

S.C.R.T.D. LIBRARY

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

SUMMARY OF PROGRESS THROUGH 1984

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

.5
8
4

TRANSPORTATION RESEARCH BOARD EXECUTIVE COMMITTEE 1984

Officers

Chairman

JOSEPH M. CLAPP, *Senior Vice President, Roadway Express, Inc.*

Vice Chairman

JOHN A. CLEMENTS, *Commissioner, New Hampshire Department of Public Works and Highways*

Secretary

THOMAS B. DEEN, *Executive Director, Transportation Research Board*

Members

RAY A. BARNHART, *Federal Highway Administrator, U.S. Department of Transportation (ex officio)*
LAWRENCE D. DAHMS, *Executive Director, Metropolitan Transportation Commission, Berkeley, California (ex officio, Past Chairman, 1983)*
MICHAEL J. FENELLO, *Acting Federal Aviation Administrator, U.S. Department of Transportation (ex officio)*
FRANCIS B. FRANCOIS, *Executive Director, American Association of State Highway and Transportation Officials (ex officio)*
WILLIAM J. HARRIS, JR., *Vice President for Research and Test Department, Association of American Railroads (ex officio)*
DARRELL V. MANNING, *Director, Idaho Transportation Department (ex officio, Past Chairman 1982)*
RALPH STANLEY, *Urban Mass Transportation Administrator, U.S. Department of Transportation (ex officio)*
DIANE STEED, *National Highway Traffic Safety Administrator, U.S. Department of Transportation (ex officio)*
DUANE BERENTSON, *Secretary, Washington State Department of Transportation*
JOHN R. BORCHERT, *Regents Professor, Department of Geography, University of Minnesota*
LOWELL K. BRIDWELL, *Secretary, Maryland Department of Transportation*
ERNEST E. DEAN, *Executive Director, Dallas/Fort Worth Airport*
MORTIMER L. DOWNEY, *Deputy Executive Director for Capital Programs, Metropolitan Transportation Authority, New York*
ALAN G. DUSTIN, *President and Chief Executive Officer, Boston and Maine Corporation*
MARK G. GOODE, *Engineer-Director, Texas State Department of Highways and Public Transportation*
LESTER A. HOEL, *Hamilton Professor, Chairman, Department of Civil Engineering, University of Virginia*
LOWELL B. JACKSON, *Secretary, Wisconsin Department of Transportation*
ALAN F. KIEPPER, *General Manager, Metropolitan Transit Authority, Houston*
HAROLD C. KING, *Commissioner, Virginia Department of Highways and Transportation*
FUJIO MATSUDA, *President, University of Hawaii*
JAMES K. MITCHELL, *Professor and Chairman, Department of Civil Engineering, University of California*
DANIEL T. MURPHY, *County Executive, Oakland County Courthouse, Michigan*
ROLAND A. OUELLETTE, *Director of Transportation Affairs, General Motors Corporation*
MILTON PIKARSKY, *Director of Transportation Research, Illinois Institute of Technology*
WALTER W. SIMPSON, *Vice President-Engineering, Norfolk Southern Corporation*
JOHN E. STEINER, *Vice President, Corporate Product Development, The Boeing Company*
LEO J. TROMBATORE, *Director, California Department of Transportation*
RICHARD A. WARD, *Director-Chief Engineer, Oklahoma Department of Transportation*

TRANSPORTATION RESEARCH BOARD COMMITTEE FOR NRC OVERSIGHT (CNO)

MILTON PIKARSKY, *Illinois Institute of Technology (Chairman)*
JOSEPH M. CLAPP, *Roadway Express, Inc.*

JOHN R. BORCHERT, *University of Minnesota*
MARK G. GOODE, *Texas State Dept. of Hwys. and Public Transp.*

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Transportation Research Board Executive Committee Subcommittee for the NCTRP

