ITRE: A Brief History

The mission of the Institute for Transportation Research and Education (ITRE) is to provide leadership in multi-disciplinary research, training, and public service activities in the field of transportation.

Transportation is broadly defined in ITRE's charter and includes not only the engineering functions of planning, design, construction, operation and maintenance of highways and other transportation facilities, but also the management of vehicle fleets, the operation and design of those vehicles, and the impacts of transportation systems on the communities they serve.

In 1977, the North Carolina General Assembly authorized The University of North Carolina Board of Governors to establish an Institute for Transportation Research and Education. ITRE was established in the office of The President of The University of North Carolina and, therefore, was designed to utilize the resources of all sixteen campuses of the UNC system.

Since its first year of operation in 1978, ITRE has become one of the major university transportation institutes in the country, with an annual budget of approximately $1.5 million.

About the Covers

Pictured on the front cover are an Otis Personal Rapid Transit, Duke University Medical Center, Durham, N.C.; a Boeing 737; a General Motors diesel locomotive; and an off-shore oil drilling ship. On the back cover are pictures of North Carolina's history: a 1919 Anderson, Winston-Salem; the Wright Brothers' pusher aircraft, Kitty Hawk; a 1917 Baldwin locomotive, Blowing Rock; and the Elizabeth II, Manteo.

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2,500 copies of this publication were printed at a cost of $1791.00 or 0.72 per copy.
The Institute for Transportation Research and Education has completed another notable year in providing service to the state of North Carolina and to local governmental agencies. Major programs continued with the NCDOT and other state agencies. In addition, the Institute continued to develop new programs in conjunction with university faculty to serve a national constituency.

Perhaps most notable during the past year has been the continued growth in the variety of transportation-related subject areas covered by Institute programs and projects. ITRE's projects covered the basic engineering sciences of materials and structures, plus transportation management, systems analysis, planning, environmental impacts, economic development, and other areas. The scope of research and training subjects reached several modes and facilities including highways and bridges, public transit and paratransit, marine terminals, and airports. Significant new sponsors of Institute programs included the Federal Highway Administration and the Urban Mass Transportation Administration.

The Institute continues to benefit from its close associations with administrators, faculty, and staff in several academic departments throughout the state university system and at Duke University. Projects in the past year have been carried out by faculty at North Carolina State University, North Carolina Agricultural and Technical State University, the University of North Carolina at Chapel Hill, and the University of North Carolina at Charlotte, in addition to full time Institute staff. Several new initiatives are being undertaken with faculty at Duke University, including a new contract which was recently awarded by the Pennsylvania Department of Transportation. Training courses are now being taught by ITRE staff and faculty throughout the country. Also, major working relationships continued with private sector sponsors and subcontractors in several areas.

As we enter ITRE's tenth year of operations, we continue to value these professional associations, and we look forward to future challenges in transportation research and education.

Edwin W. Hauser
Director
UNC Institute For Transportation Research and Education
and Campus-Based Affiliates
Local Pavement Maintenance Management Systems
Principal Investigator: James Martin, P.E., ITRE
Sponsor: Local Governmental Agencies

In addition to conducting pavement condition surveys for 45 municipalities in 1986-87, ITRE trained municipal staffs to use its computerized pavement management system.

The data gathered from visual inspections of the street system are entered into a microcomputer. Several different reports are provided from this analysis program. Results, compiled by street section, include a pavement condition rating number, an estimated total cost, estimated cost per mile, estimated square yards of full depth patching needed, type of maintenance activity needed, length, width, shoulder information, and curb and gutter information.

The results of these studies have provided many benefits. Inventories of municipal and state-maintained streets and highways are more complete. Municipalities have used pavement condition surveys to better plan daily street maintenance activities, to increase resurfacing programs, and to more effectively budget money. Many municipalities have saved money through good street maintenance practices. For example, one city was able to save more than one million dollars on its street maintenance budget as a result of the pavement condition survey. It was then able to use this money for other street projects. Other cities have used the pavement condition survey to support the need for multi-million dollar bond issues.

ITRE has continued to introduce PMS_ITRE (Pavement Management System_ITRE) to municipalities and other states. This computer software enables the agency to establish an in-house pavement management system.

Plastic Pavement Marking Materials
Principal Investigator: Robert Attaway, ITRE
Sponsor: NCDOT, Division of Highways

This project, being conducted for the Traffic Engineering Branch, involves two major areas of research. The first is the testing and evaluation of all types of pavement marking tapes. The second is the evaluation of existing thermoplastic pavement marking projects in the state.

