

RESEARCH PLANNING
FOR THE
JOINT HIGHWAY RESEARCH ADVISORY COUNCIL

by

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JHR 91-201

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16. Abstract <p>This report identifies high priority issues and research needs related to the planning, design, construction, maintenance and operation of Connecticut's state highway and publicly funded transit system.</p> <p>The report identifies road-related research needs in a variety of areas, including: travel behavior, economic impacts of large scale transportation projects, shopping center trip generation, electronic road pricing, travel demand management, cathodic protection for bridge members, increased dynamic loading due to settlement at bridge approach slabs, optimum frequency of bridge maintenance activities, effectiveness of bridge deck patching materials, the use of rubber in asphalt, and pile corrosion.</p> <p>Transit related research needs are also identified, including: cost-effective marketing techniques for small and medium size operators, most effective roles for Transit Districts, coordination of public transit services, integration of funding sources, privatization, innovative approaches to the reduction of operating costs, training, standardization of accessibility equipment for the disabled, and vehicle procurement.</p>					
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				APPROXIMATE CONVERSIONS TO SI UNITS			
Symbol	When You Know	Multiply By	To Find	Symbol	When You Know	Multiply By	To Find
<u>LENGTH</u>				<u>LENGTH</u>			
in	inches	25.4	millimetres	mm	millimetres	0.039	inches
ft	feet	0.305	metres	m	metres	3.28	feet
yd	yards	0.914	metres	m	metres	1.09	yards
mi	miles	1.61	kilometres	km	kilometres	0.621	miles
<u>AREA</u>				<u>AREA</u>			
in ²	square inches	645.2	millimetres squared	mm ²	millimetres squared	0.0016	square inches
ft ²	square feet	0.093	metres squared	m ²	metres squared	10.764	square feet
yd ²	square yards	0.836	metres squared	m ²	hectares	2.47	acres
ac	acres	0.405	hectares	ha	kilometres squared	0.386	square miles
mi ²	square miles	2.59	kilometres squared	km ²			
<u>VOLUME</u>				<u>VOLUME</u>			
fl oz	fluid ounces	29.57	millilitres	mL	millilitres	0.034	fluid ounces
gal	gallons	3.785	Litres	L	litres	0.264	gallons
ft ³	cubic feet	0.028	metres cubed	m ³	metres cubed	35.315	cubic feet
yd ³	cubic yards	0.765	metres cubed	m ³	metres cubed	1.308	cubic yards
<u>MASS</u>				<u>MASS</u>			
oz	ounces	28.35	grams	g	grams	0.035	ounces
lb	pounds	0.454	kilograms	kg	kilograms	2.205	pounds
T	short tons (2000 lb)	0.907	megagrams	Mg	megagrams	1.102	short tons (2000 lb)
<u>TEMPERATURE (exact)</u>				<u>TEMPERATURE (exact)</u>			
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C	Celcius temperature	1.8C + 32	Fahrenheit temperature

NOTE: Volumes greater than 1000 L shall be shown in m³.

*SI is the symbol for the International System of Measurement

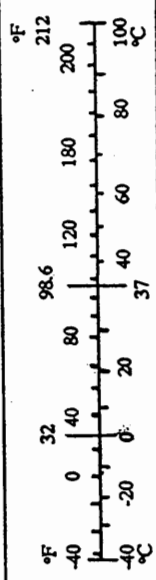


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I INTRODUCTION

The Joint Highway Research Program is a cooperative effort of the Connecticut Department of Transportation and the University of Connecticut.

The program is guided by an eight member Joint Highway Research Advisory Council. Four of the members of the Council are appointed by the Commissioner of the Connecticut Department of Transportation and four are appointed from the University of Connecticut School of Engineering's Department of Civil Engineering by the President of the University.

The purpose of the Joint Highway Research Advisory Council (JHRAC) is to develop and administer a program of applied research designed to find solutions to high priority problems faced by the Connecticut Department of Transportation (CONNDOT) in carrying out its responsibilities for the planning, design, construction and maintenance of the State's transportation system.

To insure the best use of available funds, JHRAC needs an overview of the HIGH PRIORITY problems facing CONNDOT. This report is an effort to identify some of the high priority problems, in the areas of roads and public transit, which CONNDOT now faces.

Since the State's transportation system is, by its very nature, dynamic, there will be a continuing need to identify the system's high priority problems so that the University's applied research resources can be focused on the development of effective solutions to these problems.