JOSEPH M. CLAPP, *Roadway Express, Inc. (Chairman)*

JOHN A. CLEMENTS, *New Hampshire Dept. of Pub. Works and Hwys.*

LAWRENCE D. DAHMS, *Metropolitan Transp. Commission, Berkeley, Calif.*

THOMAS B. DEEN, *Transportation Research Board*

JACK R. GILSTRAP, *American Public Transit Association*

WILLIAM J. HARRIS, JR., *Association of American Railroads*

RALPH STANLEY, *Urban Mass Transportation Administration*

Chairmen of Project Panels

Field of Administration

G. J. FIELDING

P. G. DRAKE

R. M. WORKS

F. D. SWIFT

D. P. CLAYTON

Field of Design

E. K. FARRELLY

J. P. GREENWAY

Field of Operations

O. N. SHARMA

J. R. HATHAWAY

J. W. VIGRASS

Field of Planning

MANUEL PADRON

T. W. HOCHBEIN

T. W. FRIEDMAN

JOHN MEYER

J. C. ECHOLS

K. E. STEIN-HUDSON

Field of Materials and Construction

JACK DONAHUE

Field of Special Projects

R. R. BIEGE, JR.

Program Staff

KRIEGER W. HENDERSON, JR., *Director*

LOUIS M. MACGREGOR, *Administrative Engineer*

CRAWFORD F. JENCKS, *Projects Engineer*

R. IAN KINGHAM, *Projects Engineer*

ROBERT J. REILLY, *Projects Engineer*

HARRY A. SMITH, *Projects Engineer*

ROBERT E. SPICHER, *Projects Engineer*

HELEN MACK, *Editor*

S.C.R.T.D. LIBRARY

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

**SUMMARY OF PROGRESS
THROUGH 1984**

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

1984

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Administrators, engineers, and many others in the transit industry are faced with a multitude of complex problems that range between local, regional, and national in their prevalence. How they might be solved is open to a variety of approaches; however, it is an established fact that a highly effective approach to problems of widespread commonality is one in which operating agencies join cooperatively to support, both in financial and other participatory respects, systematic research that is well designed, practically oriented, and carried out by highly competent researchers. As problems grow rapidly in number and escalate in complexity, the value of an orderly, high-quality cooperative endeavor likewise escalates.

Recognizing this in light of the many needs of the transit industry at large, the Urban Mass Transportation Administration, U.S. Department of Transportation, in 1980 got under way the National Cooperative Transit Research and Development Program (NCTRP). This is an objective national program that provides a mechanism by which UMTA's principal client groups across the nation can join cooperatively in an attempt to solve near-term public transportation problems through applied research, development, test, and evaluation. The client groups thereby have a channel through which they can directly influence a portion of UMTA's annual activities in transit technology development and deployment. Although present funding of the NCTRP is entirely from UMTA's Section 6 funds, the planning leading to inception of the Program envisioned that UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a larger number of problems each year.

The NCTRP operates by means of agreements between UMTA as the sponsor and (1) the National Academy of Sciences, a private, nonprofit institution, as the Primary Technical Contractor (PTC) responsible for administrative and technical services and (2) the American Public Transit Association responsible for operation of a Technical Steering Group (TSG) comprised of representatives of transit operators, local government officials, State DOT

officials, and officials from UMTA's Office of Technical Assistance.

Research programs for the NCTRP are developed annually by the Technical Steering Group, which identifies key problems, ranks them in order of priority, and establishes programs of projects for UMTA approval. Once approved, they are referred to the PTC for administration through the Transportation Research Board.

The Board operates under the National Research Council, which is administered by both the National Academy of Sciences and the National Academy of Engineering, and is uniquely suited for the administrative role because: it maintains an extensive committee structure from which authorities on any transportation subject may be drawn; it possesses the avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; it is recognized for its objectivity and understanding of modern research practices; its relationship to its parent organization is an insurance of objectivity; and it maintains a full-time staff of research specialists in transportation matters to take the findings of research directly to those who are in a position to use them.

Research projects addressing the problems referred from UMTA are defined by panels of experts established by the Board to provide technical guidance and counsel in the problem areas. The projects are advertised widely for proposals, and qualified agencies are selected on the basis of research plans offering the greatest probabilities of success. The research is carried out by these agencies under contract to the PTC, and administration and surveillance of the contract work are the responsibilities of the PTC and Board.

The needs for transit research are many, and the National Cooperative Transit Research and Development Program is a mechanism for deriving timely solutions for transportation problems of mutual concern to many responsible groups. In doing so, the Program operates complementary to, rather than as a substitute for or duplicate of, other transit research programs.