Research is needed in the evaluation and testing of pavement marking tapes because of the materials' high cost, the lack of field data, and the large number of these products on the market. To meet these needs, ITRE developed and implemented a test deck program to evaluate each manufacturer's product under the same conditions.

The thermoplastic portion of this project is being conducted to determine the useful life of thermoplastic marking materials. As a result of this project, the NCDOT will be able to determine the most cost-effective way to mark a section of highway, depending on the traffic and other conditions.

Analysis of Compact Pole Type Footings
Principal Investigator: Dr. Roy H. Borden, P.E., NCSU
Sponsor: NCDOT, Division of Highways

This research project, now in its second year, is an ongoing effort to develop a computer program for the analysis of the lateral load capacity of concrete piers used as foundations to support a variety of transportation structures. A mathematical model on a mainframe computer has been developed. A parameter study has been conducted to quantify the significance of the base resistance. The results of the analytical solution have been compared to the observations made in several full-scale field tests.

Work in 1986-87 involved further field verification testing, the preparation of a documented computer program, and refinements in the model based on new knowledge gained.

High Strength Concrete Research
Principal Investigator: Dr. Michael Leming, P.E., North Carolina State University (NCSU)
Sponsor: NCDOT, Division of Highways

High strength concrete in North Carolina is being investigated to determine typical maximum strength levels possible with an assortment of aggregates from across the state, as well as associated structural characteristics of these concretes. These characteristics may be only moderately related to the strength level but are strongly related to aggregate characteristics. Research is also being conducted to obtain data for such phenomena as elastic modulus, splitting tension and flexural strength behavior.

Dilatometer for Lateral Soil Response
Principal Investigator: Dr. Roy H. Borden, P.E., NCSU
Sponsor: NCDOT, Division of Highways

This research is an ongoing effort to experimentally investigate the relationship between the measured dilatometer modulus and that of a large laboratory sample of known stiffness. During the past four years, the calibration chamber necessary for this type of experimental work was designed and constructed.
Retaining Wall Construction from the Top Down
Principal Investigator: Dr. Philip C. Lambe, P.E., NCSU
Sponsor: NCDOT, Division of Highways

In this project, current techniques for constructing retaining walls from the top-down were identified. Two design methods for soil-nailed walls were implemented. To aid the work, researchers prepared two computer data bases. One data base contains references, and the other contains cases of completed retaining walls in the state.

Using the North Carolina wall data base, researchers are documenting the construction problems experienced within the state and preparing a set of typical cases experienced by the N.C. Department of Transportation. Guidelines are also being developed for selecting the appropriate commercial wall systems.

Detecting Incipient Failures in Bridges
Principal Investigator: Dr. Mrinmoy (Moy) Biswas, P.E., Duke University
Sponsor: Pennsylvania Department of Transportation; USDOT, Federal Highway Administration

The Duke University Transportation and Infrastructure Research Center, in collaboration with ITRE, has been awarded a major three-year research project for the Pennsylvania DOT to develop a system to monitor the structural integrity of bridges on the state system. Bridge degradation may exist at the point of fatigue cracks, fractures, corrosion damage, freeze-thaw damage, or damage from traffic accidents. Many of these degradations may not be easily visible, for their location may be inaccessible.

The deliverables from this research project will provide advance warning of incipient failure conditions on selected PennDOT bridges. Instrumentation developed in this research will be used in PennDOT’s bridge inspection program.

The development of the proposed system for PennDOT will be based on two basic technologies: the use of the diagnostic dynamic testing system, currently under development at Duke, and use of expert system methods, previously developed at Duke for the design of bridges.

Structural Applications of High Strength Concrete
Principal Investigator: Dr. Paul Zia, P.E., NCSU
Sponsor: NCDOT, Division of Highways

In recent years, high strength concrete with compressive strengths well over 6,000 psi have become commonly available in many parts of the country.

Many high-rise buildings have successfully used high strength concrete with considerable savings. Increasingly, high strength concrete is also being used or considered for use in highway bridges.

Recognizing the potential advantages, the NCDOT initiated a two-year research project to study the structural properties of high strength concrete made of materials that are available in North Carolina.

To date, compressive strengths up to 15,000 psi have been achieved in the laboratory from concrete mix designs which utilized three different types of aggregates. On a production scale, using a commercial ready-mix concrete plant facility, a very workable concrete with a compressive strength in excess of 10,000 psi was obtained.

The study is continuing as planned to develop more research data on short-term and long-term properties of the various groups of test specimens.

