In general, there is a need to examine more thoroughly the process of research implementation in different contexts. This could be accomplished by several intensive case studies of situations in which the management and conduct of research lead to implementation. These case studies could then be used to further articulate the conditions under which the implementation of research results is most probable. A better understanding of the barriers to research implementation awaits further inquiry.

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University Management of a Transportation Department's Research Program

Don H. Jones and W. A. Goodwin, Transportation Center, University of Tennessee, Knoxville

The Transportation Center of the University of Tennessee has entered into an agreement with the Tennessee Department of Transportation to manage a university research program. Six state universities and the University of Tennessee cooperate in the program. The Transportation Center manages the program as part of its research management functions and is the contracting agency. The commissioner of the Tennessee Department of Transportation and a vice president of the university have the final authority in all contractual matters. An office is maintained within the Tennessee Department of Transportation headquarters. The program encompasses research in all modes of transportation and involves many disciplines. An executive committee formulates policy, approves the work program, and approves the awarding of research to the various institutions. A technical advisory council is responsible for all technical aspects of the program. Monitoring teams work closely with the researchers and are responsible for implementation of research findings. The technical aspects of the program include the formulation of research needs through the development of problem statements, which are ranked in the order of need. The highest-ranked problem statements are developed into requests for proposals and forwarded to the cooperating universities, which respond in accordance with their capabilities. The proposals are evaluated, and an institution is selected to conduct the research. Agreements of understanding then are prepared and executed.

The Tennessee Department of Transportation and the University of Tennessee have developed a research management program that is unique in many respects. The program is organized to function basically along the same lines as the National Cooperative Highway Research Program (NCHRP). From its creation in December 1970, the program has grown from a purely highway-oriented research program to one that encompasses all modes of transportation. The first program director was employed in March 1972 as an assistant director of the university's Transportation Center. This research management program initiated the university's Transportation Center and the Tennessee Department of Transportation's full-fledged University Research Program. Under this program, all state universities in Tennessee are able to participate, and the Tennessee Department of Transportation draws on a vast reservoir of knowledge available through these institutions.

In 1951, the Tennessee general assembly passed an enabling act that authorized the department of highways to enter into an agreement with the University of Tennessee for research in highway design, construction, and maintenance. The act was implemented that same year, when the university and the department of highways established the Tennessee Highway Research Program on the Knoxville campus. The program functioned with an

advisory council, consisting of an equal number of highway and university representatives, that had the responsibility of supervising and directing program activities. A director was appointed by the university, in concert with the advisory council's review, to provide technical direction of the program. Research activities of the program during its 19 years of operation were directed primarily to meeting the department's research needs in the field of highway materials; limited work was performed in the areas of economic benefit and land-use studies.

The department's research needs changed over the years. Its emphasis is now on providing a balanced transportation system for the state. Because of these changing needs and emphasis, the department conducted a careful review of the activities of the Tennessee Highway Research Program, with the intent of recommending changes where appropriate and desirable in order to redirect the resources of this partnership in such a way as to provide a broader base of research support for total transportation throughout the state. This preliminary review included a study of the feasibility of involving all of the state's higher educational institutions in research to the extent of faculty interest and qualifications. In 1970, at the invitation of the department of highways, university staff met with department staff to discuss restructuring the joint program. It was immediately apparent that, in order to meet the total transportation challenge in Tennessee for all modes of transportation, a broader-based organization should be considered.

A joint task group was formed to explore and report on alternatives for structuring and implementing a research program that would assist the department most effectively in meeting its obligations and would provide the basis for initiating a comprehensive transportation research and advisory service program that served all modes of transportation. The task group gave attention to such matters as the need to find useful solutions to problems of immediate concern, the desire to bring researchers in closer contact with persons within the department who are associated with the problems, the need to provide for the implementation of practical and feasible results, the desire to foster development of a program that ultimately can play an important role in the total transportation activity of the state, and the desire to involve the state's several higher educational institutions.

As a result of the task group's report, a formal agreement between the department of highways and the university was signed in December 1970, to establish the University Research Program, which was the beginning of the Transportation Center and its research management program. The agreement ensures a cooperative research program for the department in which all state institutions of higher education, having the necessary facilities and expertise to conduct the needed research, can participate. The current level of funding to support the research to be conducted under this program was authorized by an act of the state legislature, which became effective on July 1, 1970. The administration of the Transportation Center is located within the university structure so as to provide a relationship with the university as well as with the academic units on the main campus at Knoxville and the other campuses. Figure 1 shows that the Transportation Center is not located within a particular college but in the universitywide Office of Graduate Studies and Research.

