Cooperative Research Between State Highway Agencies and Universities

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A study of cooperative research programs between highway agencies and universities in 10 states was conducted. A wide variety of cooperative arrangements was found. Major differences involved the degree of formality in the arrangement, the extent to which the university participated in the specification of the annual research program, funding provisions, and the role of the agency's research director. In all instances, the benefits of cooperative efforts were judged as being well worth the costs. The most successful programs were characterized by the following features: (a) joint participation by both the university and the highway agency in the initial development of the collaborative program; (b) a willing commitment by both parties to make the program work; (c) a truly collaborative, rather than an arms-length, relationship; and (d) lots of time, trust, and patience.

In the interest of developing a more productive research relationship with the universities in the Commonwealth, the Massachusetts Department of Public Works requested the University of Massachusetts Department of Civil Engineering to review cooperative activities in other states and to advise the department on alternative collaborative approaches that it might want to adopt. Discussions were held with highway agency and university personnel from 10 states whose cooperative research programs represent a broad range of approaches; survey materials collected by others were also used. [Note that the agencies and individuals contacted are listed in the acknowledgment at the end of this paper. The authors recognize that variations on the several approaches to research cooperation discussed here undoubtedly exist and would welcome information on which to supplement the findings of this study.] A summary of the major results of this research is provided.

MAJOR TYPES OF COOPERATIVE ARRANGEMENTS

The nature and extent of cooperation between state highway agencies and universities vary considerably among the 50 states. At one end of the spectrum are those state agencies that have vigorous, ongoing research programs, generally conducted in close collaboration with the principal public university in the state under the umbrella of a formal working agreement between the two agencies. At the other end of this spectrum are those state agencies that conduct little or no research and that maintain at best a sporadic relationship with the universities in the state. Although there is no inherent necessity that a strong highway agency research program be conducted in concert with a university, the two usually appear to go together. (The research program of the New York State Department of Transportation appears to be a notable exception to this general rule.) It is generally also the case that in those instances where a close, long-standing relationship exists between the state highway agency and a university, not only is the highway agency's research program strong, but also the university's highway education, research, and public service programs are strong. Often these activities are carried out by the university under the aegis of a clearly identified center or institute established specifically for those purposes.

The major organizational arrangements for highway agency–university collaboration may be categorized as follows:

- *University manages and conducts highway agency's research program.* The oldest and most impressive example of this type of arrangement is carried out between Purdue University and the Indiana Department of Highways under an organizational structure known as the Joint Highway Research Project (JHRP). The JHRP currently receives a sustaining allocation of about $300,000 a year in state funds to which Purdue University adds contributions in kind. In addition, approximately three-fourths of the state's HPR research money is expended by JHRP on projects selected by that program. Other states in which the highway agency's research program is essentially conducted at and by a university are Texas (with Texas A&M and the University of Texas, Austin) and Tennessee (with the University of Tennessee).
- *Highway agency locates its principal research facility and staff on a university campus.* The best established of such arrangements is found in Virginia, where the Virginia Department of Highways and Transportation Research Director and his staff are housed in a research facility built by the department on the campus of the University of Virginia, Charlottesville. The department's research program is developed and implemented by the Virginia Highway and Transportation Research Council, which is jointly sponsored by the department and the university. As far as is known, the only other state in which the highway agency's research staff is housed at a university is Arizona, on the campus of Arizona State University in Tempe.
- *Highway agency research director is an employee of both the highway agency and a university.* The only known example of this arrangement is in the state of Washington, where the Research Director of the Washington State Department of Transportation (WSDOT) is also a full-fledged member of the faculty of the University of Washington. The time of this individual is divided between the highway agency headquarters in Olympia and the university in Seattle. A substantial portion of the agency's research program is conducted by the Washington State Transportation Center (TRAC), a joint creation of the Washington State Department of Transportation, the Uni-

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versity of Washington, and Washington State University. The department's research director serves as the director of TRAC.