Deflection Parameter Correlation
Principal Investigator: Dr. Roy Borden, P.E., NCSU
Sponsor: NCDOT, Division of Highways

A follow-up study to an investigation of the use of the dilatometer for measuring lateral soil response resulted in further tests and instrumentation assistance with the NCDOT to continue the dilatometer tests in a calibration chamber, to correlate dilatometer data with lateral stiffness of samples from stress path
loading, and to correlate field dilatometer readings with NCDOT lateral load tests.

In addition, a model for predicting horizontal subgrade modulus from dilatometer modulus data has been developed.

Dr. Roy Borden, NCSU (center), discusses progress made on two research projects with graduate students, Chih-Hsing Hsu (left) and Mohammed A. Gabr (right). Hsu works on the "Dilatometer for Lateral Soil Response" project and Gabr is developing a computer program for the "Analysis of Compact Pole Type Footings".

Long Term Flexible Pavement Performance Study
Principal Investigator: Dr. N. Paul Khosla, NCSU
Sponsor: NCDOT, Division of Highways

A major ten-year research program has been approved by the North Carolina Department of Transportation to analyze the performance of flexible pavements in North Carolina utilizing full scale experimental pavement sections constructed to current design standards. Instrumentation of 24 roadway sections will account for approximately one-half of the program budget with about $42,000 per year projected for research performance.

The specific objectives of this research program are to collect data pertaining to material properties for use in mechanistic design methods, develop a mechanistic pavement performance predictive model, compare field performance of pavements of known design with predictive performance, evaluate the effect of different types and thickness of pavement layers on pavement distress and performance, and evaluate the effect of subgrade strength on the relative strength of each base course type. An experimental design has been formulated to allow consideration of the interaction of ten variables, each variable to be subjected to a statistical factorial experimental design at one, two or three levels.

Each of the twenty-four sections will be a one thousand foot centerline profile, separated by transition sections approximately 200 feet long. Information on the mechanical properties will be obtained by non-destructive field testing with the falling weight deflectometer as well as detailed laboratory testing of all materials used in the experimental pavement sections.

Other instruments included in the research program are weight-in-motion truck weight systems for the collection of axle loads and gross vehicle loads, a Gyratory Testing Machine, and electronic cells for measurement of stresses and/or strains in pavement layers. The major dividends of

Modified Asphalt Binders in Pavement Performance
Principal Investigator: Dr. N. Paul Khosla, NCSU
Sponsor: NCDOT, Division of Highways

The difficulty of designing asphalt pavements which may perform well at both low and high ambient temperatures has led to an apparent reduction in their expected life.

This has resulted in increased maintenance costs for the NCDOT. In addition, high asphalt prices and the steadily decreasing quality of aggregate are creating an untenable situation in transportation departments responsible for building and maintaining highway systems.

In fiscal 1987, the NCDOT's contract resurfacing program was ap-
proximately $77 million and will increase to $84 million in the coming year. This level of spending will not match current needs.

The objective of this research has been to develop and verify a systematic, fundamental procedure for determining the quantitative parameters which may help characterize paving materials in regard to their resistance to deformation, fatigue, and shrinkage cracking.

Using this procedure and a pavement performance prediction model, the next step was to demonstrate the influence of hard and soft asphalt cements including modified binders in paving mixtures and their resultant effect on the possible reduction of pavement's design thickness.

Further analysis has determined the optimum asphalt-modifier mix alternatives to result in a saving of asphalt material coupled with improved quality and performance of asphalt pavements, and made comparative life-cycle cost analyses of pavement systems utilizing both-conventional asphalt concrete and modified asphalt concrete.
this long-term pavement performance study will be in terms of improved predictive equations, improved design procedures, and better pavement performance at a lesser cost.

Objectives and expected outputs of this research program are similar to those of the overall research program at the national level to be undertaken through the Strategic Highway Research Program (SHRP).

Bridge Maintenance
Level of Service Policy and Prioritization
Principal Investigator: David Johnston, Ph.D., P.E.
Sponsor: NCDOT, Division of Highways

This project developed a management system in order to predict funding needs and optimal action for bridge replacement, rehabilitation and maintenance. Several algorithms were analyzed for selecting optimal maintenance activities under various levels of available funding.

The results of this project and implementation phase by the NCDOT have received national attention, specifically at the Bridge Management Workshop sponsored by the Transportation Research Board in January, 1987.

Bond of Epoxy Coated Prestressing Strands
Principal Investigator: David Johnston, Ph.D., P.E.
Sponsor: NCDOT, Division of Highways

The effect of epoxy coating on transfer length, development length and bond fatigue properties of three diameters of seven-wire prestressing strand were experimentally investigated. Comparative tests included both bare strand and grit impregnated coated strand.

