ITRE Background

Entering its second decade, the Institute for Transportation Research and Education (ITRE) serves as a catalyst for transportation research in the state, region, and nation. Equally important is the technical assistance ITRE provides to state and local governments through more than 80 individual projects.

It was in 1977 that the North Carolina General Assembly recognized the need for an institute to provide leadership for North Carolina's university transportation research and education programs. The following year ITRE was established in the office of the President of The University of North Carolina. As a unit of The UNC General Administration, ITRE draws on the resources of all 16 campuses of the UNC system and Duke University in a true interdisciplinary program.

Through this unique relationship, ITRE staff members and affiliated campus faculty join together in transportation research, training, and technology transfer programs.

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This publication was prepared in August, 1988, by the UNC Institute for Transportation Research and Education, P.O. Box 12551, Research Triangle Park, N.C. 27709-2551.

3,500 copies of this public document were printed at a cost of $1,989.00 or $.57 per copy.

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Letter from the Director

On March 1, 1988, ITRE completed its tenth year as a university transportation institute. Over its ten-year history, cumulative revenues from ITRE grants and contracts have totaled $11.1 million.

One hundred and two faculty and professional staff have worked on ITRE programs and projects. In the last ten years, 230 graduate and undergraduate students have worked on ITRE projects or have been supported by ITRE grants and contracts. Sixty-five of these students are now employed in transportation-related occupations or are working on graduate degrees in transportation-related disciplines.

For the $11 million expended in ITRE research and training programs, it is estimated that over $50 million has been saved by transportation agencies and the motoring public as a result of these programs. We feel that this is a notable achievement for the $150,000 initial investment by the state of North Carolina to establish the institute in 1977-78.

During the past year, several milestones were reached that were memorable and noteworthy. The increased number of projects and their dollar value, approximately $2.2 million, are milestones for a fiscal year. On the following pages of this annual report are summaries of these projects from the various program areas.

Over the course of the year, ITRE continued to expand the scope and diversity of its base of support with approximately 20% of research and training grants and contracts coming from federal agencies.

Also during the year, ITRE moved its operations staff to more spacious quarters in Raleigh, where Associate Director Robert L. Martin is the administrator. The director’s office and teaching facilities remain at Research Triangle Park. ITRE’s project office at UNC-Charlotte has increased its staff to thirteen. In addition, 22 faculty on five UNC campuses are currently involved in programs and projects.

We are also very pleased that ITRE is part of the new southeastern transportation research center. As the administrator of a four-year, $2 million grant awarded by the Office of the Secretary, U.S. Department of Transportation, ITRE will provide members of the new center, the Southeastern Consortium of University Transportation Centers (SECU TC), with leadership and project management. SECU TC serves as a link between federal, state, and local governments in the effort to serve the transportation needs of the nation, and the southeast in particular. The Consortium currently includes universities in Florida, Kentucky, Tennessee and North Carolina; other members are anticipated to join.

And finally, another milestone in the history of ITRE was passed and, indeed, an era in transportation management and leadership ended with the retirement of Professor W. F. Babcock, who served as ITRE’s first director and as associate director since 1984. His service to ITRE and the state of North Carolina will be sorely missed.

Edwin W. Hauser, P.E., Ph.D.
Director
ITRE to Administer Southeastern Transportation Center

ITRE has begun administering a four-year, $2 million grant, awarded by the U.S. Department of Transportation, to members of the Southeastern Consortium of University Transportation Centers (SECUTC). This grant, matched with funds from state, local, and private sources, establishes the consortium as one of the 10 regional transportation research centers in the country.

In each regional center, university researchers will address critical transportation issues that include developing transportation system technology, transportation safety, and the relationship between transportation and regional development.

In the newly established southeastern center, ITRE and the University of North Carolina system will provide leadership and project management for research programs involving universities in North Carolina, Florida, Kentucky, Tennessee and other southeastern states. Dr. Edwin W. Hauser is center director.

Research and training grants will be awarded through the center to universities in the southeast including a number of North Carolina institutions: North Carolina State University, the University of North Carolina at Chapel Hill, the University of North Carolina at Charlotte, North Carolina Central University, North Carolina Agricultural and Technical State University and Duke University.

ITRE’s entry as a transportation center began in September, 1987, when four state universities in the southeast (USDOT Region IV) established SECUTC as a link between federal, state, and local governments in the effort to serve the transportation needs of the nation, and the southeast in particular.

On behalf of the consortium, The University of North Carolina system was proposed as the lead institution. The other universities in the consortium are Duke University, the University of Florida, the University of North Florida, the University of Kentucky, the University of Tennessee and Vanderbilt University.

UNC Vice President for Research Dr. Jasper Memory stated that the new regional center “will establish ITRE as one of the premier national resources for the advancement of scientific knowledge and the development of innovative methods and techniques to help our country solve an array of complex transportation problems.”