The high priority research issues identified in this report were developed through interviews with, various CONNDOT employees, conducted by faculty from the University's Department of Civil Engineering.

II POTENTIAL RESEARCH TOPICS

A. BRIDGES:

The following issues and research needs emerged from an October 1, 1990 meeting attended by: Dan Coffey, CONNDOT and John T. DeWolf, Michael L. Accorsi, and Gregory C. Frantz, Civil Engineering, UCONN.:

a. THE ISSUE: Cathodic Protection.

Many bridges, which are not being renovated in CONNDOT's current "10 year program," have been classified as "poor" in recent surveys.

Most deck renovations do not allow complete removal and replacement of the concrete due to the need to maintain vehicular traffic. Cathodic protection may help prolong the life of these bridges.

RESEARCH OBJECTIVE: Evaluate the feasibility, cost effectiveness, and extent to which cathodic protection techniques can be applied in the rehabilitation of bridges.

RESEARCH OBJECTIVE: Identify cost effective bridge rehabilitation strategies which make use of a mix of cathodic protection and replacement of bridge elements and the criteria for the application of such strategies.

b. THE ISSUE: Increased Dynamic Loading Due to Settlement at Approach Slab to the Bridge Deck.

Headers at the access to a bridge can be a problem. When settlement occurs, the vehicle wheels hit the edge of the bridge. The bridge is then loaded with a dynamic load which may not have been taken into account in the original design of the bridge.

RESEARCH OBJECTIVE: Model the dynamic loading, resulting from wheel impact loading associated with settlement at the access to the bridge. Identify the magnitude of the dynamic loading resulting from varying amounts of settlement and determine when settlement becomes critical.

B. DISTRICT ENGINEERING:

The following issues and research needs emerged from an April 4, 1990 meeting attended by: A. Gruhn, A. Hourihan, personnel from the CONNDOT Districts, and R.P. Long, UCONN:

a. THE ISSUE: Frequency of Bridge Maintenance Activities

The concerns involve the optimum interval between bridge maintenance activities such as deck replacement, superstructure repainting and other activities required to keep bridges in good condition.

RESEARCH OBJECTIVE: Identify the optimum frequency of application of cost effective bridge maintenance activities required to insure minimal bridge life cycle costs.

b. THE ISSUE: The Removal of Lead-based Bridge Paint

Bridges built prior to 1975 were painted with lead-based paint. To repaint these bridges with modern safe paint, requires the removal of the lead-based paint. The present method for removal of the lead-based paint is sand blasting. Since the sand blasting of lead-based paints has significant environmental implications, extraordinary and costly precautions must be implemented. In addition, time consuming training of maintenance personnel is required.

RESEARCH OBJECTIVE: Identify Alternative, Cost Effective and Environmentally Safe Techniques for Paint Removal and the Repainting of Bridges.

c. THE ISSUE: The Long Term Effects of the Chloride Content of "Shop Coat" Paints

Paints presently used in the "shop coat" for structural steel sections and reinforcing bars contain chloride. Although the material can be encased during shipment, there is concern for subsequent effects, especially the effects on corrosion and paint.

RESEARCH OBJECTIVE: Identify the long term effects of the chloride content of "shop coat" paints on corrosion and the life cycle of final surfacing coatings.

RESEARCH OBJECTIVE: If the long term effects of the chloride content of "shop coat" paints are determined to be detrimental, identify cost effective alternatives or techniques for eliminating or reducing the detrimental effects.

d. THE ISSUE: The Effectiveness of Bridge Deck Patching Materials

A study of the serviceability of patching for bridge decks is needed. Patches installed on bridge decks, over the last few years, do not seem to be holding up very well.

RESEARCH OBJECTIVE: Identify, through a literature search, the latest techniques and materials for bridge deck patching. Establish test sections which will expose test patch samples to the appropriate critical serviceability parameters. Evaluate the patching techniques/materials through field tests utilizing the test sections.

C. MAINTENANCE:

The following issues and research needs resulted from a March 20, 1990 meeting attended by: R. W. Bissell and maintenance personnel from the CONNDOT Districts, and R.P. Long, UCONN:

a. THE ISSUE: Bridge Expansion Joints and Bearings

The typical expansion joint requires frequent attention to insure that it is free to work properly. The typical bearing also requires frequent attention in the form of lubrication and cleaning.