06697

MAILING ADDRESS:

TRANSPORTATION RESEARCH BOARD
2101 Constitution Avenue, NW
Washington, D.C. 20418

HE
192.5
.N38
1984

OFFICES AT:

2100 Pennsylvania Ave., NW
Washington, D.C.
Phone: 202-334-3224

NCTRP TECHNICAL STEERING GROUP

Annual research programs for the NCTRP are recommended to UMTA by the NCTRP Technical Steering Group (TSG). Under contract to UMTA, the American Public Transit Association is responsible for operation of the TSG, the membership of which is as follows.

Chairman

JOHN DYER, *General Manager, Southern California Rapid Transit District*

APTA Transit System Members

PAUL J. BALLARD, *Vice President, and Eastern Regional Manager, American Transit Corporation*

THEODORE D. BECK, JR., *General Manager, Niagara Frontier Transportation Authority*

HENRY C. CHURCH, *General Manager, Greater Richmond Transit Company*

JERRY L. EDDY, *Director of Transportation, Regional Transportation District (Denver)*

BERNARD J. FORD, *Executive Director, Chicago Transit Authority*

WARREN H. FRANK, *Executive Director, Central New York Regional Transportation Authority*

HAROLD H. GEISSENHEIMER, *General Manager, San Francisco Municipal Railway*

FRANCIS A. GORMAN, *Vice President and General Manager, Port Authority Trans-Hudson Corporation*

KENNETH M. GREGOR, *Acting General Manager, Metropolitan Atlanta Rapid Transit Authority*

GERALD T. HAUGH, *General Manager, San Mateo County Transit District*

L. L. HEIL, *President, McDonald Transit Associates, Inc.*

ROBERT D. LORAH, *General Manager, Connecticut Transit*

ERNIE MILLER, *General Manager, Metro Regional Transit Authority (Akron)*

DON S. MONROE, *Executive Director, Pierce Transit*

JAMES E. READING, *General Manager, Central Ohio Transit Authority*

J. WILLIAM VIGRASS, *Assistant General Manager, Port Authority Transit Corporation*

APTA State DOT Members

LEE F. DETER, *Chief, Division of Mass Transportation (Sacramento)*

DAVID D. KING, *Director, Public Transportation Division, North Carolina Department of Transportation*

KENNETH W. SHIATTE, *Director, Transit Division, New York State Department of Transportation*

UCTI/PTI Members

FRANK KIOLBASSA, *Director of Public Works, City of San Antonio*

ALAN LUBLINER, *Program Manager, Office of the Mayor (San Francisco)*

JAMES PARSONS, *Manager, Land Use and Transportation Project (Seattle)*

Transit Labor Representatives

GEORGE LEITZ, *International Vice President for Bus Operations, Transport Workers Union of America*

Non-Voting Members

PETER BENJAMIN, *Associate Administrator, Office of Technical Assistance, Urban Mass Transportation Administration*

FRANK J. CIHAK, *Executive Director, Technical and Research Services, American Public Transit Association*

JOHN DURHAM, *Office of Technical Assistance, Urban Mass Transportation Administration*

PEGGY SCHWARTZ, *Acting Transportation Director, Public Technology, Inc.*

TRB Liaison

KRIEGER W. HENDERSON, JR., *Director, Cooperative Research Programs, Transportation Research Board*

NCTRP PANELS

All work in the NCTRP is assigned to broad research fields under which panels are organized to deal with research in specific problem areas falling within the broad fields. Each project is assigned a panel comprised of outstanding individuals highly knowledgeable in the specifics of the particular project and who are looked to for guidance and counsel throughout the research phase. A listing of all NCTRP panels currently active during this reporting period follows. (*Mr. Frank J. Cihak, Secretary, Technical Steering Group, serves as the TSG liaison representative for all NCTRP Projects. He is assisted in this function by Mr. Deane N. Aboudara.*)

NCTRP Research Field—Administration: Economics

Panel A30-1—Robert M. Works (Chairman), William W. Allen, Kamel Boctor, Michael Dewey, John F. Donahue, Jr., Rudolph V. Giangrande, Robert D. Owens, Peggy Schwartz, Patrick M. Sullivan, C. Michael Walton, John Ridgely (UMTA Liaison Representative), W. Campbell Graeub (TRB Representative), R. Ian Kingham (NCTRP Staff).