Babcock Retires from ITRE

ITRE’s first director, W. F. "Bill" Babcock, officially closed his door at the institute on June 30, 1988.

The former state highway administrator and professor of civil engineering became ITRE’s first director in 1978 and served for six years. In 1984, he semi-retired but continued as manager of the research and training program ITRE conducts for the North Carolina Department of Transportation, Division of Highways.

Throughout his long career - from his graduate studies at Massachusetts Institute of Technology to becoming North Carolina State University’s first professor of transportation in the civil engineering department to his 12-year career as state highway administrator - Mr. "B" became a legend for his commitment and devotion to the North Carolina transportation system.

His knowledge and excellent teaching skills have had a profound influence on hundreds of students. And his outstanding service to ITRE and the state of North Carolina, with his emphasis on professionalism and competence, will be remembered by those fortunate enough to have worked with him.
Highway and Transportation Engineering Research

Pavement Marking Materials Program
Principal Investigator: Robert W. Attaway, ITRE
Sponsor: North Carolina Department of Transportation (NCDOT), Division of Highways

This research is assisting the Traffic Engineering Branch in selecting the best marking materials for North Carolina roadways.

The three major research areas are testing and evaluating pavement marking paints, including pre-mixed and non pre-mixed paints under test conditions; studying more durable pavement marking materials under test deck and in-service conditions; and determining acceptable and unacceptable reflectivity levels for pavement marking materials under dry nighttime conditions.

Appearance, durability, and reflectivity are the evaluation criteria for all three projects. Since most pavement marking products fail because of poor nighttime visibility, much attention is being given to this area. A panel evaluation is being developed to help determine acceptable levels of reflectivity for pavement markings.

Optimizing System-Level Bridge Management Decisions
Principal Investigators: Dr. David W. Johnston, P.E., and Dr. Foad Farid, North Carolina State University (NCSU)
Sponsor: NCDOT, Division of Highways

Project results will aid bridge managers in predicting future needs and performance of bridges throughout the state system.

In previous projects, methods and algorithms have been developed for predicting optimum future funding needs with economic models under no funding constraint. Additional procedures and algorithms for optimum allocation of multi-year funding under budget constraints will be produced.

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

This two-year project continued its research into determining the potential benefits from using high strength concrete in highway bridge superstructures with materials available in North Carolina. These benefits include greater strength, durability, and economy.

Computer programs using parametric studies of standard I, T, and box-shaped prestressed concrete girders, as well as rectangular and circular pier sections, have been completed. Analytical studies of girders, box beams and pier sections will be finished soon.

The Role of Modified Binders in the Performance of Pavements
Principal Investigator: Dr. N. Paul Khosla, NCSU
Sponsor: NCDOT, Division of Highways

This research is exploring the potential benefit of modifiers in the performance of asphalt pavements. Three asphalt cements (AC-5, AC-10, and AC-20), used...
as the base asphalts, were each modified with carbon black, polymer (styrene), and latex to improve their respective characteristics. Specifically, the tests included resilient modulus values, creep characteristics, and fatigue characteristics.

An analysis of the data is being performed, comparing pavements for fatigue cracking, rutting, and serviceability.

A Comparative Study of Performance of Different Designs for Flexible Pavements

Principal Investigator: Dr. N. Paul Khosla, NCSU

Sponsor: NCDOT, Division of Highways

As part of a multi-year project to analyze pavement performance in North Carolina, the NCDOT is constructing 48 full-scale pavement test sections of different types and thicknesses. Each section will make simultaneous measurements of temperature and moisture along with stress-strain characteristics of the pavement system.

Weigh-in-motion platforms will be installed to monitor traffic loadings. The test sections will be monitored over a ten-year period and should result in an improved predictive equation, improved design procedures, and better pavement performance at a lesser cost. Test sections are being constructed on the U.S. 421 bypass near Siler City, N.C.

Feasibility of Incremental Benefit-Cost Analysis for Optimal Allocation of Limited Budgets to Maintenance, Rehabilitation and Replacement of Bridges

Principal Investigators: Dr. David W. Johnston, P.E. and Dr. Foad Farid, NCSU

Sponsor: FHWA Demonstration Projects Division

This study investigated how well a budget allocation algorithm, the Incremental Benefit-Cost (INCBEN) Program, can be used in determining limited bridge improvement budgets.

INCBEN was applied to a sample of highway bridges to determine the optimal (cost-effective) set of bridge improvement alternatives. Twenty-five North Carolina in-service bridges with varying degrees of structural or functional deficiencies were used for the sample. Necessary parameters of costs and benefits were estimated; and feasible maintenance, rehabilitation, and replacement alternatives were developed.