The findings of the study included analytical expressions to predict behavior of the strand as well as characteristics of behavior which should be useful in design of bridges and other prestressed concrete structures.

Work in the "Bonding of Epoxy Coated Prestressing Strands" is being conducted at the Center for Transportation Engineering Studies at North Carolina State University by Dr. David W. Johnston (left) with the assistance of graduate research assistant Ladson Brearley (right).

Quick Response Technical Assistance
Principal Investigators: ITRE and CTES; Dr. Paul Zia, P.E., Coordinator
Sponsor: NCDOT, Division of Highways

In order to be responsive to short term, quick response research projects that are needed throughout a given fiscal year by the North Carolina Division of Highways, ITRE and CTES principal investigators respond to many requests for field investigations, laboratory tests, and professional and technical services in many areas, including pavements, traffic operations, planning, and field engineering.

Projects that have been undertaken in the past year include analysis of temporary pavement markings, structural testing of pavement failures, the analysis of falling deflection meter data, and planning for long-term pavement performance, among other projects.

1987-88 NCDOH Research Program
Principal Investigators: ITRE, NCSU, and UNC-C
Sponsor: NCDOT, Division of Highways

In addition to the continuation of many of the highway engineering research projects described above, the research and development committee of the North Carolina Division of Highways recently approved new research projects which will begin in July, 1987.

These projects include: Soil Stabilization in Pavement Structures, Optimizing Network Level Bridge Management Decisions, Determination of Shear Strength for Design of Cut Slopes in Partially Weathered Rock and Saporlite, Roadside Mowing Efficiency and Spraying Efficiency, Pavement Marking and Sign Test and Evaluation Program, and Evaluation of Pavement Marking Materials for Wet Nighttime Conditions.
Training Programs and Technology Transfer

Professional Development Courses for the NCDOT
Principal Investigator: W.F. Babcock, P.E., ITRE
Sponsor: NCDOT, Division of Highways

ITRE has a direct role with the NCDOT’s Division of Highways. First, it functions as a manager for the research and training programs. Secondly, it works with the department managers in developing and conducting technical training courses for many of the division’s 10,000 personnel.

One of the more important training activities that has continued during the past year is the series of professional development courses, including the Professional Engineer’s Review Course, the Engineer-in-Training Review Course, the Highway Engineering Concepts Course, the Highway Technology Course, and the Crew Leader training program. Each of these courses is designed to upgrade the professional competence of personnel in their current jobs and, in some cases, provide training that the Highway Division requires for promotion. More than 850 persons have taken one or more ITRE courses to date.

Highway Capacity Manual
Principal Instructors: Dr. Paul D. Cribbins, P.E., and Dr. Clinton Heimbach, P.E., NCSU
Sponsor: Various agencies

ITRE has conducted a series of workshops for federal, state, and local government personnel on the 1985 Highway Capacity Manual. Lecture topics included traffic characteristics, basic freeway segments, ramps and ramp junctions, weaving areas, multi-lane highways, freeway systems, signalized intersections, two-lane highways, unsignalized intersections, and urban and suburban arterials.

Problem solving sessions followed each major subject.

Technology Transfer Project for the NCDOT
Principal Investigator: Robert Attaway, ITRE
Sponsor: NCDOT, Division of Highways

The Technology Transfer Project developed by ITRE for the N.C. Department of Transportation is multidimensional in scope and includes an assortment of activities to facilitate the implementation of new technology.

The following are major portions of the project: publishing abstracts on transportation reports and documents; conducting computer searches of transportation data bases on topics requested by NCDOT personnel; and writing a newsletter for field personnel.

NCDOT Maintenance Management System
Principal Investigator: W.F. Babcock, P.E., ITRE
Sponsor: NCDOT, Division of Highways

Since 1983 ITRE has assisted the NCDOT in conducting their pavement condition survey of the entire paved road system in North Carolina. This is done on a periodic basis and ITRE was involved originally in developing this system. ITRE provided training for the NCDOT maintenance engineers across the state in conducting the Pavement Condition Survey and entering the data on a computer. Each highway maintenance engineer, district engineer and division engineer received complete computer printouts showing every segment of highway and its condition rating within their jurisdiction. These printouts have been used over the past five years in planning and scheduling maintenance on the state highway system.