NCTRP Research Field—Administration: Finance

Panel A31-1—Gordon J. Fielding (Chairman), Harvey Berlin, Robert Brownstein, Gary R. Cowan, David E. Fox, Neil D. Lawer, Genevieve L. Leary, Aloysius J. Nehr, Arna V. Shaffer, Kenneth Cook (TRB Representative), R. Ian Kingham (NCTRP Staff).

NCTRP Research Field—Administration: Personnel Management

Panel A-33-1—Peter G. Drake (Chairman), Walter Bierwagen, William E. Cross, Jr., Thomas Griess, Chester W. Higgins, Pam Salisbury, Robert M. Works, Frank E. Enty (UMTA Liaison Representative), James K. Williams (TRB Representative), Robert E. Spicher (NCTRP Staff).

NCTRP Research Field—Administration: Personnel Management

Panel A33-2(2)—Forest D. Swift (Chairman), Cynthia Burton, Eileen Cioe, Melvin Howard, Byron Lewis, Michael D. Meyer, Hugh A. Mose, Frank Shipman, Betsy Voss, Charles T. Morison, Jr. (UMTA Liaison Representative), Kenneth E. Cook (TRB Liaison Representative), Crawford F. Jencks (NCTRP Staff).

NCTRP Research Field—Administration: Personnel Management

Panel A33-3—Dennis P. Clayton (Chairman), William W. Allen, Malcolm J. Campbell, Michael T. Landers, W. J. Parks, A. B. Hallman (UMTA Liaison Representative), Kenneth C. Cook (TRB Liaison Representative), Harry A. Smith (NCTRP Staff).

NCTRP PANELS—Continued

NCTRP Research Field—Planning: Alternative Analysis

Panel B36-1—Manuel Padron (Chairman), John R. Breeding, Don Bryan, Kevin E. Heanue, Buford Johnson, Michael D. Meyer, R. David Minister, Edward V. Taylor, Theodore von Briesen, James M. Ryan (UMTA Liaison Representative), W. Campbell Graeub (TRB Liaison Representative), R. Ian Kingham (NCTRP Staff).

NCTRP Research Field—Planning: System Planning

Panel B38-1—Terry W. Hochbein (Chairman), Stuart A. Bothwell, John F. Davidson, Nathan S. Erlbaum, John R. Gratchner, Robert E. Holibaugh, John M. Reilly, Frank E. Tracy, Conrad A. Wogrin, Thomas Hillegass (UMTA Liaison Representative), W. Campbell Graeub (TRB Liaison Representative), Harry A. Smith (NCTRP Staff).

NCTRP Research Field—Planning: Route Planning

Panel B39-1—Thomas W. Friedman (Chairman), Bruce T. Bowles, Martin Feuerstein, A. B. Hallman, David A. Hines, Rudolf Kolaja, Charles E. Zell, Brian E. McCollom, George Izumi (UMTA Liaison Representative), W. Campbell Graeub (TRB Liaison Representative), Crawford F. Jencks (NCTRP Staff).

NCTRP Research Field—Planning: Impact Analysis

Panel B40-1—John Meyer (Chairman), Gary R. Allen, John E. Arnold, Charles A. Lave, Aloysius J. Nehr, Louis R. Rainone, Robley Winfrey, Edward L. Thomas (UMTA Liaison Representative), Kenneth E. Cook (TRB Liaison Representative), Robert E. Spicher (NCTRP Staff).

NCTRP Research Field—Design: Track and Ancillary Systems

Panel C43-1—Edward K. Farrelly (Chairman), George Donato, John C. Mould, Galen Sarno, James Stewart, Ray Wlodyka (UMTA Liaison Representative), Edward J. Ward (TRB Liaison Representative), Harry A. Smith (NCTRP Staff).

NCTRP Research Field—Planning: Impact Analysis

Panel B40-3—Kathleen E. Stein-Hudson (Chairman), Steven F. Bloomfield, Alinda Burke, Robert T. Dunphy, Bruce Hutchinson, Susan Stropes, Brian E. Sullivan, Vukan Vuchic, Edward L. Thomas (UMTA Liaison Representative), Kenneth E. Cook (TRB Liaison Representative), R. Ian Kingham (NCTRP Staff).

