or by written memoranda.

(2) The charges made by the UNIVERSITY to the STATE under any PROJECT AGREEMENT or RENEWAL AGREEMENT for any cooperative investigation shall not exceed the amount specified in the PROJECT AGREEMENT or the RENEWAL AGREEMENT including any subsequent amendments thereto, or the actual cost incurred in the investigation which is chargeable to the STATE according to Section VI.

VI. Responsibilities Assumed: (A) In furtherance of the PROGRAM to be conducted hereunder, the STATE agrees:

(1) To assign one or more members of its staff to cooperate with the officials and staff members of the UNIVERSITY in the planning and administration of the PROGRAM, in the conduct of the investigations, and in the preparation of all reports. Payment of the salaries and expenses of such staff members shall not be made a charge against any project fund under the PROGRAM.

(2) To appoint, with the consent and approval of the individuals and agencies concerned, a Project Advisory Committee for each cooperative investigation. All agencies cooperating directly with the STATE for a cooperative investigation shall be represented on the Project Advisory Committee for that investigation. The Project Advisory Committee shall provide the project supervisor in immediate charge of a specific project and the project investigator on the project with technical advice and with suggestions for work programming to promote the efficient and prompt attainment of the research objective as set forth in the approved prospectus for the project. No compensation will be paid from project funds to members of a Project Advisory Committee by virtue of their service on that Committee.

(3) To pay through project funds the cost of labor and salaries of the special staff assigned by the UNIVERSITY to each cooperative investigation under the PROGRAM, and the compensation of consultants who may be retained.

(4) That a sum equal to 1-½ % of that portion of each special staff member's salary, as is paid from project funds, shall be transferred to UNIVERSITY funds for a reserve against contingent liabilities under the Workmen's Compensation Act. Also, if the UNIVERSITY is required to contribute a sum to the University Retirement System of Illinois on behalf of any special staff members who are participants in that system, the UNIVERSITY shall be reimbursed from project funds as to that portion of the sum which is based on a percentage of the staff members' salaries paid from these funds.

(5) To pay through project funds the cost of materials, supplies and equipment, the cost of publication of the results, and all other expenses necessary for the proper carrying on of each cooperative investigation under the PROGRAM, exclusive of such costs as are to be borne directly by the STATE and the UNIVERSITY according to the terms of this BASIC AGREEMENT.

(6) To deposit with the UNIVERSITY as project funds at such times and in such amounts as may be mutually agreed upon by authorized representatives of the STATE and the UNIVERSITY for expenditure during the period of the PROJECT AGREEMENTS and RENEWAL AGREEMENTS such sums of money as are needed to pay, as they are incurred, those costs of the projects which are chargeable to the STATE, but in no case shall the total amount deposited with the UNIVERSITY during any fiscal year exceed the total of the amounts stated in the PROJECT AGREEMENTS and RENEWAL AGREEMENTS including any subsequent amendments thereto for that fiscal year.

(B) In furtherance of the PROGRAM to be conducted hereunder the UNIVERSITY agrees:

(1) To assume, under the advice and general direction of the STATE, direct charge of each cooperative investigation which may be established under the PROGRAM; to supervise, direct, and prosecute or cause to be prosecuted all experimental and analytical work, the computation and reduction of the results obtained, and the placing of the data in form for presentation.

(2) To assign such members of its staff as may be necessary to supervise and direct the PROGRAM as a whole and each of the investigations under it. One member of the UNIVERSITY staff approved by the STATE shall be designated to coordinate, supervise, and direct the PROGRAM, through appropriate channels. This staff member shall serve as the medium of contact between the STATE and the UNIVERSITY on all matters of administration and operation relating to the PROGRAM. Payment of salaries and expenses of such staff members shall not be made a charge against any project funds, except in special cases where the services of individuals in connection with the supervision and direction of the PROGRAM are desired during the summer months beyond the requirements and obligations of their UNIVERSITY contracts. In these special cases the salaries and expenses of the designated staff members may be paid from appropriate project funds, provided specific approval is obtained from the officials of the STATE in each case.

(3) To employ research staff, mechanicians, clerks, typists, and other help necessary for the effective prosecution of the PROGRAM. The salaries of such employees shall be paid from project funds. Members of the special staff for all projects shall be regarded as members of the research corps of the Engineering Experiment Station of the University during their connection therewith.

(4) To furnish, without charge, the rooms necessary for this PROGRAM, together with light, heat, power, and water, and to permit the use of such laboratory apparatus and experimental facilities as it may possess which are not in use for other purposes.

(5) To purchase or construct such special apparatus and equipment as may be necessary and which may not be available in the laboratories of the UNIVERSITY, the cost of such items to be charged to project funds.

(6) To permit representatives of the STATE, the Bureau of Public Roads and other cooperating agencies to observe the work in progress at all reasonable times.