The report includes: selections of optimal bridge improvement alternatives under several levels of budget granted; advantages and limitations of the methodology; level of effort required; sensitivity of budget allocation results to the discount rate, remaining life, and service life; and comparison of results with those of sufficiency-rating methods.

Expert Systems for Bridge and Structural Design

Principal Investigator: Dr. Minnmay (Moy) Bhasaw, P.E., Duke University

Sponsor: Richard Leach Endowment Research Fund

A microcomputer-based, interactive, graphic expert system has been developed for rapid preliminary bridge design. With close cooperation of NCDOT Structural Design Unit personnel, researchers used department bridge design rules and practices to develop this system’s knowledge base. Research is continuing in the area of automated knowledge acquisition and knowledge base development.

Soil Stabilization in Pavement Structures

Principal Investigators: Dr. Phillip C. Lambe, P.E. and Dr. N. Paul Khosla, NCSU

Sponsor: NCDOT, Division of Highways

This two-year research program will reveal the optimum type and quantity of additives to economically stabilize typical soils found in the state.

Researchers have conducted classification, compaction, California Bearing ratio, and resilient modulus tests on unstabilized samples of five representative North Carolina soils. Selected percentages of lime and cement, two additives currently being used by the NCDOT, Division of Highways, will be tested with each soil sample.

Determination of Shear Strength for Design of Cut Slopes in Partially Weathered Rock and Sapolite

Principal Investigator: Dr. Phillip C. Lambe, P.E., NCSU

Sponsor: NCDOT, Division of Highways

Analysis began on two cut slopes that have failed along interstate highways in North Carolina.
Examination of the problems during construction include seven different areas involving 17 different failures. A computer program was used to identify the most critical slip surface and the factor of safety along with generating resistance envelopes for each slide.

Roadside Mowing Efficiency and Spraying Efficacy
Principal Investigator: Dr. Joseph M. DiPaola, NCSU
Sponsor: NCDOT, Division of Highways

Plant growth regulators have been developed to reduce mowing requirements of turf grasses along roadsides and rights-of-way. Mowing accounts for as much as 80 percent of the total vegetation maintenance budget, and overgrowth is a potential fire and safety hazard.

Research was conducted to determine the influence of surfactants and additives on the efficacy and phytotoxicity of herbicides and growth regulators on roadside turf; and to determine the effects of consecutive annual applications of plant growth regulators on turf cover and performance under roadside conditions.

1988-89 NCDOT Research and Training Program
Principal Investigators: ITRE; NCSU
Sponsor: NCDOT, Division of Highways

In addition to continuing all of the NCDOT-sponsored highway engineering research projects described above, the research and development committee of the North Carolina Division of Highways recently approved new research projects that began July, 1988, including: Repair and Protection Alternatives for Coastal Highways Vulnerable to Storm Damage, Shoreline Erosion and Sea Level Rise; Training Needs Analysis and Pilot Training Project; and a Maintenance Organization Study.

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

This project developed a management system 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 project results and its implementation phase by the NCDOT have received national attention, specifically at the bridge management workshops sponsored by the Transportation Research Board in January of 1987 and 1988 and the Region IV and VI State Highway Agency Research Directors Conference in August, 1988.

National Paratransit Survey Update
Principal Investigators: Dr. Raymond Burby, UNC-CH; Michael T. Stanley, ITRE
Sponsor: International Taxicab Association (ITA)

ITRE completed a statistical analysis of data obtained from a nationwide survey of the private for-profit taxicab and paratransit industry, and prepared a final report documenting the project. ITA collected data from a sample of paratransit operators by means of two mail-in surveys.

ITRE staff coded and analyzed the data and constructed a statistical summary profiling the industry. This project was initiated in part as a follow-up to a similar analysis performed in 1982 by the Center for Urban and Regional Studies at the University of North Carolina at Chapel Hill.

Economic Change in North Carolina and Its Implications for Highway Planning
Principal Investigators: Dr. James Clay, Dr. Alfred W. Stuart, and Dr. Wayne A. Walcott, UNC-Charlotte
Sponsor: Better Transportation for North Carolina, Inc.

This statewide study examined the role of highway accessibility in economic development. Each of North Carolina's 100 counties was analyzed individually and in groups of similar counties.

The study analyzed changing economic structures of the state and of each county, industrial mix, manufacturing versus non-manufacturing, the wage quality of jobs, recent growth trends and related inter-county commuting patterns. Attention was given to overall indications of material well-being and the relation of economic growth to population change. Longitudinal data were developed whereby highway expenditures by county were compared to change in population, employment, income, and tax base over the past decade.