On July 1, 1972, the Tennessee Department of Highways became the Tennessee Department of Transportation, broadening its scope of responsibility to include all modes of transportation. In September 1972, the Transportation Center became fully functional, with a main office on the Knoxville campus and a satellite office in Nashville, designated as the Tennessee Department of Transportation Division, to manage the University Research Program.

Research projects originate through a technical advisory council. This council is analogous to the committees of the American Association of State Highway and Transportation Officials (AASHTO). An executive committee, which functions similarly to the executive committee of TRB, has the responsibility of reviewing and approving all actions of the technical advisory council. The Transportation Center acts as the managing

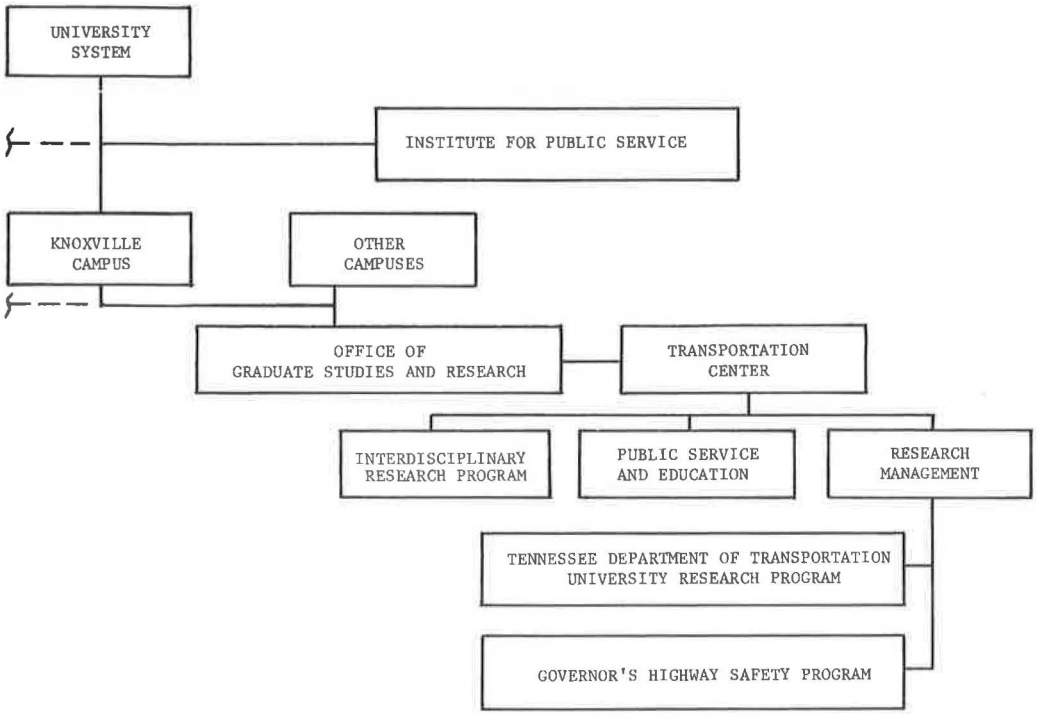


Figure 1. Location of the Transportation Center within the university.

Figure 2. Research management unit of the Transportation Center.