NCDOT Task Forces
Principal Investigator: W.F. Babcock, P.E., ITRE
Sponsor: NCDOT, Division of Highways

A series of Task Forces was formed by the NCDOT to make recommendations in the following areas: general maintenance, pavement maintenance, unpaved secondary roads, visual aids, landscape, traffic services, and maintenance planning.

The Task Forces generally consisted of a division engineer, two district engineers and two highway maintenance engineers. ITRE staff members are assigned to two or more Task Forces and have been involved in the operation of these Task Forces. The Task Forces reviewed the current function codes used by the NCDOT in...

Babcock Receives ARTBA Education Award

The American Road and Transportation Builders Association honored an engineer also known as a "builder of men" -- W.F. "Bill" Babcock, ITRE Associate Director.

The S. S. Steinberg Award, which recognizes a person who has made an outstanding contribution to transportation education, was presented to Babcock in 1986.

Not only has Babcock worked to keep the motto the "good roads state" a true synopsis of North Carolina, but also to train young men and women as civil engineers and to provide continued professional training for them and others involved in the transportation field. Babcock has served as North Carolina's state highway administrator and was the first director of ITRE. He is also professor emeritus of civil engineering at North Carolina State University.
reporting maintenance activities. Recommendations for changes and improvements in these codes were made by each Task Force.

**NCDOT Maintenance Bulletins**

Principal Investigator: W.F. Babcock, P.E., ITRE
Sponsor: NCDOT, Division of Highways

Using the basic findings of the Task Forces, ITRE has written more than thirty maintenance bulletins for NCDOT to fully explain each function code and corresponding maintenance activity. Ten bulletins have final approval for distribution to field personnel. Others are in preparation. The maintenance bulletins are formatted with the following major headings: definition, explanatory text, unit of measure, objectives, related general statutes and/or policies, conditions which warrant activity, general scheduling considerations and safety procedures priority.

**Technology Transfer to Local Transportation Agencies**

Principal Investigator: Robert L. Martin, P.E., ITRE
Sponsor: FHWA, NCDOT

In 1986, ITRE expanded its services to municipal and county governments through a Technology Transfer Program for Local Transportation Agencies, sponsored by the Federal Highway Administration and conducted in cooperation with the N.C. Department of Transportation.

This program, which can be described as a "mini-extension" service, compiles research results into useable information and disseminates that information to the practicing professional. ITRE uses technical assistance, training workshops, publications, and a quarterly newsletter to provide government leaders with solutions to their transportation problems.

During the first year of the program, local government leaders attended workshops in the following areas: the 1985 Highway Capacity Manual for local government agencies; pavement maintenance management and operations and provides staff support on special projects defined by the host agency.

The Internship Program provides part-time work experience in the public transportation field to students enrolled in transportation-related graduate programs. The interns work on a variety of public transportation-related projects under the supervision of the Public Transportation Division staff.

**Public Transportation Training Programs**

Principal Investigator: Michael T. Stanley, ITRE
Sponsor: NCDOT, Public Transportation Division

ITRE continues to manage two popular programs aimed at providing university students and graduates with valuable training and experience in the areas of public transportation management, operations, and marketing.

The Apprenticeship Program provides funds to participating transportation agencies to hire a university graduate as an apprentice on a full-time basis for one year. During that time, the apprentice is trained in various aspects of system management and operations and provides staff support on special projects defined by the host agency.

The Technology Transfer Program for Local Governments at ITRE uses workshops as its primary training tool. Top Photograph: Katy Roe, ITRE summer intern, video tapes the "Legal Liability, Risk Management and Maintenance for Rural Public Transportation and Paratransit Providers" Workshop. Bottom Photograph: ITRE Assistant Director James Martin distributes training certificates to participants at the Asphalt Pavement Technology and Inspection Workshop.
School Bus Scheduling and Routing
Principal Investigator: Derek Graham, ITRE
Sponsors: N.C. Department of Public Education; Energy Division, N.C. Department of Commerce; and Local Education Agencies

The first year of installing a microcomputer-based system to provide computer assistance in school bus routing and scheduling has been completed in the state. Following a significant amount of research and pilot testing of alternative algorithms, a comprehensive system design was achieved in preparing a request for proposals for software around which to mold the state's Transportation Information Management System (TIMS). Specialists from Kertron, Inc. worked with ITRE on that project.

A computer program written by Educational Logistics of Missoula, Montana, has been adapted for North Carolina. In 1986-87, ITRE provided training to Cumberland County and Durham County schools as part of the statewide pilot program. In anticipation of installing TIMS in all local education agencies (LEAs) in the state, approximately ten LEAs will begin using the system during each of the next two years.