Several methods, including topological evaluations of direct highway linkages, were tested as measures of highway accessibility. Also the measures of economic characteristics and change were compared statistically with the accessibility measures in order to test the nature of the relationships between the two.
Groups of counties that are similar in highway and economic development characteristics were identified, which in turn helped to suggest a variety of potential strategies for linking highway development to economic development.

Properties of Epoxy Mortar for Highway Bridges

Principal Investigator: Dr. Mrinmay (Moy) Biswas, P.E., Duke University
Sponsor: National Science Foundation

Using these research results, transportation professionals can evaluate the long term durability of all structural mortars, especially those used for structural rehabilitation and overlay of bridge decks.

Experimental methods, benchmark data, and mathematical models have been developed for constitutive properties, failure criteria, and damage state for epoxy mortar. Preliminary research work was also done on acrylic, latex modified, as well as portland cement concrete based, mortars. Continued research includes developing new techniques for detecting materials degradation and developing information on damage mechanisms.

Detecting Incipient Failures in Bridges

Principal Investigators: Dr. Mrinmay (Moy) Biswas, P.E. and Dr. Eric Pas, Duke University
Sponsors: Pennsylvania Department of Transportation; FHWA

The Duke University Transportation and Infrastructure Research Center, in collaboration with ITRE, was awarded a major three-year research contract by the Pennsylvania DOT to develop a system to monitor the structural integrity of bridges.

The development of the proposed system is based on two basic technologies: the use of the diagnostic dynamic testing system and the use of expert system methods.

Current research falls into four major areas: computer simulation of dynamic behavior of failure-induced bridge structure; experiments with laboratory scale bridge models including simulated failures; field experiments with real highway bridges (number of preliminary field tests were performed on NCDOT bridges); and development of expert systems based on digital signal processing and the artificial intelligence techniques of pattern recognition. Future work will include experimental dynamic field testing of highway bridges with artificially induced major failures.

Research Equipment for Constitutive Properties and Benchmark Resistance of Plastics Construction Materials

Principal Investigator: Dr. Mrinmay (Moy) Biswas, P.E., Duke University
Sponsor: National Science Foundation

A comprehensive testing laboratory has been established for basic research in construction material science. Major equipment includes a 220 Kip, closed loop controlled MTS dynamic testing machine; a one yard capacity automatically controlled, programmable temperature and humidity chamber with a temperature range of (-100) degrees F. to (+)350 degrees F.; microcomputer based data acquisition, control, and data analysis system; a freeze-thaw chamber; and a spectral analysis system including broad band (impulse hammer) and narrow band (modal shaker) forcing function devices.

Monies from a Department of Defense University Research Instrumentation Program grant, the Duke Endowment, and the Duke University Research Council were also used to develop the research laboratory.

Dr. Mrinmay "Moy" Biswas, Duke University, performs experiments on a laboratory scale model bridge using a spectrum analyzer and an impulse hammer system.
Technology Transfer - Training and Technical Assistance

Technology Transfer to Local Transportation Agencies

Principal Investigator: Robert L. Martin, P.E., ITRE
Sponsors: Federal Highway Administration (FHWA); NCDOT

This technical training, information and assistance program bridges the gap between North Carolina’s transportation researchers and practicing professionals.

Technology transfer takes research results off the shelf and puts them to practical use to improve our roads, bridges, and public transportation services.

Acting as a "mini-transportation extension service," the North Carolina Technology Transfer Program for Local Governments offers five primary types of assistance to municipal, county, and state government personnel: workshops, technical materials, technical information services, quarterly newsletters, and technical assistance.

Fourteen major areas, ranging from asphalt pavement inspection to improving communication skills, were featured in workshops during 1987. Also during the year, the staff distributed over 400 free publications or reports to more than 140 government leaders.

North Carolina’s program is one of 44 programs nationwide funded by the Federal Highway Administration, National Highway Institute, through the Rural Technical Assistance Program. It is conducted by ITRE in conjunction with the N.C. Department of Transportation and enables ITRE to enhance and expand its on-going program of technology transfer to local governments throughout the state.

Traffic Operations Training Courses for Rural and Small Urban Areas

Principal Investigator: Dr. H. Douglas Robertson, P.E., UNC-Charlotte
Sponsors: FHWA; NCDOT

Recognizing that local government personnel often are not trained in the latest traffic engineering techniques related to rural and small urban area traffic problems, the FHWA has contracted through ITRE with UNCC to develop a package of four one-day courses to provide state-of-the-art training for rural and small urban area personnel. The project began in October, 1987, and is nearing the completion of Stage I, the development of a course on conducting traffic operations reviews. The pilot workshop was held at UNCC on June 7, 1988.

In the coming year, three more courses will be developed on the topics of traffic control devices, traffic signal designs, and human factors and driver expectancy in design and operations. All four courses include "hands-on" training and practical applications. Traffic simulations, using videotapes and slides, allow course participants to solve problems and reinforce what they have learned.