RESEARCH OBJECTIVE: Review the design and operation of the most frequently used bridge expansion joints and bearings with the objective of identifying modifications which will reduce maintenance requirements.

b. THE ISSUE: Crack Sealers

There is a need for an improved crack sealer which will work in various temperatures and have a long useful life.

RESEARCH OBJECTIVE (A Technology Transfer Project): Conduct a literature search on crack sealers (including Jack Stephens 1978 JHRAC project) summarize the information and disseminate the summary report.

c. THE ISSUE: Non-corrosive Deicing Materials

There is a need for a competitively priced alternative to salt as a deicer.

RESEARCH OBJECTIVE (A Technology Transfer Project): Conduct a literature search of deicing materials, summarize the information and disseminate the summary report.

d. THE ISSUE: Chemical Growth Retardants

There is a need for better and safer growth retardants to reduce the need for mowing.

RESEARCH OBJECTIVE - Phase I (A Technology Transfer Project): Through a literature search, identify the availability or lack of availability of cost effective non-hazardous chemical growth retardants. Summarize and disseminate the results of the literature search.

RESEARCH OBJECTIVE - Phase II (If Phase I does not identify cost effective non-hazardous chemical growth retardants): Evaluate the feasibility of developing a cost effective, non-hazardous chemical growth retardant.

e. THE ISSUE: Painting in Cooler Temperatures

There is a need for a paint or coating for bridges which can be applied in cooler temperatures, thereby extending the maintenance season.

RESEARCH OBJECTIVE - Phase I (A Technology Transfer Project): Through a literature search, identify the availability or lack of availability of cost effective bridge coatings which can be applied effectively in cooler temperatures or, techniques which will accommodate the application of coatings in cooler temperatures. Summarize and disseminate the results of the literature search.

RESEARCH OBJECTIVE - Phase II (If Phase I does not identify cost effective bridge coatings which can be applied in cooler temperatures): Evaluate the feasibility of developing a cost effective bridge coating which can be applied in cooler temperatures.

D. MATERIALS:

The following issues and research needs resulted from a November 2, 1990 meeting attended by: S. Gage, K. Lane, J. Mitchell, and V. Ritchie of CONNDOT, and R. P. Long, UCONN:

a. THE ISSUE: Field Testing of Concrete

There is some question as to the best field method for determining quality, consistency and water/cement ratios of concrete.

RESEARCH OBJECTIVE (A Technology Transfer Project): Through a literature search, identify available alternative field tests for determining quality, consistency and water/cement ratios of concrete. Identify the advantages and limitations of each test. Summarize and disseminate the results.

b. THE ISSUE: Alternative Methods of Concrete Mix Design

There is a need to evaluate the Absolute Volume method of concrete mix design compared to alternative methods.

RESEARCH OBJECTIVE: Identify and describe the alternative methods of concrete mix design. Establish criteria for and evaluate the alternative methods including the Absolute Volume method.

c. THE ISSUE: Standards for 1/2" Stone

There is presently a CONNDOT specification for 1/2" stone that is slightly different than the ASSHTO specification (M43-82). Many contractors from out of state question the difference in the specifications. There is a need to know what the ramifications are of using the AASHTO specifications.

RESEARCH OBJECTIVE: Evaluate the CONNDOT and AASHTO specifications for 1/2" stone.

d. THE ISSUE: Extraction of Asphalt from Bituminous Concrete

There is a need to evaluate the alternative methods for extracting asphalt from bituminous concrete, i.e., by heating in a muffle furnace and by using solvents.

RESEARCH OBJECTIVE: Evaluate the extraction of asphalt from bituminous concrete by heating in a muffle furnace compared to by the use of solvents.

e. THE ISSUE: Variability in the Test for Soundness of Aggregates.

The results from the present test for soundness of aggregates are variable. There is a need for a better method of testing this important property.

RESEARCH OBJECTIVE - Phase I (A Technology Transfer Project): Through a literature search, identify the availability or lack of availability of alternative methods for testing the soundness of aggregates. Summarize and Disseminate the results of the literature search.

RESEARCH OBJECTIVE - Phase II (If Phase I identifies alternative methods for testing the soundness of aggregates): Evaluate the variability of the results of alternative methods for testing the soundness of aggregates.

f. THE ISSUE: Pitting of Mineral Particles in Bituminous Concrete

Bituminous concrete made with certain red sands found in Connecticut shows pitting of the mineral particles after a few cycles of freezing and thawing. There is a need to be able to test mineral aggregates for this property before their use.