- *Highway agency and principal state university establish a general agreement under which research projects are conducted by the university.* This is the least elaborate and most common of the formal arrangements between highway agencies and universities. The Illinois Cooperative Highway and Transportation Research Program, established by written agreement between the Illinois Department of Transportation and the University of Illinois, typifies this type of arrangement. This general agreement provides the framework under which an annual program agreement is developed between the university and the department. The program agreement specifies the individual research projects to be conducted during the year by the university and the funds to be provided by the department for the work. The program director is appointed from the university staff with the department's approval. This individual and one or more additional university staff, along with key department personnel, sit on the Illinois Highway Research Council, which develops the state's annual research program.

A similar arrangement exists in Connecticut between the Connecticut Department of Transportation and the University of Connecticut. The Connecticut Joint Highway Research Council was created pursuant to state statute and funding authorization. Unlike the Illinois program, state funds (currently in the amount of $50,000/year) provide continuing base support for the council's program. The council, which consists of four members of the department of transportation and four members of the civil engineering department of the university at Storrs, develops the transportation department's annual research program. Funding for projects under this program are negotiated by the department with the university and others as appropriate.

Highway Agency–University Agreements

In states in which a formal cooperative research arrangement between the highway agency and one or more universities exists, a written agreement specifying the rights and responsibilities of each party is usually in effect. In several instances, the authority for the agreement is found in a specific legislative act. This is the case, for example, in Connecticut, where explicit statutory authorization exists both for the establishment of a ". . . . Continuing Cooperative Highway Research Program to be undertaken by the Connecticut Highway Department and the University of Connecticut . . ." and for the use of state funds to support this program on a continuing basis. In other instances, the highway agency–university agreement is entered into pursuant to general legislation authorizing such interagency agreements. Such is the case in Washington, where the agreement between the University of Washington, Washington State University, and WSDOT is authorized by the state's Interlocal Cooperation Act.

Reference to state enabling legislation is made in the context of cooperative agreements between a state highway agency and one or more state universities. In every state reviewed thus far, agency–university agreements were limited to public institutions. Where private universities and other nonpublic entities participated in state highway research programs, they did so under a contract limited to a specific project.

Funding Arrangements

As with most other aspects of highway agency–university cooperation, there is considerable variation in funding arrangements from state to state. However, one feature is constant among all states with productive cooperative programs—continuity of funding. This is not to say that large amounts of money are necessarily involved or even that a set amount is guaranteed from year to year. What does hold true is that by practice or written agreement a commitment has been made by the highway agency to sustain a level of support sufficient to elicit a commitment on the university's part to devote sufficient faculty and other resources to meet the highway agency's needs.

In other major respects—whether monies are provided via grants or contracts; whether state funds, as distinguished from HPR monies, are used; and whether reimbursement is limited to direct project expenses or also cover university administrative costs—state practices vary widely. Most states operate on a contract rather than a grant basis. The major exception is Indiana, where the base support for the Joint Highway Research Project is a grant ". . . for the use and benefit of Purdue University in carrying on programs of highway research . . .". In most states in this study a measure of state-funded support is provided to sustain the cooperative program, with the bulk of the research funding coming from the state's HPR program. This state-funded support ranges from less than $50,000 a year to about $300,000 a year (in Indiana). Indirect costs (overhead) are usually accepted as a legitimate contract cost, although often a reduced rate of overhead is applied. In those instances where both state and HPR funds are used, overhead is often allowed on the HPR funds only.

RESEARCH MANAGEMENT WITHIN THE HIGHWAY AGENCY

The effectiveness of highway research programs, in the view of those interviewed for this study, is related to the commitment to research by upper management in the highway agency. The most important expression of this commitment is the personal involvement of senior management in the research policy board or executive committee that reviews and approves the agency's annual research program. In Washington State, for example, the Research Executive Committee is chaired by the Deputy Secretary of the Department of Transportation; in Indiana, it is the Executive Director of the Department of Highways; and in North Carolina, it is the Assistant State Highway Administrator. Active participation by senior agency executives in the management of the research program not only provides a ready communication channel between the research function and the policy and budgeting echelons of the agency, it also makes it clear to middle managers and their staff that research is considered by top management to be an important activity in fulfilling

the agency's mission to provide safe, effective, and efficient highway transportation to the people of the state.