Therefore, as traffic increases in rural and small urban communities, better traffic management can be employed using the latest in traffic engineering principles and techniques. These courses eventually will be offered nationwide through FHWA’s Rural Technical Assistance Program.

Municipal Pavement Management Systems

Principal Investigator: James B. Martin, P.E., ITRE
Sponsor: Municipal Governments

ITRE performed pavement condition surveys for more than 50 municipalities in North Carolina and other states in 1987 and 1988.

The information gathered from these surveys is entered into a microcomputer using ITRE’s custom written software PMS-ITRE (Pavement Management System-ITRE) to analyze the data. Survey results provide a pavement condition rating number, the estimated cost of repair, and type of maintenance repair needed for each street section. The results also provide an overall summary of the condition and maintenance needs of the entire municipal street system.

Municipal leaders have used the survey results to more cost effectively plan their street maintenance program. By using this information, department heads have justified budget requests for increased street maintenance and resurfacing.

ITRE has also made its software PMS-ITRE available to those municipalities that have had pavement condition surveys. More than 20 municipalities have PMS-ITRE in-house. ITRE continues to revise and update PMS-ITRE to enhance its capabilities.

Research is under way to develop an additional module to the software that would provide life cycle curves for municipal streets within North Carolina. This would provide a more accurate prediction of future conditions based upon current levels of service and maintenance practices.
At the 1988 annual meeting of the Transportation Research Board (TRB), the paper entitled Pavement Management for North Carolina Municipalities depicted the success and wide-spread acceptance of PMS-ITRE. James Martin presented the paper which will be published by TRB.

Pavement Structure Repair Techniques
Principal Investigator: James B. Martin, P.E., ITRE
Sponsors: FHWA; NCDOT

Training local pavement maintenance personnel will be easier when the six videotapes and an interactive videodisc system are completed for this project.

The six pavement structure repair techniques to be covered are asphalt chip seals, pothole patching, maintenance of gravel roads, crack sealing, shoulder maintenance, and ditch maintenance. Each videotape will be approximately 15 to 20 minutes in length and will simply and thoroughly explain the proper procedure for performing the various pavement repairs.

Using ITRE-written scripts, a professional crew has begun videotaping. ITRE is preparing a 15 to 20 page supplement, containing photographs, sketches, and example calculations for each videotape.

ITRE is also developing an interactive videodisc training system that will enable users to view pavement maintenance techniques. ITRE is designing the videodisc training package to cover essentially the same material as the six videos. The system will include a videodisc player, a microcomputer, and a video monitor, all of which will be packaged for shipping and will operate with minimum setup.

The user will view a combination of still frames, text slides, and motion video footage, all accompanied by audio. By responding to a menu, the user will be able to make random selections to interact with the system and test himself on any of the six topics.

To be completed in 1989, this project serves as a pilot for developing other interactive videodisc systems.

NCDOT Pavement Management Program
Principal Investigator: James B. Martin, P.E., ITRE
Sponsor: NCDOT, Division of Highways

For the past several years, ITRE has worked with the N.C. Department of Transportation in coordinating the pavement condition survey conducted by the Division of Highways.

More than 60,000 miles of the paved road system were surveyed from February to May, 1988, using methodology developed by ITRE in 1982. ITRE assisted in training the more than 70 teams that actually conducted the pavement condition survey. ITRE was responsible for reviewing and updating maintenance costs that were used to calculate the results.

Left photograph (left to right): James Martin and Robert Attaway, ITRE, discuss the pavement maintenance scripts with Eugene Murray and JoAnne Harrington of The Department of Administration's North Carolina Agency for Public Telecommunications. Right photograph: Donald King, NCDOT, reviews previous shots with Robert Attaway and James Martin. Six videotapes are being developed for the Pavement Structure Repair Techniques project.
The survey results have been used to allocate contract resurfacing funds across the state. Field personnel find it useful in planning and scheduling routine maintenance as well as preparing resurfacing priority lists. The results are also used to justify budget requests presented to the North Carolina General Assembly.

NCDOT Maintenance Manual Vol. II
Principal Investigator: James B. Martin, P.E., ITRE
Sponsor: NCDOT, Division of Highways

State transportation field personnel now have an updated maintenance manual to direct them in performing their duties.

During the year, ITRE assisted the North Carolina Division of Highways Maintenance Unit in preparing, publishing and distributing the North Carolina Division of Highways Maintenance Manual, Volume II.

Included in this manual are guidelines for performing various routine maintenance activities. Ten maintenance bulletins containing the guidelines have been finalized and approved by highway management. Another 20 bulletins are in draft form and are to be added to this manual during the current year.

Each maintenance bulletin is fully illustrated and includes a description of the activity objectives, conditions that warrant the activity, personnel requirements, equipment requirements, productivity rates, and proper operating procedures for each activity.