EMS Operational Improvements
Principal Investigator: Michael T. Stanley, ITRE
Sponsor: State Office of Emergency Medical Services

ITRE continues to provide training and technical assistance to the staff of the state Office of Emergency Medical Services (OEMS), in the area of EMS resource placement, evaluation and analysis.

The program is now in its third phase, wherein OEMS regional staff is being instructed in the use of microcomputer software evaluated and tested in the project's initial phase, as an aid in identifying alternatives for placement of EMS squads and comparing the relative costs of those alternatives. As part of the regional staff training effort, a study was recently completed on behalf of Stokes County EMS, and a second study is under way in Rowan County.

Contracting for Public Transportation Services
Principal Investigator: Dr. Harvey Goldstein, UNC-Chapel Hill
Sponsor: Urban Mass Transportation Administration

The Department of City and Regional Planning at the University of North Carolina at Chapel Hill is directing a study of competitive-bid contracting by public transportation agencies and the factors which affect an agency's decision to contract or not, with particular attention to the impact of federal labor protection provisions on contracting decisions.

ITRE staff provided assistance to the research team in scheduling and conducting detailed on-site case studies with eleven public transportation agencies around the country.

National Taxicab Survey Update
Principal Investigator: Dr. Raymond Burby, UNC-CH
Sponsor: International Taxicab Association

ITRE has begun providing technical assistance in conducting a survey of taxicab operating characteristics in the United States. ITA will collect data from a random sampling of taxi firms through a two-stage survey process, and ITRE staff will analyze the data and prepare a statistical summary profiling the present-day taxicab industry. This study will serve to update a similar analysis performed in 1981 by the Center for Urban and Regional Studies at the University of North Carolina at Chapel Hill.
Site Impact Traffic Evaluation
Principal Investigator: Dr. John Stone, NCSU
Sponsor: Federal Highway Administration

ITRE is collaborating with researchers at North Carolina State University and the University of North Carolina at Charlotte to develop a training course on site impact traffic evaluation. Transportation planners and engineers trained by this program will be better able to reduce the impact of traffic by reducing traffic congestion.

The course materials and accompanying microcomputer applications are being finalized. The course will be taught three times during the summer of 1987.

Solid Waste Management Improvements
Principal Investigator: Larry Minor, ITRE
Sponsors: Energy Division, N.C. Department of Commerce and Local Government Agencies
Since 1981, ITRE has provided technical assistance to local governments in developing solid waste routing plans for both residential and commercial collection services.

In 1986-87, ITRE worked with several local governments to analyze various aspects of their solid waste management programs. ITRE is also addressing related questions, such as public versus private provision of services, and providing integrated waste management, i.e. recycling, hazardous waste, etc.

Environmental Impacts of Transportation Systems
Principal Investigator: Dr. Wayne Walcott, UNC-Charlotte
Sponsor: Radian Corporation

Under contract with the U.S. Environmental Protection Agency, the Radian Corporation is involved in a multi-year study of alternative modeling approaches for simulating human exposure and risk resulting from airborne pollutants.

Since risk varies from place to place, Radian was interested in exploring the possibility of modeling population movements on an hour-by-hour basis. ITRE was asked to prepare a comprehensive assessment of travel demand modeling techniques with respect to their incorporation in the larger risk assessment model.

The work was divided into three parts: to review travel demand modeling techniques by evaluating their strengths and weaknesses with respect to risk assessment; to review and identify sources of travel demand oriented data sources; and to develop a preliminary travel demand model designed for use within the risk assessment model. Recommendations have been made for a preliminary design.

Traffic Signal Management Program
Principal Investigator: Robert L. Martin, P.E., ITRE
Sponsor: Energy Division, N.C. Department of Commerce

ITRE continues to administer this unique two-year energy conservation program to optimize the timing of traffic signals on North Carolina's highway system. It is being conducted in cooperation with NCDOT and funded through the State Energy Division with petroleum violation escrow (oil overcharge) funds.

ITRE employed three engineering graduates and three electronics technician graduates in 1985, and placed them as trainees with the Signal Management Unit of the NCDOT's Traffic Engineering Branch.

These six people received extensive training and experience in traffic engineering and with three NCDOT personnel formed the new Statewide Signal Optimization Squad.

During the first eleven months of fiscal year 1986-87, the squad retimed 392 signalized intersections throughout North Carolina, bringing the 23-month total to 821 retimed intersections. These modifications result in an estimated annual energy savings of 11.3 million gallons of fuel, for an average of 13,745 gallons per signalized intersection, and a total estimated annual operating cost savings (for fuel, delays and stops) of $41.8 million, for a ratio of total cost savings to direct program costs of 107 to 1.