RESEARCH OBJECTIVE: Develop a test to determine the susceptibility of bituminous concrete mineral aggregates to pitting due to freeze/thaw cycles.

g. THE ISSUE: Substitutes for Sand in Portland Cement and Bituminous Concrete

There is a need to determine the feasibility of using "stone sand" or fine aggregates from other sources as substitutes for sand from conventional sources in portland cement and bituminous concrete.

RESEARCH OBJECTIVE: Evaluate the effect of substitutes for sand from conventional sources on portland cement and bituminous concrete.

E. PAVEMENTS:

The following issues and research needs resulted from an October 3, 1990 meeting attended by: R. Vitale, CONNDOT and R.P. Long, UCONN:

a. THE ISSUE: The use of Rubber in Asphalt

There is a need to know more about the economics and performance of rubberized asphalt.

RESEARCH OBJECTIVE: (A Technology Transfer Project): Conduct a literature search on rubberized asphalt. Summarize and disseminate the results of the literature search.

b. THE ISSUE: Heat Scarified, Remixed Asphalt Pavement

There is a need to know more about the cost effectiveness and environmental aspects of the heat scarified asphalt pavement recycling process.

RESEARCH OBJECTIVE: (A Technology Transfer Project): Conduct a literature search on the cost effectiveness and environmental aspects of the heat scarified asphalt pavement recycling process. Summarize and disseminate the results of the literature search.

c. THE ISSUE: Microsurfacing

There is a need to know more about microsurfacing (mixed in place emulsion with latex added, using various gradations of aggregate). This process is thought to be used by 38 of the 50 states.

RESEARCH OBJECTIVE: (A Technology Transfer Project): Conduct a literature search on microsurfacing. Summarize and disseminate the results of the literature search.

d. THE ISSUE: Relating Laboratory Resilient Modulus to Field Design Equations

The present design methods are based on an equivalent elastic modulus for each layer in the pavement and its foundation. This elastic parameter is called the resilient modulus. It is not a constant but varies with environmental conditions, especially moisture. At the present time these values have never been measured for Connecticut soils.

RESEARCH OBJECTIVE: Measure the resilient modulus under a variety of conditions appropriate for soils being considered for inclusion in pavement foundations in the State.

F. PLANNING:

The following issues and research needs resulted from an August, 1990 meeting attended by: R. Martinez, J. Sullivan, and a group from Planning and Preconstruction, CONNDOT, and C. Davis, UCONN, and from a communication from C. Gudatis, CONNDOT.

a. THE ISSUE: Transportation Behavioral Research

In April, 1990, household travel data will be available for over 2200 Connecticut households as part of the Nationwide Personal Transportation Study. In addition 1990 Census data will become available. These new data will provide an exceptional opportunity for behavioral research relative to transportation.

RESEARCH OBJECTIVE - Phase I: Through a literature search and more in-depth interviews with CONNDOT's planning staff, identify the critical travel behavior research issues.

RESEARCH OBJECTIVE - Phase II: Utilizing the household travel data from the Nationwide Personal Transportation Study and the appropriate data from the 1990 Census, implement the research projects identified in Phase I including a model for forecasting the usage of High Occupancy Vehicle lanes.

b. THE ISSUE: The Impact of Large Scale Transportation projects on the State Economy

There is a need to have a better understanding of the impact of large scale transportation projects on the State's economy including the effect on corporate decisions.

RESEARCH OBJECTIVE: Develop and test a transportation investment, economic impact model utilizing Connecticut based data.

c. THE ISSUE: Shopping Center Trip Generation

There is a need to develop a better understanding of shopping center trip generation in Connecticut, particularly "pass-by" and "diverted trips".

RESEARCH OBJECTIVE: Utilizing Connecticut based data develop and test shopping center trip generation equations and forecasting techniques for estimating "pass-by" and "diverted" trips.

d. THE ISSUE: Electronic Road Pricing (ERP)

Hong Kong has implemented an electronic road pricing demonstration project. There is a need to investigate the feasibility of ERP in Connecticut as a means of reducing or controlling congestion.