(7) To keep accurate records of the nature and character of the work undertaken, of the work performed, and of the analysis of the assembled data.

(8) To prepare and submit to the STATE on June 1 of each year annual progress reports for each project undertaken as part of the PROGRAM, and such other interim reports as may be deemed necessary by the STATE.

(9) To prepare and submit to the STATE at the conclusion of the experimental and analytical work on each project a complete and comprehensive report for the project.

(10) To keep accurate records for each separate project of all disbursements made and expenses incurred and to make a proper accounting of each project to the STATE for such disbursements as may be chargeable to it under this agreement.

(11) To refund to the STATE any unexpended or unobligated balance of the deposit remaining at the end of the period of any PROJECT AGREEMENT or of any RENEWAL AGREEMENT, unless by the terms of a subsequent RENEWAL AGREEMENT such remaining balance is to be continued to the credit of the account for expenditure during the period of such subsequent RENEWAL AGREEMENT.

VII. Ownership of Equipment: It is mutually agreed by and between the parties hereto that all apparatus and equipment purchased with funds provided by the STATE and which are of such nature that they may be used by the Division of Highways in the conduct of its work shall remain the property of the STATE.

VIII. Records, Publications, and Publicity: It is further agreed that all records are to be the property of both parties. The original copies are to be kept on file by the UNIVERSITY, but copies of the test data shall be furnished to the STATE on request. Each party shall have the right to publish the results of any investigation provided the manuscript for each such publication is submitted to and approved by the other party prior to publication. Any disapproval of such manuscript must be based upon reasonable grounds specifically stated in writing. The publication shall contain a description of the investigation and a report of the results and conclusions. All publications giving the results of any investigation shall recognize in the text and on the title page its cooperative character.

IX. Patentable Discoveries: It is agreed by the parties hereto that results of experimental work, including patentable discoveries, developed under the direction of the scientific staff of the UNIVERSITY, belong to the UNIVERSITY and will be used and controlled so as to produce the greatest benefit to the public.

X. Worker Discrimination: In the performance of the work required by this agreement, the UNIVERSITY shall not discriminate against any worker because of race, creed, color, or national origin.

XI. Duration of Agreement: This BASIC AGREEMENT shall be effective as of July 1, 1951 and shall continue in full force and effect in its present form or as subsequently amended until such time as it may be terminated by the mutual consent of both parties, or until terminated by notice in writing given by one party to the other at least six months prior to the date upon which the termination is to become effective, with the understanding that such termination shall not extinguish the duty of both parties to complete any PROJECT AGREEMENT or renewal thereof for which obligations were made or upon which work was started before the notice to terminate is given.

XII. Execution of Agreement: This agreement is hereby executed upon the completion of the indicated signatures by each of the parties.

Approved by:

THE BOARD OF TRUSTEES OF
THE UNIVERSITY OF ILLINOIS

By _____
Comptroller

_____ _____
Head of Department (Date)

By _____
Secretary

_____ _____
Dean or Director (Date)

Approved by: (Continued)

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS
AND BUILDINGS
DIVISION OF HIGHWAYS

_____ _____
Legal Counsel (Date)

_____ _____ By _____
Busar/Business Mgr. (Date) Chief Highway Engineer

_____ _____ By _____
For the President (Date) Director

Date of final signature completing this agreement _____

Sample Form
Enclosure No. 1 to
BASIC AGREEMENT

PROJECT AGREEMENT FOR COOPERATIVE INVESTIGATION

SUPPLEMENTAL AGREEMENT

to

BASIC AGREEMENT

for

ILLINOIS COOPERATIVE HIGHWAY RESEARCH PROGRAM

Illinois Division of Highways and University of Illinois

I. As a supplemental agreement to and in full conformity with the terms and requirements of BASIC AGREEMENT for ILLINOIS COOPERATIVE HIGHWAY RESEARCH PROGRAM, Illinois Division of Highways and University of Illinois, effective _____, 19 __, as amended by:

Basic Agreement Amendment No.	Date Effective	Basic Agreement Amendment No.	Date Effective

this agreement between the Board of Trustees of the University of Illinois and the State of Illinois, Department of Public Works and Buildings, Division of Highways, for a cooperative investigation to study

for the period _____, 19__ to _____, 19 __, is hereby executed upon completion of the indicated signatures by each of the parties.

II. The immediate purpose of this investigation is

III. The STATE agrees to pay the UNIVERSITY the sum of $_____ to provide for the STATE's share of the expenses of this investigation as prescribed in the BASIC AGREEMENT.