In addition to the active involvement of one or more senior department executives in the research policy board, participation by the directors of the agency's major functional units, including field directors, is a common feature of most of the programs. Usually one or more university representatives are also included on the policy board. In Connecticut and Indiana, for example, the highway agency and the university are represented in equal numbers.

Of equal importance is the status of the research director in the highway agency hierarchy. The most common placement for the research director is either within the planning or the materials division. In the latter instance, nonphysical research is often conducted through the planning division. Whether the research director is in the planning or the materials division, there are still several layers of authority between the research function and senior management. This being the case, the involvement of a senior department executive in the research policy board becomes even more important. The arrangement in Washington is instructive in this regard. In that state the research director reports to the assistant secretary for planning, research, and public transportation. However, the research director also has direct access to the deputy secretary of WSDOT by virtue of the latter's role as chairman of the research executive committee. The research director of the Virginia Department of Highways is even more favorably situated. He reports directly to the deputy commissioner and, as secretary of the administration board of the Virginia Highway and Transportation Research Council, works closely with the deputy commissioner, who is chairman of the council.

IDENTIFICATION AND SELECTION OF RESEARCH TOPICS

There are two major issues concerned with the identification and selection of research topics. The first issue centers on how research needs are identified within the highway agency and how a list of research topics is established in order of priority from whatever statements of needs are developed. As with almost every other aspect of research management, the range of procedures is large. Until recently, for example, the University of Tennessee Transportation Center, which manages the state's research program, conducted a mini-NCHRP process within the state involving solicitations of research problems from department of transportation staff and University of Tennessee faculty and a lengthy winnowing process that eventually led to the establishment of a priority list of research problem statements. Finding that elaborate process much too unwieldy, the center no longer formally solicits research problems from faculty and department staff, but develops a short list on the basis of informal discussions and its own knowledge and experience.

In Indiana, an advisory board composed of six Purdue University faculty and six Indiana Highway Department staff, including the executive director (or his deputy) as chairman, solicits problem ideas from department personnel at an annual 1-day meeting and then meets almost monthly to review written proposals and approve projects.

In Maryland problem statements are submitted by major unit heads in the Department of Highways and by university faculty to a Research Advisory Council each fall. These statements are distributed to appropriate staff in the department for review and are eventually developed into a draft research program by the chief of the bureau of research. The Research Advisory Committee establishes funding priorities from this tentative program at its spring meeting.

The procedures for the solicitation of and the assignment of priorities to research problems in Illinois follow much the same pattern as that in Maryland with one major difference being the more active role taken by the University of Illinois in this process. Perhaps the simplest procedure is that followed in Connecticut, where the director of the office of research initiates, prepares, and oversees all aspects of the agency's research program.

The second major consideration in the identification and selection of research topics is the position of a research advisory group in this process and the role of the participating university in that group. In every state reviewed, responsibility for the development of the annual program of joint research was vested in an advisory group composed of both university and highway agency personnel. In Tennessee, the University of Tennessee is actively involved in both the advisory group, which recommends the annual research program, and the executive committee, which approves the program.

BENEFITS OF COOPERATION

In every instance in which an active cooperative program exists between a highway agency and a university, both parties interviewed expressed satisfaction with most features of that program. True, concerns about one or another aspect of the relationship were often voiced by either one party or another, but the benefits were considered by most to far outweigh the costs. Although the exact nature and extent of the benefits accruing to the highway agency and the university varied with the type of cooperative arrangement between them, a number of common themes were expressed by all of those interviewed.

The major benefit to the highway agency in maintaining a collaborative research program with a university is the assured access that such collaboration provides to the specialized knowledge available at the university. Such knowledge is not limited to narrow discipline foci, such as engineering materials or geotechnical engineering; equally as important, if not more important, is the general knowledge and experience of faculty in developing and conducting research. Universities are, among other things, research institutions; highway agencies are not, and if the benefits of research are of interest to an agency, it is appropriate that they turn to universities in this regard.