Project Review
UMTA's Associate Administrator Ken Butler (back right) and Chuck Hedges (back left) review preliminary reports of a study of competitive-bid contracting by public transportation agencies with the project team.

The primary objectives of this program are to reduce energy (fuel) consumption, vehicle emissions, traffic delays and traffic congestion, and to increase annual energy and total operating costs savings (for costs of fuel, delays and stops).

Vehicle Maintenance Program
Principal Investigator: Robert L. Martin, P.E., ITRE
Sponsor: Energy Division, N.C. Department of Commerce

This energy conservation program -- Car Care Clinics for energy efficien-
cy for North Carolina motorists -- has been administered by ITRE since fiscal year 1983-84. ITRE also provides comprehensive publicity for the program, which is being conducted in cooperation with the Independent Garage Owners of North Carolina (IGONC) and funded through the State Energy Division with petroleum violation escrow (oil overcharge) funds.

IGONC's automotive technicians check vehicle tire pressure and wear, hoses, belts, air filters, oil and transmission fluid levels, and engine emissions at the two-day clinics.

Fourteen clinics were held in 1986 at major shopping centers throughout the state. A total of 3,684 vehicles (motorists) participated in those clinics, and 92 percent of the vehicles tested had one or more major maintenance problems.

Correction of these problems would result in an estimated annual energy (fuel) savings of at least 90 gallons per vehicle per year, for a total of 305,000 gallons of fuel (a ratio of fuel costs savings to direct program costs of over 4 to 1).

The primary objectives of this program are to reduce fuel consumption, improve vehicle operating efficiency and emissions, and increase annual energy savings.

Assistance to the State Ports Authority
Principal Investigator: Derek Graham, ITRE
Project Sponsor: State Ports Authority, N.C. Department of Commerce

The primary objectives of the first project in this technical assistance were to (1) provide an initial assessment of the container terminal capacity of the Port of Wilmington in its present configuration; and to (2) examine alternative port capacity analysis strategies and computer programming techniques that would ultimately provide the best way for the State Ports Authority to conduct in-house capacity analyses.

Program Receives ITE Award

North Carolina's Traffic Signal Management Program was named the recipient of the Institute of Transportation Engineers' 1987 Transportation Energy Conservation Award.

Through this unique two-year energy conservation program, the Statewide Signal Optimization Squad of the North Carolina Department of Transportation has optimized the timing of 820 traffic signals on the state highway system. These modifications resulted in an estimated annual energy savings of 11.3 million gallons of fuel.

The program is administered by ITRE and conducted in cooperation with the NCDOT, and funded through the State Energy Division with petroleum violation escrow funds.

The award, which will be presented at the 57th Annual Meeting of the Institute of Transportation Engineers in August, 1987, memorizes Frederick A. Wagner.
In addition to a full-time research and training staff of 28 persons, ITRE draws additional resources from its research affiliates at a number of campuses of the University of North Carolina system and at Duke University.

In fiscal year 1987, ITRE collaborated with campus-based researchers on more than half of its funded research and training programs. Twenty-five faculty members and 37 students were supported through ITRE programs and projects. The following is a brief description of some of the transportation programs at these campuses.

North Carolina State University

The Center for Transportation Engineering Studies (formerly known as the North Carolina Cooperative Highway Research Program) in the Department of Civil Engineering dates back to the 1950's. In this center, engineering studies are conducted in the areas of planning, design, construction, maintenance, and operations involving highway structures and pavements.

Also on the Raleigh campus, the Department of Mechanical and Aerospace Engineering conducts transportation research in pavement-tire interactions, tire noise, engine performance, innovative fuels, aircraft design and aircraft noise. A significant new five-year research program, funded at $1 million annually, was initiated this year on the hypersonic aircraft.

University of North Carolina - Chapel Hill

Since 1966, the Highway Safety Research Center has conducted a very strong program of research and public service including the areas of transportation regulations, evaluating highway safety needs inventories, professional training on highway safety topics, and analysis of national, state, and local accident data.

Also on the Chapel Hill campus, the Department of City and Regional Planning has an outstanding graduate program and has conducted a number of transportation planning and public transportation studies with special emphasis on the taxi industry.

East Carolina University

Consistent with the mission of this regional university, research has been conducted by the Department of Sociology and Economics on the social and economic impacts of transportation on communities, with emphasis on those in coastal environments. A public service and training program is also conducted here by the Traffic Safety Center.