RESEARCH OBJECTIVE: Identify the elements of a "state-of-the-art" electronic road pricing system. Determine the effectiveness of such a system to reduce congestion and generate other travel related or environmental benefits. Investigate the socio-economic feasibility of implementing electronic road pricing in Connecticut.

e. THE ISSUE: Travel Demand Management

A recent FHWA report on Travel Demand Management (TDM) entitled "Evaluation of Travel Demand Management Measures to Relieve Congestion" found the following:

- 1) That Travel Demand Management can significantly reduce low-occupancy vehicle trip demand at a site, in a corridor, or within a subarea;
- 2) To inspire use of key TDM actions, either some type of legal pressure is necessary, or the individual firm must have a readily apparent, economic self interest in adopting these measures.

RESEARCH OBJECTIVE: Develop a model Travel Demand Management ordinance and the appropriate parameters for adapting the ordinance by size of employer.

G. SOILS:

The following topics are extensions of research presently underway and resulted from discussions between R. Isabelle of CONNDOT and R.P. Long of UCONN:

a. THE ISSUE: Pile Corrosion:

Steel Piles driven through miscellaneous fill material, have, in some instances, exhibited tendencies toward corrosion.

RESEARCH OBJECTIVE: Review bridge plans to identify existing bridges which may contain steel piles driven through miscellaneous fill material. Conduct a boring, testing, and excavation program to verify the field corrosion behavior of the piles.

RESEARCH OBJECTIVE: Study the effect of stray electrical current, in the vicinity of bridges located near electrified railroad tracks, on corrosion of nearby steel piles.

H. PUBLIC TRANSIT:

This section describes potential research topics which were identified through personal interviews conducted by G.M. McCarthy with the following transit managers and administrators:

- Housatonic Area Transit District
Danbury, CT Thomas Williams, Exec. Director
- Middletown Transit District
Middletown, CT Thomas Cheeseman, Administrator
- Milford Transit District
Milford, CT Henry Jadach, Exec. Director
- Norwalk Transit District
Norwalk, CT Nancy Turgeon, Asst. Admin.

In addition to the above transit operators, the following persons were interviewed:

- James Sanders, Manager
Community Transit Services
Connecticut Department of Transportation
- Thomas Phillips, Director
Transportation Services
City of Hartford, and
Chairman CT Association of Community Transportation

To the extent that the above managers of transit operations and administrators of transit services are representative of Connecticut's small to medium size transit operators, the issues and research needs presented below are also representative of Connecticut's small to medium sized transit agencies.

For the purpose of this study, small to medium transit operators have been defined as those transit operators having the following characteristics:

- Fleet Size < 50 vehicles
- Total Annual Ridership: < 1.75 million passengers

In 1986, a committee of transit industry representatives was convened by the National Research Council's Transportation Research Board to conduct a critical review of the nation's public transportation research program. The Committee for the Strategic Transportation Research Study for Transit concluded:

"The federal transit research program now provides limited support for problem-solving research directed toward the everyday need of local transit agencies."¹

The committee also identified a variety of issues as being uppermost in the minds of transit managers and grouped them into the following categories: human resource management, service configuration and marketing, service delivery models, internal efficiencies, maintenance, equipment, and innovative financing¹.

The categories identified by the Transportation Research Board's Committee for the Strategic Transportation Research Study for Transit have been used to group the high priority transit issues identified through the above interviews.

The following high priority issues and research needs emerged from the personal interviews and a review of relevant studies and reports which were identified during the interviews:

1. SUBJECT AREA: Human Resource Management:

a. THE ISSUE: Training

The Connecticut RTAP Consortium (the state's five rural Transit Districts) has prioritized its training needs as follows²:

- Defensive Driving Techniques for Drivers
- Passenger Sensitivity and Assistance Techniques
- Emergency and Accident Procedures
- Safety Considerations in Transporting the Elderly/Disabled
- Vehicle Maintenance Problem Recognition for Drivers
- Risk Management and Safety Plan Development for Managers

In addition, the following training needs were identified:

- Dispatching (demand-responsive service)
- Supervisory Skills for 1st-Line Supervisors
- Management Skills for Transit Managers (including labor/management relations)
- Maintenance Management Systems
- Application of Computers to the Management of Small to Medium Size Transit Operations (including: maintenance management, cost accounting, inventory control)
- Strategic Planning for Transit Managers and Policy Board Members
- The Role of Transit Policy Boards

RESEARCH OBJECTIVE: Develop a comprehensive inventory of training programs presently available and suitable to meet the needs of Connecticut's small to medium size transit operators, identify deficiencies, and develop a prioritized list of the additional training programs needed to meet the needs of Connecticut's small to medium transit operators.