NCDOT Pavement Maintenance Principles
Principal Investigator: James B. Martin, P.E., ITRE
Sponsor: NCDOT, Division of Highways

ITRE prepared and published the text for a series of training courses entitled "Pavement Maintenance Principles." ITRE also assisted the NCDOT in teaching these courses across the state to more than 200 maintenance engineers and supervisors.

The two-day classroom session included lecture, videotape, slide presentation, and field demonstrations. The course notebook contained more than 300 pages of text.

Course topics included fundamentals of bituminous pavements, bituminous pavement distress, bituminous pavement maintenance procedures, fundamentals of portland cement concrete (PCC), PCC pavement distresses, PCC pavement maintenance procedures, and work zone traffic control.

Bob Foyle, ITRE assistant director, teaches numerous topics for the three professional development courses ITRE created for the NCDOT, Division of Highways. Since 1985, more than 1,040 persons have attended one or more of the three courses. They include the Professional Engineering Review Course, the Engineer-in-Training Review Course, and the Highway Engineering Concepts Course.

Career Development Program
Principal Investigator: Robert S. Foyle, P.E., ITRE
Sponsor: NCDOT, Division of Highways

Since 1985, the NCDOT, Division of Highways, has been dedicated to establishing professional development opportunities for their employees. As a part of this goal, ITRE is continuing to teach the Professional Engineering Review Course, the Engineer-in-Training Review Course, and the Highway Engineering Concepts Course for department employees.

Two sessions for each course were held this past year with 190 employees attending. To date, more than 1,040 persons have taken one or more of these courses.

The EIT and PE courses form an integral part of the department's effort to get personnel in engineering classifications registered as professional engineers. The Highway Engineering Concepts course is an intense 16-day program designed to upgrade the technical expertise of technician level employees in the basic scientific principles and practices that a bachelor of science in civil engineering graduate learns.

During fiscal year 1989, two courses each for the Professional Engineering Review, the Engineer-in-Training Review, and the Highway Engineering Concepts will be scheduled.

In 1988, the Professional Engineering Review and the Engineer-in-Training Review courses were begun for local government personnel.
Highway Capacity Manual Workshops

Principal Instructors: Dr. Paul D. Cribbins, P.E. and Dr. Clinton L. Helmbach, 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.

Public Transportation Training Programs

Principal Investigators: John N. Kent and 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 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 staff.

N.C. Street and Highway Management Conference

Conference Director: Dr. Edwin W. Hauser, P.E., ITRE
Sponsors: ITRE; NCDOT

More than 240 persons attended the December 15-17, 1987, North Carolina Street and Highway Management Conference. The conference provided training in general management principles for current and future transportation system managers, and identified critical national, state, and local transportation management issues. "Leadership: Achieving Excellence in Management" was the conference theme.

"Whether we are on the local, state, or federal level, we are in the same business: serving the American people. To accomplish that mandate and to fulfill that trust, we must strive to do our best everyday," said U.S. Department of Transportation Secretary James H. Burnley IV. The North Carolina native addressed participants at the Tuesday evening dinner.

Instructors were D. L. Howell, Tim Stockert, Emol Fails, and Steve A. Martin.

The success of the conference was also due to the cooperation and support ITRE received from its co-sponsor, the North Carolina Department of Transportation, and the contributors: Carolina's Branch, Associated General Contractors of America; Carolina Asphalt Pavement Association; North Carolina Aggregates Association; Carolina Ready Mixed Concrete Association; and the Consulting Engineers' Council of North Carolina.

The N.C. Street and Highway Management Conference will be held again on November 3, 1988, with the theme "Public Management in Changing Times."

U.S. Department of Transportation Secretary James H. Burnley IV discusses transportation issues at the 1987 North Carolina Street and Highway Management Conference, which was held in Research Triangle Park. More than 240 state and local government leaders attended the three-day conference, sponsored by ITRE and the North Carolina Department of Transportation.
School Bus Scheduling and Routing

Principal Investigator: Derek S. Graham, ITRE

Sponsors: N.C. Department of Public Education; Local Education Agencies; Energy Division, N.C. Department of Commerce

North Carolina has reaped energy, financial, and administrative savings through ITRE's program of technical assistance in computer-assisted school bus routing and scheduling. The program consists of two distinct areas: the Scheduling Assistance Model (SAM) and the Transportation Information Management System (TIMS).

Assistance in computer-assisted scheduling via SAM was provided to the Guilford County and Wake County school units. For the fall 1987 school opening, Guilford County reduced its fleet by approximately 50 busses as a result of staggering school times. Wake County is analyzing similar strategies for 1988-89.