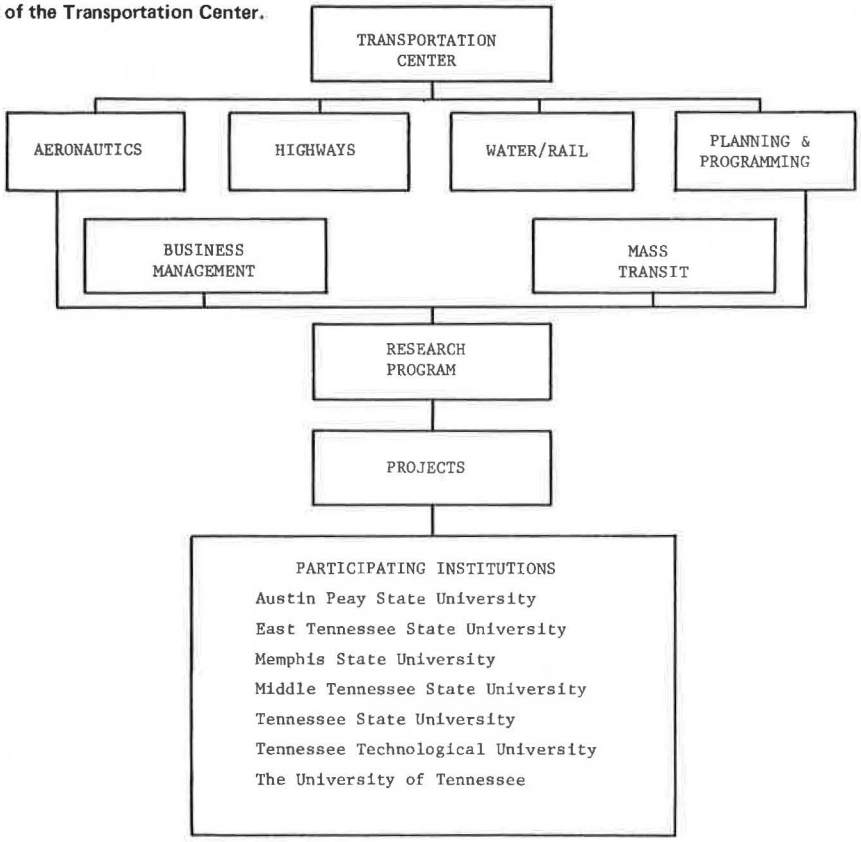
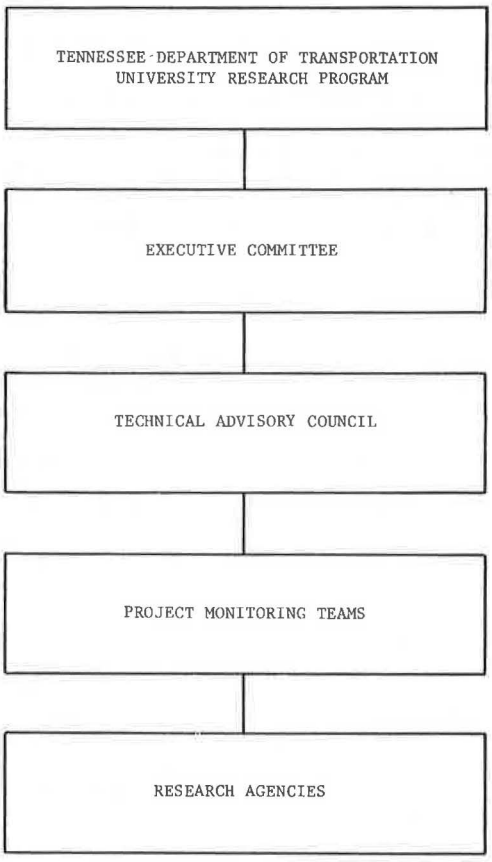


Figure 3. Structure of management units.