RESEARCH OBJECTIVE: Based on the above prioritized list of training program needs, develop training program materials for Connecticut's small to medium size transit operators.

2. SUBJECT AREA: Service Configuration and Marketing:

a. THE ISSUE: Marketing

There is a lack of marketing of transit services by small to medium transit operators. The reason most often given, by the transit managers interviewed, for not doing marketing, was the lack of adequate funds for the even more essential activities of their transit operations.

Transit planning and marketing need to be more closely coordinated with regional land use and transportation facilities development in order to insure that transit has an opportunity to play a more prominent role in serving the transportation needs of emerging suburban development patterns.

There is a need for more emphasis on long range planning and marketing oriented to ridership growth by small and medium sized transit operators.

RESEARCH OBJECTIVE: Identify and/or develop effective marketing techniques for Connecticut's small to medium size transit operators.

3. SUBJECT AREA: Service Delivery Models:

a. THE ISSUE: Transit District Roles

In Connecticut, Transit Districts perform a variety of roles. Some perform the transit service coordination and contract administration roles, some perform the transit service coordination and direct management role, and some perform all three.

RESEARCH OBJECTIVE: Examine the alternative roles which transit districts perform, determine the relative advantages and disadvantages and develop guidelines for determining the circumstances under which the alternative roles are most effective.

b. THE ISSUE: Coordination of Public Transportation Services and Funding Sources

The need for improved coordination of public transportation services has been recognized by administrative agencies and legislative bodies.

In a study released in 1987³, the Connecticut Department of Transportation recognized the need, created by fractured service patterns, to enhance service coordination of elderly and handicapped transportation services. The Connecticut Department of Human Resources, also recognizing the need for improved coordination of transportation services, established a committee to examine the issue as it relates to the provision of transportation services for human resource related needs. The committee's recommendations are contained in the State Plan on Disabilities⁴.

During its 1990 session, the Connecticut Legislature also responded to the coordination issue by directing the Connecticut Public Transportation Commission to study the following coordination issues⁵:

- The feasibility of coordinating transportation services between transportation providers in the same region of the state.
- The coordination of transportation services between the providers of public transportation services, which are funded by the more traditional public transportation funding sources (Sect. 9, Sect. 18 of the Surface Transportation Act) and the providers of transportation services which are funded by other sources (Title 19 of the Social Security Act or Title IIIb of the Older American's Act).

RESEARCH OBJECTIVE: Examine the existing policy making and administrative structures associated with the delivery of the broad range of transportation services and identify the barriers which prevent a more effective coordination of these services.

RESEARCH OBJECTIVE: Examine the various funding sources presently available for the broad range of transportation services being provided in the community, identify the barriers which prevent these funding sources from being used in a more coordinated manner and quantify the potential benefits which would result from overcoming these barriers and achieving a more effective and coordinated use of the funds.

c. THE ISSUE: Privatization

A high incidence of private participation was found in the operations of the small to medium transit operators interviewed for this study. This includes participation by private, not-for profit, entities, as well as, the traditional private, for-profit, entities. Vehicle maintenance and repair, and the provision of specialized and conventional transit services are areas of privatization most frequently found among the small and medium transit operators interviewed.

RESEARCH OBJECTIVE: Identify and evaluate the alternative contractual mechanisms and administrative procedures presently used by small to medium transit operators for implementing private participation, determine the most effective mechanisms and procedures, develop guidelines for effective contractual mechanisms and procedures.

RESEARCH OBJECTIVE: Examine the advantages and disadvantages of privatization for small and medium transit operators and the conditions which contribute to its success or failure.

4. SUBJECT AREA: Internal Efficiencies

- a. THE ISSUE: The existing lack of adequate funding for transit services and the anticipation of level funding in the future from the traditional federal state and local sources, creates a pressing need for the examination of current practices and the identification of ways to reduce costs. Labor, fuel, and insurance costs were identified as major cost factors in the operation of small to medium transit operations.

RESEARCH OBJECTIVE: Identify the major operating cost elements for Connecticut's small to medium sized transit operators and identify innovative approaches to the reduction of these costs.