Approved by:

THE BOARD OF TRUSTEES OF
THE UNIVERSITY OF ILLINOIS

_____ _____ By _____
Head of Department (Date) Comptroller

_____ _____ By _____
Dean or Director (Date) Secretary

Approved by: (Continued)

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS
AND BUILDINGS
DIVISION OF HIGHWAYS

Legal Counsel (Date)

Busar/Business Mgr. (Date) By Chief Highway Engineer

For the President (Date) By Director

Date of final signature completing this agreement _____

Sample Form
Enclosure No. 2 to
BASIC AGREEMENT

UNIVERSITY OF ILLINOIS

RENEWAL OF AGREEMENT FOR COOPERATIVE INVESTIGATION
under the
ILLINOIS COOPERATIVE HIGHWAY RESEARCH PROGRAM
Illinois Division of Highways and University of Illinois

RENEWAL OF ARTICLES OF AGREEMENT between the Board of Trustees of the University of Illinois, and the

State of Illinois
Department of Public Works and Buildings
Division of Highways

hereinafter designated as the Sponsor.

WHEREAS, the parties identified above entered into an agreement for a cooperative investigation to study

the period of which extended from _____, 19____, to _____, 19____, and which was subsequently extended for the period beginning _____, 19____, and terminating _____, 19____.

WHEREAS, said parties desire to extend such agreement beyond the date of termination indicated above,

THEREFORE, said parties now mutually agree to the renewal of said agreement for the period beginning _____, 19____ and extending to _____, 19____ under the same terms and conditions as set forth in the original agreement with subsequent amendments. The Sponsor agrees to pay the University the additional sum of $_____ to provide for the expenses of the investigation, and agrees further (See*)

This renewal of the aforesaid agreement is hereby executed ~~this xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx~~ upon the completion of the indicated signatures by each of the parties.

* that the balance remaining in the project fund account as of _____, 19__, shall be continued to the credit of the account for expenditure during the period of this renewal agreement.

APPROVED BY:

Head of Department (Date)

Dean or Director (Date)

Legal Counsel (Date)

Bursar/Business Manager (Date)

For the President (Date)

THE BOARD OF TRUSTEES OF THE UNIVERSITY OF ILLINOIS,

By _____
Comptroller

By _____
Secretary

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS AND BUILDINGS
DIVISION OF HIGHWAYS
Sponsor

By _____
Chief Highway Engineer

By _____
Director

(45239)

Date of final signature completing this agreement _____.

Note: This form was used as a basis for the Highway Research Board Canvass of 1952

State _____ 3/27/52

48 State Canvass on

Research Organizations in the State Highway Departments

Purpose of Canvass: To compile an inventory of organizational types and functions to be published in bulletin form answering frequent questions received on this subject.

Questionnaire

A. THE FORMAL RESEARCH DIVISION:

1. Do you have a formal research unit in the highway department: (Do not include co-operative or joint research programs — shown below under "C"). Yes _____ No _____

   Name _____ When established _____

2. How did the research division come into being? Was it the result of legislation, written agreement, Minute Order, directive, or informal action?

   (Are copies of any printed material relating to establishment and history available?)

3. Does the research division farm out any or all of its research projects? Yes _____ No _____

   If so, to whom?

4. Does the research division engage in operating its own research projects? Yes _____ No _____

B. RESEARCH WORK IN OPERATING DIVISIONS:

5. Is research work undertaken by any of the individual operating divisions? Yes _____ No _____

6. If research work is done by individual operating divisions, is it scheduled as part of an over-all planned program by a director of research, or is it planned by and carried out within each operating division?

C. THE JOINT ORGANIZATION, OR CO-OPERATIVE ENDEAVOR:

7. Do you have a co-operative or joint program with any of the following:

   State University (Name) _____

   Bureau of Public Roads (Thru Planning Survey, or direct) _____

   Industry (Name) _____

   Other (Name) _____

8. Was the co-operative or joint research work inaugurated informally, or by Minute Order, written agreement, or legislation? Copies Available?

9a. Is the co-operative research work done by a special organization jointly sponsored by highway department and university similar to the Purdue Joint Highway Research Project, or by the regular faculty and students. (Distinguish between a joint organization, and a co-op. endeavor)

9b. What is the name of the joint highway research organization? _____

D. THE RESEARCH PROGRAM:

10. Is there a highway research advisory group set up to help formulate and plan the over-all research program? Yes _____ No _____

11. What engineers,(or others), comprise the advisory group?

12. How are the research projects conceived and developed into a program?

13. Who (what engineer, or group) is responsible for the different phases of research:

	Physical	Planning-Research
(a) Programming research projects		
(b) Planning research projects		
(c) Operating research projects		

14. (a) What proportion of your physical research is basic research? _____%

(b) " " " " planning-research is basic research? _____%

15. What proportion applied research? _____%

16. Which operating divisions if any are now doing research in the following fields:

Economic _____

Finance and Taxation _____

Administration _____

Traffic and Safety _____

Construction _____

Maintenance _____

Materials _____

Soils and Geology _____

Geometric Design _____

Structural Design _____

Location _____

Roadside Development _____

Other _____

E. THE RESEARCH PROJECT:

17. In planning the individual project —

(a) Is a written project statement prepared ? Yes _____ No _____

(b) Is library research conducted and findings reported in writing?
Yes _____ No _____

(c) Are research methods discussed and written up? Yes _____ No _____

18. Is there a means for the project research engineer in the formal research division to get together with designated non-administrative engineers in the operating divisions to obtain ideas? — or with professors at the university?