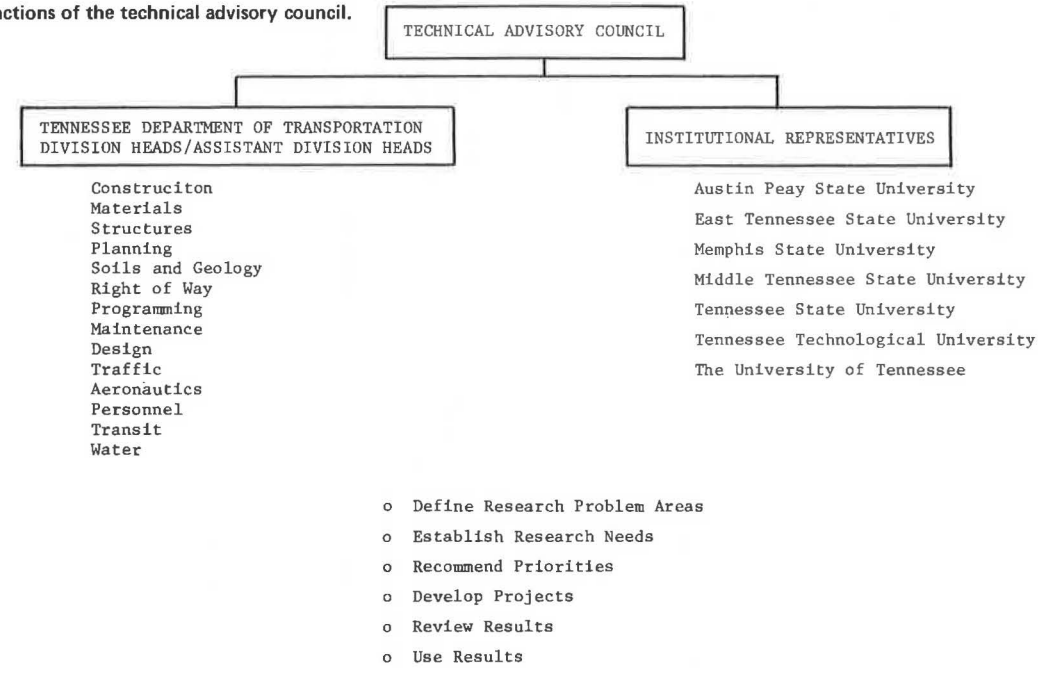


agency for the conduct of authorized research and is officially the contracting authority. The management of the research by the Transportation Center is quite similar in almost every respect to the management of research by NCHRP.

ADVISORY ORGANIZATIONS AND FUNCTIONS

Research, training, and educational activities undertaken in a particular functional area (such as highways, mass transit, or waterways) are carried out with the review, advice, and approval of the technical advisory council. The technical advisory council is composed of technical persons from the various operational divisions within the functional areas. In addition, participating institutions, including the Federal Highway Administration (FHWA), are represented by institutional liaison members, who can participate in the deliberations of the technical advisory council and advise on (among other things) the available manpower to perform studies. Subelements of the technical advisory council (monitoring teams) participate in monitoring the research and aid in implementing research results. An overall policy group (executive committee) sets policies, establishes funding levels, and exercises final approval on programs. The membership of the policy group is composed of the head of each functional area being served. The desire of the Tennessee Department of Transportation is to organize the needed research activities. The general structure of the functional areas as related to the Transportation Center is shown in Figure 2. Figure 3 shows the relationship to the Tennessee Department of Transportation. In order to accomplish the program objectives in an orderly manner, this arm of the Transportation Center is housed physically within the Tennessee Department of Trans-

Figure 4. Functions of the technical advisory council.



portation's headquarter offices in Nashville.

Executive Committee

The executive committee and its chairperson are appointed by the commissioner of the Tennessee Department of Transportation. This policy group has overall responsibility for the program. The committee is made up of the directors of the various bureaus within the department and was established to review, approve, and authorize all actions of the technical advisory council on the research projects funded by the department through the center. The director of the Transportation Center, who is an ex officio member of the executive committee, acts as secretariat to the committee and provides the staff services necessary for the committee to carry out its duties and responsibilities effectively. However, the program director, who is an assistant director of the Transportation Center, is responsible for the day-to-day operations of the program and works closely with the executive committee and the technical advisory council in all matters. The executive committee reviews the progress of the program and recommends to the commissioner the annual appropriation for the operation of the program. The executive committee is responsible for the appointment of members to the technical advisory council. The executive committee also

1. Establishes policy relating to the overall program,
2. Reviews and approves annual obligations,
3. Reviews and acts on recommendations of the technical advisory council, and
4. Counsels the director of the Transportation Center on matters related to its administration.

Technical Advisory Council

The technical advisory council was formed to manage the technical aspects of the department's research. The membership of this council is determined by the executive committee and consists of heads or assistant heads of certain operating divisions from the various bureaus within the department. In addition to these members, institutional liaison representatives are assigned by the various institutions that participate in the program. A representative from FHWA is also included. Monitoring teams are formed as needed to monitor particular research projects and to assist in implementing the results. The program director from the Transportation Center serves as the secretariat to the council. Figure 4 shows the structure of the technical advisory panel. The technical advisory council

1. Meets as often as needed (at least quarterly) to review transportation-oriented activities;
2. Defines problem areas, establishes research needs, and recommends priorities;
3. Establishes projects and studies;
4. Provides counsel and advice regarding technical conduct of projects; and
5. Assists in the dissemination, application, and evaluation of the results of studies and projects.

Specific activities of the council include the following:

1. Identification of the research problem areas;
2. Preparation of definitive statement of objectives for projects within the problem areas (project statements constitute requests for proposals);
3. Review of research proposals and recommendations of research agencies;
4. Designation and organization of teams to monitor project activities; and
5. Specific recommendations for implementation of research findings.