ITRE’s second year of TIMS installation and training increased to 12 the number of school units using this comprehensive pupil transportation planning tool. An additional 40 school units will begin using TIMS during 1988-89.

TIMS uses a digitized street network map and provides information on bus routes, including passengers, bus stops, times, student eligibility, and driving instructions. An optimization component allows transportation personnel to develop efficient bus routes and schedules, making use of this extensive data base.

To accommodate this dramatic expansion of the TIMS installation effort, ITRE has increased not only its office space, but its personnel resources as well. Fifteen part-time student research assistants from local universities have joined the nine professional staff members in Raleigh and at UNC-Charlotte.

The TIMS project is being funded through the Department of Public Education (DPE) by the Energy Division, N.C. Department of Commerce. As TIMS is installed in school units throughout North Carolina, the DPE continues to rely on ITRE for its system installation and training.

Emergency Medical Services Transportation Studies

Principal Investigator: Michael T. Stanley, ITRE

Sponsor: N.C. Office of Emergency Medical Services

ITRE completed a program of training and technical assistance to the North Carolina Office of Emergency Medical Services staff (OEMS) in the area of EMS squad placement analysis. This program used computer-assisted techniques to evaluate alternatives for locating ambulance bases and related resources by optimizing response time. OEMS and ITRE staff completed a study for Rowan County EMS as part of the training process. In connection with this project, ITRE staff also conducted a squad placement analysis for Alexander County EMS.
North Carolina Emergency Energy Conservation Plan

Principal Investigator: John N. Kent, ITRE
Sponsor: Energy Division, N.C. Department of Commerce


Vehicle Maintenance Program

Principal Investigator: Robert L. Martin, P.E., ITRE
Project Leader: Kathyrn P. Roe, ITRE
Sponsor: Energy Division, N.C. Department of Commerce

Already in its fifth year, the Car Care Clinic program for energy efficiency continued to give North Carolina motorists a better understanding of proper car care and techniques for preventive maintenance.

Funded through the State Energy Division with petroleum violation escrow (oil overcharge) funds and conducted in cooperation with the Independent Garage Owners of North Carolina (IGONC), this program is designed to reduce fuel consumption, improve vehicle operating efficiency and emissions, and increase annual energy savings. ITRE manages the program and provides complete publicity for the two-day clinics hosted each summer at major shopping centers throughout the state.

At the clinics, IGONC automotive technicians check each vehicle’s tire pressure and wear, hoses, belts, air filters, and oil and transmission fluid levels, and conduct electronic analyses of engine emissions. Participants receive a copy of all test results with recommended repairs and maintenance procedures, free car care manuals and brochures, and plastic waste bags promoting car pooling. This year, for the first time, participants also received state maps and tire pressure gauges.

In 1987 a total of 4,608 vehicles were processed during the 15 two-day clinics, with 95 percent of those vehicles revealing one or more major maintenance problems. Correction of all problems would save each motorist at least 94 gallons of fuel per year, for a total savings of 411,000 gallons of fuel. When comparing fuel cost savings to direct program costs, these figures indicate a benefit-to-cost ratio of almost 5 to 1. An extensive database is being developed for analysis of vehicle maintenance and emissions data.

Traffic Signal Management Program

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

ITRE continued to administer this unique energy conservation program to optimize the timing of traffic signals on North Carolina’s highway system. For two and one-half years (through November, 1987), the program was conducted in cooperation with the North Carolina Department of Transportation and funded through the State Energy Division with petroleum violation escrow (oil overcharge) funds. (Due to its outstanding success, the program was continued after November, 1987, with Energy Division funding going directly to the NCDOT.)

ITRE employed three engineering graduates and three electronics technician graduates in 1985 and placed them as trainees with the Signals Management Unit of 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 (SSOS).

During the first five months of fiscal year 1987-88, the squad retired 140 signalized intersections throughout North Carolina, bringing the program total to 980 retired intersections. These modifications resulted in an estimated annual savings of 12.2 million gallons of fuel (an average of 12,410 gallons per signalized intersection) and a total estimated annual operating cost savings (for fuel, delays, and stops) of $45.1 million. The ratio of total cost savings to direct program costs was 98 to 1.

Solid Waste Management Program

Principal Investigator: Larry W. Minor, ITRE
Sponsors: Local Government Agencies

Since 1981, ITRE has provided solid waste management technical assistance to more than 40 municipalities and counties in North Carolina. ITRE staff are continu-
ing to respond to specific state and local government requests for technical assistance.

strengthened by its continued involvement with public works officials throughout the state and other areas of the country, ITRE provides a variety of services to local governments. These services are routing studies, feasibility studies, workshops and presentations, mainframe and personal computer applications, surveys, project advice for in-house local government studies, and other technical assistance tailored to specific government needs.