Universities also provide the potential for benefits that go beyond their role as centers of knowledge and research experience. Under the proper circumstances, the university's flexibility in hiring highly qualified technical professionals on a temporary basis can serve to extend the highway agency's staff to meet rapidly changing needs for which research positions within the agency are not available or cannot be filled. In the view of many interviewed, universities are also considered to

be the most-cost effective means for conducting research; no doubt in part because of the availability of student research assistants. The willingness of a university to forego reimbursement for part or all of the administrative cost associated with a cooperative research program is often also a major factor in assuring the competitive position of the university. As an outgrowth of the active involvement of students in agency-funded research, the pool of trained junior engineers who are interested in and knowledgeable about the highway agency is significantly increased. In certain instances, highway agencies have also found that a close working relationship with a major university enhances their ability to attract and retain qualified professionals at all levels.

The benefits of cooperation do not all run in one direction. Cooperating universities benefit in equal degree, if not in identical terms. The most obvious and direct benefit is the financial support that cooperative programs provide to help sustain research activities at the university. The immediate beneficiaries are students, primarily graduate students, who are supported as research assistants. However, because qualified graduate students are the *sine qua non* of a viable program of advanced scholarship and research in a university, the institution gains as well. The institution, if it is a public university, also gains by virtue of the public service aspect of collaboration with another state agency.

Faculty benefit in several ways from programs of cooperative research with highway agencies. Most obvious, although not necessarily most significant, is the additional financial support that faculty and their programs enjoy. This support usually takes several forms: (a) equipment purchases; (b) travel in connection with specific research activities, as well as travel to technical and professional meetings; and (c) supplements to their base university salary. This last form of support is generally limited to the summer period, during which faculty usually are not paid by the university.

Of greater significance is the opportunity that collaboration with a highway agency provides to faculty and their students to work on problems of an immediate and practical nature. Indeed, intimate, sustained exposure of faculty to the day-to-day engineering problems faced by the highway agency was cited repeatedly by those interviewed as a fundamental condition for the existence of a program of collaborative research that is considered useful and worth the time and money invested by the highway agency. Whatever their formal structure, successful collaborative programs share many of the same characteristics that foster this depth of faculty involvement. Among these characteristics are

1. *Joint participation by both the university and the highway agency in the development of the collaborative program.* Both parties are involved from the beginning so that the interests, concerns, capabilities, and limitations of each party are understood by the other and factored into the collaborative arrangement. Participation by both parties at every step also engenders the sense of involvement vital to the development of a good working relationship.

2. *A commitment by both parties to doing whatever may be necessary to make the program work.* On the part of the university this involves a willingness of the faculty who will be involved in the program to spend substantial amounts of time talking with highway agency personnel, on their terms, about their problems. It also requires the willingness of university administrators—from the department head up—to support this type of activity and to reward it. On the part of the highway agency, such a commitment involves a willingness by highway personnel to devote their share of the time and effort necessary to establish a meaningful dialogue with their university counterparts.

3. *A collaborative rather than an arm's-length relationship.* Research is not a commodity or even an engineering service that can be specified, let out to bid, and awarded to the lowest qualified bidder. The most productive collaborative programs are just that—collaborative. In such programs, research problems are identified, refined, and assigned a priority through the joint efforts of highway agency and university staff, and university and agency staff collaborate in the preparation of research task descriptions and, often, in the conduct of the research when appropriate. It is only in the negotiations regarding the specifics of a given contract that an arm's-length position is taken.

4. *Time, trust, and patience.* Underlying all of the preceding characteristics of a successful collaboration are these three eternal verities of productive relationships. When those highway agency–university programs that work best are examined, it is amazing how little meaning there is in formal, written agreements in the absence of these unwritten commitments. At the outset there must be sufficient trust by all parties in the potential benefits in the undertaking and in the determination of all to work for those goals. Then there must be the patience to deal with the inevitable delays, frustrations, and setbacks that are part of any cooperative enterprise. Finally, provisions must be made to sustain the effort over a sufficiently long period of time so that what is sown and cultivated has an opportunity to reach harvest.