Institutional Liaison Members

Six state universities and the University of Tennessee participate. All of the participating institutions have a representative (institutional liaison member) on the technical advisory council. These institutions may submit proposals on proposed projects for which they have capabilities to conduct the indicated research. These institutions also may submit problem statements to the technical advisory council on any area of research they

deem appropriate. The problem statements are then considered by the technical advisory council in the same light as problem statements generated within the department. Any unsolicited proposals submitted by the institutions are treated as problem statements. Although not a participating agency, FHWA also may be represented by an institutional liaison member. The institutional liaison members

1. Meet with the technical advisory council to review and comment on existing research activities, to discuss proposed research, to explore new research areas, and to advise on methods and procedures for carrying out research;
2. Maintain, for use in the program, a current inventory of researchers and institutional specialists, their areas of interest, and their experience in the field of transportation research; and
3. Provide the point of contact between the Transportation Center (for the department) and the participating institution.

Although the liaison members have no voting responsibility, they may (and are encouraged to) enter into discussions of any issues generated within the technical advisory council and provide any relevant information. In general, they act as an advisory panel to the technical advisory council. They advise on such things as types of research currently under way, capabilities of their institutions in various fields, how general research is conducted, facilities necessary to conduct research in any given area, and the practicality of any problem tendered.

Monitoring Teams

During the conduct of a particular research project, it is desirable to identify the individuals within the Tennessee Department of Transportation who have the greatest need for implementing the results. These persons, along with the assistant director of the Transportation Center (program director), form a monitoring team that visits with the researcher, discusses the work, and maintains a close liaison with the researcher in an effort to use findings as quickly as they become available. Members of the monitoring team are appointed by the chairperson of the technical advisory council and the technical advisory panel member whose unit has the greatest interest in the research. This team may vary in size from a minimum of three (i.e., the department's division representative, the program director, and the researcher) to whatever is needed to aid effectively in the monitoring of the research. The monitoring team

1. Meets at least quarterly with the researcher,
2. Reviews the research progress,
3. Examines the research findings for possibilities for implementation,
4. Determines if the research is on schedule,
5. Determines if the research is proceeding on the proper course or direction,
6. Performs audits as necessary, and
7. Reports findings, results, and recommendations to the technical advisory council.

The program director has the responsibility for scheduling meetings of the monitoring team with the researcher and for providing for presentations of the research results and findings to the various functioning groups. In addition to reviewing the research as it progresses, the monitoring team is responsible for providing information regarding possibilities for implementation in the field and for reviewing and recommending the acceptance or rejection of interim and final reports.

Program Director

The general responsibilities and functions of the Transportation Center's assistant director (program director) assigned to this program are as follows:

1. To serve as secretariat to the technical advisory council working in concert with the council chairperson in carrying out the programs;
2. To provide for the conduct of specific and general research, special studies, workshops, seminars, and training relating to the needs of the Tennessee Department of Transportation;
3. To establish a working relationship and effective communication with other members of the council as related to fulfilling the research, training, and educational needs of the department;
4. To provide for the monitoring of all program research in accordance with the wishes of the council;
5. To provide the necessary coordination and liaison with related programs and other activities, including those within the participating institutions as well as within organizations throughout the country;
6. To provide for systematic review, evaluation, and application of research results;
7. To maintain a continuing awareness and inventory of current and completed research relating to the department's needs;
8. To cooperate in the maintenance and operation of the department's technical library as a measure of providing the needed program materials; and
9. To assist in the review and dissemination of findings and results from the research completed by other agencies, institutions, and organizations.

The program director prepares and distributes requests for proposals. The director is available to provide assistance to the various cooperating institutions in the preparation of problem statements and proposals as well as to assist in other areas of research effort. The director also is responsible for the preparation and execution of any contracts that originate as a result of the activities of the technical advisory council and for obtaining the approval of the executive committee. It is the program director's responsibility to see that monitoring teams are established, to see that the research is progressing as stated in the contracts and proposals, and to see that reports and other informational sources are generated as necessary.

The program director acts through the institutional liaison members in the preparation and development of the contracts, quarterly progress reports, interim reports, final reports, and closing of the projects. The director serves as a contact between the institutional liaison members, various members of the technical advisory council, and other personnel of the Tennessee Department of Transportation. The program director assists the institutional liaison members in gathering information from the various divisions within the department needed in the preparation of problem statements and in the conduct of research projects and other efforts. The program director also acts as a contact for research project directors and potential researchers.