ITRE has also helped to further cooperation among the various state government agencies, university campuses, and research institutes involved in solid waste management.

North Carolina Recycling Project
Principal Investigator: Larry W. Minor, ITRE
Sponsor: N.C. Department of Natural Resources and Community Development

Recycling may become more common as a solid waste management alternative for North Carolina governments and residents. An integral part of local government recycling programs is collecting and handling recyclable materials.

Work began in June, 1988, to develop directories and computerized data bases of commercial and industrial recyclers serving North Carolina businesses and households along with governmental contacts for recycling information and assistance.

This project will provide municipal and county government recycling contacts with information about other local government recycling programs and activities; state and regional contacts for recycling information and assistance; and commercial and industrial recycler information.

This project will also provide North Carolina residents and businesses with general information on what they can recycle; how and where they can recycle; and who they can call for more information and assistance.

Site Impact Traffic Evaluation
Principal Investigator: Dr. John R. Stone, NCSU
Sponsor: FHWA

This three-day course examines the complex issues of development-related traffic congestion and possible solutions to unsnarl it.

Publications, including this report, are designed on a computer using desktop publishing software. Pam Cheek, technical information and training coordinator, begins work on the layout of ITRE Technology Transfer, T²'s quarterly newsletter.

It is complemented by a complete set of Lotus-based software which the project team developed and which implements the Federal Highway Administration site impact traffic evaluation (SITE) methodology.

Recognizing the value of the course and software, state departments of transportation in North Carolina, Oregon, New York, Alabama, Florida, New Jersey, Texas, Ohio, Michigan, Iowa, Nebraska, and California have hosted the course and implemented the software.

In addition, a number of cities, universities, and metropolitan planning organizations are using the FHWA/ITRE methodology and software.

1988-1989 Technology Transfer - Training and Technical Assistance
Principal Investigators: ITRE; NCSU; UNCC
Sponsors: Various Agencies

ITRE Trains Future Leaders

While ITRE is working to resolve current transportation problems, it is also training future transportation leaders.

In 1987-88, 45 undergraduate and graduate students worked with ITRE's professional staff on a variety of projects, ranging from computer-assisted school bus scheduling and routing to the pavement marking materials program. An additional five students are learning first-hand about transit system management through an internship program administered by ITRE for the N.C. Department of Transportation.

The fifteen university students who joined the ITRE school bus scheduling and routing project team are digitizing street networks and working with local education agency personnel. The work of these research assistants and the nine full-time staff has enabled several local school units to begin using this comprehensive public transportation planning tool to design computer-assisted school bus routes and schedules.

"Being in civil engineering and concentrating in transportation, ITRE is giving me the best introductory course I have had to the field of transportation," said Karen Eason, a research assistant for the school bus scheduling and routing project.

Also, her work has enabled her to "sharpen her communication skills" as she has traveled to local education agencies.

Beginning her second year at ITRE, graduate student Kathryn Roe led the publicity project team for the successful vehicle maintenance program. She also helped to develop the computerized catalog system for the library and to coordinate and conduct the technology transfer workshop, "Getting Your Message Understood: Communicating with Decision-Makers, Citizens, and the Media." She has also conducted in-house training for ITRE staff.

"...ITRE is giving me the best introductory course I have had to the field of transportation."

- Karen Eason
Research Assistant

"By working closely with the technology transfer program, I should be able to more effectively communicate technical information on transportation issues through workshops, newsletters, and the media," Roe said.

"If I choose not to stay in transportation, the experience I've gained at ITRE in leadership skills, project management, technical communications, and computers will be invaluable to me in any career I choose," Roe continued.

Of the 230 students that have worked on ITRE projects during the last ten years, sixty-five are now employed in transportation-related occupations or are working on graduate degrees in transportation-related disciplines.

Computerized Catalog System Developed for Library

As ITRE has grown, so has the number of publications, journals, documents, and reports written and used by the staff. Therefore, a quick information retrieval system was needed to efficiently locate library materials.

To accomplish this, a menu-driven computer program for cataloging publications was created. Within seconds, the user can now locate any publication stored in ITRE's library or in the offices of ITRE staff.

In addition, the system allows the user to generate reports listing publications specific to various categories, such as author, agency, or key word. A user's manual introduces the fundamentals of the menu-driven program and shows how to use the program simply and efficiently.

Along with publications, videotapes of workshops and training courses are becoming an important part of ITRE's growing library. The location of videotapes is also included in the menu-driven program.

A staff member maintains the database by adding new entries, deleting old ones, or editing the lists through a separate program.

Beth McDaniel (left) and Katie Roe, ITRE research assistants, demonstrate the computerized catalog system they developed for ITRE library publications.
Council on Transportation Research and Education

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

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The University of North Carolina - General Administration

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School of Engineering, North Carolina State University

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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.

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