F. THE RESEARCH CLEARING HOUSE:

19. Do you have a clearing house on research to collect research reports from outside sources, screen for pertinent findings, recommend use of findings?
Yes _____ No _____

20(a)Do you have a reference library? Yes _____ No _____

(b)Do you have a full-time or part-time librarian?
Full _____ Part _____ None _____

(c)Do you distribute listings of current literature periodically?
Yes _____ No _____

G. ADAPTION OF FINDINGS:

21. Is there an established means of getting research findings of your own used in everyday operations (such as in specifications, standards, etc.)?
Yes _____ No _____

22. What means (committee or other?)

H. THE RESEARCHERS EMPLOYED:

23. Is research done by specialists on full-time basis, or done in spare time by engineers who are engaged primarily in other work?

24. How many employees are engaged in research operations?

If employees in Materials and Tests, or Highway Planning are counted, show how much of their time is devoted to research (developing and testing new methods, procedures — not routine acceptance testing nor routine, conventional planning studies?

I. THE FINANCIAL ASPECTS:

25. How much money was spent in 1951 on research Physical $ _____
Planning Division $ _____

(Do not include cost of experimental roads in lump sum for research, nor expenditures for routine testing or planning)

26. Is the Bureau of Public Roads, State University, other educational institutions, or any industry or other agency giving financial support to the research work?

27. What financial arrangements were made with each of the agencies named in Question No. 26?

J. THE PUBLICATION PROGRAM:

28. (1) May we obtain list of current research projects, authorized and in progress?

(2) May we obtain list of research projects completed since January 1, 1951?
(a) Written up
(b) Not written up

K. PICTURES:

29. May we obtain pictures of research laboratory, inside or outside?

L. CLEARING FOR PUBLICATION:

30. With whom shall we clear our write-up before we publish results of this survey?

Answered by:

_____

_____
(Title)

_____

_____
(Title)

Form No. ___

Highway Research Board
2101 Constitution Avenue
Washington 25, D. C.

3/28/52

Note: This form was used by the University of Tennessee in its survey of highway research in colleges and universities.

REQUEST FOR INFORMATION REGARDING HIGHWAY RESEARCH

1. Name of institution or department _____

2. A. Does your institution, or department, engage in a definite and continuing highway research program _____

B. Is it the policy and practice to engage in occasional highway research in connection with other activities? _____

3. Approximately what is the extent of your program in the following particulars?

A. Annual expenditures

B. Value of physical plant used for highway research

C. Number and class of personnel engaged: Professional _____
Sub-Professional _____
Clerical _____
Student, undergraduate _____
Student, graduate _____

(Note: For uniformity, show all personnel on the basis of equivalent full-time employees.)

D. Overhead (housing, utilities, etc.) _____

E. Others, if any (Explain) _____

5. A. Approximately what percent of the total used to support your highway research program is derived from Federal funds? _____

B. Of the total non-Federal funds used to support your highway research program, what percent is derived from each of the following sources?

State highway road use and gasoline taxes _____

County highway funds _____

Municipal street funds _____

State-supported college or university _____

Other (Explain) _____

6. A. Is there in your state a cooperative highway research program administered jointly by the state highway department and the state university (or other state-supported college)? _____

B. If no formal cooperative program is in effect, to what extent does the state university (or other engineering colleges of the state) engage in research for the state highway department? _____

C. If a formal cooperative program is in effect, is the administrative authority vested primarily in the state highway department or in the educational institution involved (or other)? _____

D. Did initiation of a cooperative research program require special enabling legislation? _____

E. Is there in your state a highway research board or committee which functions primarily for the benefit of the state highway department, but which is independent of either the highway department or the university? ("Yes" or "No"; explain under "Remarks", below). _____

7. Approximately what percent of total research effort is devoted to each of the following classes of research projects:

A. Fundamental and broad in scope ("long term") _____

B. Fundamental and narrow in scope ("intermediate") _____

C. Superficial ("short term") _____

(NOTE: A specific comparison of materials or methods with little or no attempt to seek out underlying scientific fundamentals should fall in the last classification, even though the actual observations are made over a period of several years, e.g., inservice tests.)

8. Remarks _____

_____

_____

_____

Form No. ___

HRB: M-174

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