The story of the American tourist's admiration of a verdant lawn at Oxford College is worth considering here. When asked how he managed to get such a beautiful carpet of green, the college gardener replied that all it took was a little seed, a little water, and a little rolling. "Is that all?" asked the incredulous tourist. "Aye," said the gardener, "that and 300 years." Perhaps it will not take that long to reap the benefits of investment in a collaborative program of research, but some reasonable span of time must be allowed in which the investment may mature.

ACKNOWLEDGMENTS

The authors are most grateful to Michael D. Meyer, Director of the Bureau of Transportation Planning and Development of the Massachusetts Department of Public Works (MDPW), for his support and encouragement. The assistance of Walter H. Kondo and others in MDPW is also gratefully acknowledged.

The authors would also like to thank the many helpful people in the several highway agencies and universities who provided the information from which this paper is derived. The following list is as complete as the authors can recollect; they apolo-

gize to anyone who has been inadvertently omitted and will be happy to correct such omissions brought to their attention.

Connecticut: Charles E. Dougan, Connecticut Department of Transportation, and Richard P. Long, University of Connecticut.

Illinois: Richard Taylor and Marvin L. Traylor, Illinois Department of Transportation; Morland Herrin and Marshall R. Thompson, University of Illinois, Urbana-Champaign; and Joseph L. Schofer, Northwestern University.

Indiana: Harold L. Michael, Purdue University.

Maryland: A. Haleem Tahir and A. Scott Parrish, Maryland Department of Transportation; Everett C. Carter and Lowell K. Bridwell, University of Maryland.

North Carolina: M. P. Strong, North Carolina Department of Transportation; William F. Babcock and Edwin W. Hauser, University of North Carolina.

Pennsylvania: Barbara Harter and Harvey Haack, Pennsylvania Department of Transportation; Robert D. Pashek, John C. Spychalski, Evelyn A. Thomchick, H. Randolph Thomas, Bohdan Kulakowski, David A. Anderson, and Fred L. Mannering, The Pennsylvania State University.

Tennessee: Michael S. Bronzini, University of Tennessee.

Texas: Clyde E. Lee, University of Texas, Austin.

Virginia: Howard H. Newlon, Jr., Virginia Department of Highways and Transportation; and Lester A. Hoel, University of Virginia.

Washington: V. W. Korf and Robert S. Neilsen (currently with CALTRANS), Washington State Department of Transportation; G. Scott Rutherford, Washington State Department of Transportation and University of Washington.

A Workshop Format for Developing Technology Transfer Materials

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Value engineering, or value analysis, has been used by numerous state highway agencies since the early 1970s, but it has not been widely applied on a smaller scale by local agencies such as counties, municipalities, and townships. The purpose of this project, which was funded under the Rural Technical Assistance Program, is to develop training materials that will support the transfer of the value engineering technique to local highway agencies. In an attempt to ensure that the training materials produced in this project would be appropriate and responsive to local needs, they were developed in a series of four, 1 ½-day workshop sessions held over a 4-month period. The project team provided instruction in value engineering principles, and two value engineering studies were conducted by nine persons from nine different local highway agencies. The participants' comments and questions about the instructional techniques and training materials were used to develop a new 1 ½-day seminar for local highway agencies. Several months later, the participants and the researchers met again, in a day-long session, to review the revised materials, including a slide-tape presentation. The experience gained in the workshop proved to be valuable in clarifying for the researchers the needs of local highway personnel and in identifying the limited applicability of previously developed value engineering training materials.

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Earlier attempts at transferring technology to local transportation agencies have had mixed results. The principal problem appears to have been that the investigators have overestimated or underestimated the level of sophistication and understanding of the audience, primarily local administrators and roadmasters. The purpose of this paper is to describe the lessons learned from using a workshop-oriented approach for developing technology transfer training materials. The project, "Value Engineering for Local Highway Agencies," was sponsored by the Pennsylvania Department of Transportation in cooperation with the Federal Highway Administration, U.S. Department of Transportation, using Rural Technical Assistance Program funds. The objective of the project was to develop a 1 ½-day seminar that would support the transfer of value engineering techniques to local highway agencies.