The program director monitors the financial status of the projects and is responsible for assisting in any necessary audits and in the proper documentation and support of project costs.

The technical staff for this program consists of the director and a secretary. (Basically, the program func-

tions by committee.) Additional help is available through the center's main office in Knoxville and through the committees working with the program director. The Tennessee Department of Transportation provides office space, certain office supplies, phone, reproduction facilities, and mailing services for the program director and staff.

OPERATIONAL MECHANICS

The program director is responsible for the generation of problem statements and, at various times (usually annually), initiates requests for problem statements from various organizations. These requests go to all division heads within the department and to responsible regional and field personnel. Requests also are sent to the institutional liaison members of the participating universities and to anyone within the state's educational institutions who has an interest in or knowledge of research needs pertinent to transportation. They also are sent to other governmental agencies, such as metropolitan planning commissions, transportation authorities, city engineers, county highway engineers, city traffic engineers, and certain civic organizations (e.g., Tennesseans for Better Transportation, the Tennessee Roadbuilders Association, and the Highway Users Federation).

When the problem statements are received, they are reviewed by the program director and are coded as to specific areas of interest (e.g., highway safety, public or mass transportation, or water transportation). Then they are forwarded to the technical advisory council members who are working in the area addressed by the problem statement. The program director queries TRB's Highway Research Information Service (HRIS) to determine what research has been conducted or is under way relative to those problems chosen for research in the program. The program director later visits each of the technical advisory council members to review the problem statements forwarded to that particular member. Jointly, the technical advisory panel member and the program director revise the problem statement to meet the specific needs of the department in the area addressed. The problem statements may be expanded to include other areas, or areas in which no additional research is needed may be eliminated. After the problem statements have been reviewed in this fashion, they are presented to the technical advisory council in a formal session, along with a list of the titles of those eliminated through the first process. In the formal meeting, with the assistance of the institutional liaison members, the problem statements may be revised further. If necessary, they are ranked in order of need or assigned a priority rating. The council determines how many of the highest-rated problems should be recommended to the executive committee for funding in the program. The program director transmits the recommendation to the executive committee for review, acceptance, rejection, or revision.

Proposals

On acceptance of the problem statements and authorization for the funding of the projects, the program director meets with the chairperson of the technical advisory council and the technical advisory council member or members responsible for the work in the area addressed by the problem statements. This team prepares the project statement, which sets forth in detail the problem, the proposed research, and the goals and objectives of the research project. When the project statement has been prepared in an acceptable form, it is forwarded as a request for proposals to the participating educational institutions. The institutional liaison members for the participating institutions disseminate the request for proposals to interested members of the institution's staff. Included in the project statement (request for proposals) is a deadline date for submission of the proposal, information pertaining to the preparation of proposals, and estimated cost of the project.

Researchers use different procedures for the preparation of proposals, but, in general, they are prepared in accordance with a set of guidelines provided by the program director. The proposals normally include a proposed research plan, the proposed staffing, an itemized budget, available facilities, what the researcher hopes to accomplish, how the results or findings may be applied, and a suggested implementation plan.

Proposals are submitted to the program director; copies are then forwarded along with a rating sheet to each of the voting members of the technical advisory council, and a formal meeting date of the council is scheduled. Prior to this meeting, the technical advisory panel chairperson appoints an evaluation committee of technical advisory panel members who work in fields related to the proposed research. This committee reviews the research proposals and visits the researchers for a conference, during which various aspects of the proposal are discussed. The committee examines the proposals for relevance and approach, considers the expertise, capabilities, and past performance of the researcher, and determines whether the institution can provide the support and has (or can obtain) the facilities and equipment needed to conduct the research. This committee reports its findings and recommendations to the full technical advisory panel at the formal meeting. At the formal meeting, a session is provided for discussion of the merits of the proposals, rating sheets are completed and tabulated, and the results are posted. The institutional liaison members and program director may participate in the discussions, but they may not vote.

The technical advisory council uses this process to determine which institution will be recommended to the executive committee to conduct the proposed research. The program director submits the proposals and the recommendations of the technical advisory council to the executive committee, which reviews the proposals, ratings, and recommendations of the council and makes the final decision about the disposition of the project and awarding of the contract. The technical advisory council usually recommends a first and second choice, and its recommendations usually are accepted. However, the decision is based on the amount of research being conducted by the institution recommended, the quality of past performance, and the general distribution of the research effort throughout the various cooperating institutions. When the executive committee awards the project, the program director prepares the contract.