University of North Carolina Central University

Located in Durham, N.C., an interdisciplinary Transportation and Infrastructure Research Center conducts research in transportation demand modeling and research on transportation facilities.

Another program with which ITRE collaborates includes the Executive Management Program in the Fuqua School of Business.

University of North Carolina - Wilmington

Specialized studies are being conducted here on the effects of transportation systems on coastal environments and on port development issues.

North Carolina Agricultural and Technical State University

Since 1971, researchers at the Transportation Institute and in other departments on this campus have conducted studies on transportation logistics, motor freight management, public transportation, rural transportation, and paratransit services. A traffic safety education program is also located on this Greensboro campus, and assistance is being provided to ITRE for workshops on technology transfer to local governments.
Policy and Advisory Boards

Council on Transportation Research and Education

Purpose: Recommends policies for the operation of ITRE to the President of The University.

Roy Carroll
Vice President for Planning
The University of North Carolina - General Administration

Felix Joyner
Vice President for Finance
The University of North Carolina - General Administration

William DeMaria
Medical Director
Blue Cross-Blue Shield of North Carolina

Jasper Memory (Council Chairman)
Vice President for Research
The University of North Carolina-General Administration

James E. Harrington
Secretary
N.C. Department of Transportation

Larry Monteith
Dean
School of Engineering, North Carolina State University

George Herbert
President
Research Triangle Institute

John Sanders
Director
Institute of Government

ITRE Advisory Committee

Purpose: Assists the Council on Transportation Research and Education in ensuring that ITRE's programs are responsive to user needs and that ITRE is meeting its program goals.

Carl E. Annas
Corporate Group Vice President (retired)
Burlington Industries Transportation, Inc.

Carson D. Culbreth
Director
Energy Division, N.C. Department of Commerce

Elbert L. Peters, Jr.
Executive Vice President
N.C. Trucking Association

C. Ronald Aycock
Executive Director
N.C. Association of County Commissioners

David Reynolds
Executive Director
N.C. League of Municipalities

John Brantley
Executive Director
Raleigh-Durham Airport Authority

Tom Runkle
Deputy Controller
State Board of Education

Henry Clegg
Director
Highway Division, Carolina's Branch
Associated General Contractors of America

C. Ed Vick, Jr.
President
Kimley-Horn and Associates, Inc.

William W. Edwards
Executive Director
State Ports Authority

George E. Wells (Advisory Committee Chairman)
State Highway Administrator
N.C. Department of Transportation

Bobby Mattocks
President
Jenkins Gas and Oil Company

Carl Wills
Director of Public Works
City of High Point, North Carolina
ITRE Technical Coordinating Committee

**Purpose:** Gives advice to ITRE's Director in the formulation and coordination of programs.

**W. F. Babcock**
Associate Director
Institute for Transportation Research and Education (ITRE)

**Edwin W. Hauser (TCC Chairman)**
Director
Institute for Transportation Research and Education (ITRE)

**John J. Manock**
Director
Office of Research Administration
UNC-Wilmington

**John Bailey**
Head
Mechanical Engineering Department
North Carolina State University

**Al King**
Director
Traffic Safety Center
East Carolina University

**Ken Murray**
Chairman, Civil Engineering Dept.
N.C. Agricultural and Technical State University

**Mrinmay Biswas**
Director
Transportation and Infrastructure Research Center
Duke University

**Ellis King**
Chairman
Department of Civil Engineering
UNC-Charlotte

**Woodrow W. Nichols**
Chairman
Department of Geography
North Carolina Central University

**B.J. Campbell**
Director
Highway Safety Research Center
UNC-Chapel Hill

**Ben Loeb, Jr.**
Assistant Director
The Institute of Government
UNC-Chapel Hill

**Michael Stegman**
Chairman
Department of City and Regional Planning, UNC-Chapel Hill

**L. Milton Glisson**
Director
Transportation Institute
N.C. Agricultural and Technical State University

**Al Stuart**
Chairman
Department of Geography and Earth Sciences, UNC-Charlotte

**John R. Maloof**
Chairman
Department of Sociology, Anthropology, and Economics
East Carolina University

**Paul Zia**
Head, Civil Engineering Department
North Carolina State University

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The Institute for Transportation Research and Education Staff Organization

[Diagram of organizational structure]

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The Institute for Transportation Research and Education:
Staff and Research Affiliates

Administration
Edwin W. Hauser, Director, Ph.D., P.E.
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Robert L. Martin, Associate Director, M.S., P.E., AICP
Rosalie Neville, Administrative Secretary
Diane Mealer, Secretary

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Pamela Cheek, B.A.
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