5. SUBJECT AREA: Maintenance

a. THE ISSUE: Training

The maintenance issues identified by the transit operators, who have a full staff of vehicle maintenance personnel, concerned the difficulty in recruiting and hiring skilled maintenance personnel. Therefore, they are faced with a need to create skilled vehicle maintenance personnel through training.

Since the smaller transit operators are more likely to purchase maintenance services from "outside" sources, their maintenance related needs were found to be associated with the administration of these maintenance service contracts.

RESEARCH OBJECTIVE: Review the current practice of the transit industry for the training of vehicle equipment maintenance personnel, identify innovative approaches which would be appropriate for Connecticut's small to medium size transit operators.

RESEARCH OBJECTIVE: Review the current practice of the transit industry for the contracting and management of purchased vehicle maintenance services, develop guidelines for contract negotiation, performance, monitoring and evaluation.

6. SUBJECT AREA: Equipment

a. THE ISSUE: Standardization of Accessibility Equipment for Users with Disabilities.

The Americans with Disabilities Act⁶ will place increased demands on transit operators to accommodate persons using mobility assistance equipment. At the same time, the growing variation in the types of personal mobility assistance equipment is adversely impacting: the access of the disabled to transit vehicles (lift limitations and incompatibilities), the ability of the transit operator to safely accommodate the equipment once on board the vehicle (tie down incompatibilities), and the on-time performance of the service.

RESEARCH OBJECTIVE: Identify the nature and extent of the variability in personnel mobility assistance equipment, assess the future technology of such equipment and examine the feasibility of standardization of such equipment and the associated lift and tie down equipment.

b. THE ISSUE: Vehicle Procurement

Small to medium size transit operators very often lack the procurement resources and skills (expertise in: the preparation of vehicle specifications and, pre-acceptance vehicle inspections) needed to support vehicle replacement programs.

RESEARCH OBJECTIVE: Develop vehicle procurement guidelines (including pre-acceptance inspection procedures) and related training materials for use by small to medium size transit operators.

7. SUBJECT AREA: Innovative Financing

a. THE ISSUE: Inadequate Funding

Inadequate funding was a common issue among all of the small to medium size transit operators interviewed. It was given most often as the most significant factor contributing to a wide range of issues facing transit operators.

The outlook for significant increases in existing transit funding sources is bleak. The most optimistic outlook is for "level" funding for the immediate future.

In addition, transportation services are now being funded by a wide variety of uncoordinated public funding sources. When aggregated, the total amount of public funding for transportation services is substantial.

RESEARCH OBJECTIVE: Examine the various funding sources presently available for the broad range of transportation services being provided

in Connecticut, identify the barriers which prevent these funding sources from being used in a more coordinated manner and quantify the potential benefits which would result from overcoming these barriers and achieving a more effective and coordinated use of existing funds.

REFERENCES: PUBLIC TRANSIT

1. Research for Public Transit: New Directions, Special Report 213, Transportation Research Board, Washington, D.C., 1987.
2. Development of Connecticut RTAP Consortium, Housatonic Area Regional Transit District, March, 1990.
3. Elderly and Disabled Transportation Study, CONNDOT, April 1987.
4. State Plan on Disabilities: Foundation for the Future, CT Department of Human Resources, 1990.
5. Special Act 90-10, Connecticut General Assembly, 1990.
6. "U.S. Moves Toward Barrier-Free Society." Civil Engineering, Vol. 60. Nov. 11, Nov. 1990.

III RECOMMENDED FUTURE WORK

It is recommended that the "DIALOG/TRIS" database be utilized to determine whether or not the research issues identified herein have been addressed previously by other state/federal agencies.

If it is determined that relevant research has been conducted by other agencies, the results of such research should be summarized and presented to CONNDOT, utilizing appropriate technology transfer techniques.

Appendix A

Faculty who Participated in Collecting the Research Statements

Faculty and Staff	Specialty	Phone
Accorsi, Michael L.	Structures	486-5642
Davis, Christain F.	Transportation	486-2248
DeWolf, John T.	Structures	486-5023
Frantz, Gregory C.	Structures	486-2468
Long, Richard P.	Geotechnical	486-2074
McCarthy, Gerald	Public Transit	486-5400

In addition the following might also be contacted concerning questions in their specialties:

Faculty	Specialty	Phone
Garrick, Norman	Bituminous Materials	486-2990
Grasso, Domenic	Environmental	486-2680