Contracts

Contracts are constructed along a standard form, which is altered and structured to fit each research project. Occasionally, the researcher may be requested to submit revisions or supplements to the proposal that, along with addendums, are incorporated into the contract and become a part of it, as does the project statement. Draft copies of the contract are forwarded for review to the institution approved to conduct the research, to the legal staff of the University of Tennessee, and to the legal staff of the Tennessee Department of Transportation. Any changes requested by any of these agencies and agreed on by the others are incorporated in the contract. The program director is responsible for reconciling dif-

ferences. Contracts are approved by the Tennessee Department of Transportation and are executed between the University of Tennessee and the university chosen to conduct the research agency. When the contracts are executed fully, the researcher is authorized to proceed. At this stage, the monitoring team assumes responsibility for the project.

In the conduct of any research through this program, it is the policy not only to avoid discrimination in the research projects but also to avoid discrimination in any endeavor or deliberation of any of the participants. In this regard, all participants endeavor to comply fully with all state and federal laws pertaining to discrimination and with any executive orders of the governor pertaining to this subject.

Project Funding

There are basically three sources of funding. The state legislature in 1970 authorized an annual appropriation to the University of Tennessee for the funding of research projects in this program. In addition to these funds, 1.5 percent of the total federal appropriation for highway construction to the state (called highway planning and research funds) is set aside within the department. Occasionally, the various bureaus will have funds in their budgets for specific research projects.

It is the responsibility of the executive committee to determine from which one of these sources the projects will be funded. It is the responsibility of the program director to recommend to the executive committee the best source of funding. Since all the bureau directors are members of the executive committee, there is a general awareness of funds available through the various bureaus that may be available. Occasionally, a research project not given a high priority by the technical advisory council but considered essential by a bureau director will be funded from that bureau's budget. With the approval of the commissioner of transportation, this may be done without the concurrence of the executive committee. Occasionally, but rarely, a project may arise that other state departments may support. In such instances, the program director, with the help and assistance of the executive committee, may approach that department and arrange for joint funding and the development of a cooperative effort. In most instances, a participating university is willing to share cost for the project. Usually cost sharing takes the form of a reduction in overhead costs.

Implementation

This program is directed more toward the solution of problems of great concern rather than toward the pursuit of pure research in areas hitherto unexplored, although both categories are within the realm of the program and are considered when appropriate. In this respect, implementation of the research findings and results is of paramount consideration. With the aid of FHWA and other transportation research organizations, a set of implementation guidelines was developed. In the development of these guidelines, the need was recognized to consider implementation from the time the problem was conceived until such time after the completion of the project that the possibility of implementation could be rejected or the findings could be implemented as deemed adequate or appropriate.

The guidelines address the subject of implementation, beginning with the development of the problem statement, through the preparation of the request for proposals, the development of the proposals, the selection of the institution to conduct the research, the monitoring-team activities, the preparation of interim and final reports, and a period for evaluation after the completion of the project.

In order to have a successful program of implementing research findings and results, it is necessary for those at all administrative levels within the department to be concerned, to take an interest, and to be willing to accept innovative changes. It is sometimes difficult to realize the value that may result from the findings until they are actually tried. But the main reason for such a rigid implementation program is to prevent good research effort from becoming lost and forgotten and to encourage proper and careful utilization of resources.

SUMMARY

The restructuring of the Tennessee Highway Research Program led to the establishment of the Transportation Center within the Office of Graduate Studies and Research at the University of Tennessee. Although the university has an agreement with the Tennessee Department of Transportation to serve its research needs, the Transportation Center functions as a coordinating and (where appropriate) management unit within the university system. This includes providing public service in conjunction with research to fulfill needs in transportation. The nature of the Transportation Center's organizational structure permits it to serve local, state, and federal agencies and private industry in a variety of ways.

This Tennessee Department of Transportation University Research Program has been functional since 1970 and is continually developing research needs and contracting for specific research projects. (An identical program for managing research under the governor's Highway Safety Program has been functional since July 1976.) The program director for the University Research Program is housed in the department's headquarters in Nashville. This represents a unique approach to managing the department's research and is unlike similar organizations, where a university works with a department in assisting with its research program. This approach is believed to be a vital element in developing a program that not only meets the department's needs but also materially aids in the implementation of research results.