NCTRP Research Field—Design: General Design

Panel C46-1—Joseph P. Greenway (Chairman), Patrick J. Dunne, Victor Hernandez, Alexander L. Irving, Patrick J. McEvaddy, Eugene W. Riley, Ronald O. Swindell, Fred Sing (UMTA Liaison Representative), Edward J. Ward (TRB Liaison Representative), Crawford F. Jencks (NCTRP Staff).

NCTRP Research Field—Materials and Construction: General Materials

Panel D47-1—Jack Donahue (Chairman), Jesse Ronald Cole, Harry L. Cuthbert, James T. Hogan, William Laule, Ralph Malec, Duane Perrin, Robert A. White, Denis Symes (UMTA Liaison Representative), Adrian G. Clary (TRB Liaison Representative), Harry A. Smith (NCTRP Staff).

NCTRP Research Field—Operations: Energy Efficiency

Panel F54-2—Onkar N. Sharma (Chairman), Kamel Boctor, Michael McKenna, Carl Natvig, Orin Zimmerman, Ronald Kangas (UMTA Liaison Representative), Stephen Blake (TRB Liaison Representative), Harry A. Smith (NCTRP Staff).

NCTRP Research Field—Operations: Performance Effectiveness and Efficiency

Panel F55-1—J. William Vigrass (Chairman), Martin J. Foley, John G. Gaul, Charles Kalkhof, Keith Prouty, Walter Kulyk (UMTA Liaison Representative), James K. Williams (TRB Liaison Representative), Harry A. Smith (NCTRP Staff).

NCTRP Research Field—Special Projects

Project Committee—SP60-1—R. R. Biege, Jr. (Chairman), Verdi Adam, Robert N. Bothman, Jack Freidenrich, David S. Gedney, Sanford P. LaHue, Bryant Mather, Thomas H. May, Theodore F. Morf, Edward A. Mueller, David K. Phillips, Robert J. Betsold (FHWA Liaison Representative), K. B. Johns (TRB Liaison Representative), Robert J. Reilly (NCTRP Staff).

CONTENTS

1	SUMMARY OF PROGRESS
	Introduction
	Programs and Financing
	How the NCTRP is Organized to Administer Research Programs
	How the Projects Are Placed Under Contract
	Keeping Track of Research In Progress
	Systematic Planning for Getting Research Results from NCTRP Projects into Practice
	Promoting Useful Results
	NCTRP Reporting of Research Results
	Implementing Research Results
	Summary
11	PROGRESS BY PROJECT
11	Area Thirty: Economics
11	Area Thirty-One: Finance
	Area Thirty-Two: Policy Development
12	Area Thirty-Three: Personnel Management
	Area Thirty-Four: Labor Relations
	Area Thirty-Five: Procurement
14	Area Thirty-Six: Alternative Analysis
	Area Thirty-Seven: Forecasting
15	Area Thirty-Eight: System Planning
16	Area Thirty-Nine: Route Planning
16	Area Forty: Impact Analysis
	Area Forty-One: Vehicles
	Area Forty-Two: Vehicle Auxiliary Systems
19	Area Forty-Three: Track and Ancillary Systems
	Area Forty-Four: Stations
	Area Forty-Five: Bridges and Tunnels
19	Area Forty-Six: General Design
20	Area Forty-Seven: General Materials
21	Area Forty-Eight: Specifications, Procedures, and Practices
	Area Forty-Nine: Vehicles
	Area Fifty: Vehicle Auxiliary Systems
	Area Fifty-One: Maintenance of Way and Structures
	Area Fifty-Two: Scheduling
	Area Fifty-Three: Control Systems
21	Area Fifty-Four: Energy Efficiency
22	Area Fifty-Five: Performance Effectiveness and Efficiency
	Area Fifty-Six: Fare Collection
	Area Fifty-Seven: Supplemental Services
23	Area Sixty: Special Projects
24	HOW TO ORDER PUBLICATIONS AND OTHER MATERIALS

FIGURES

- 2 Figure 1. Flow diagram for each program from initiation to referral by UMTA for administration by the PTC
- 3 Figure 2. Flow diagram for each program after referral to the PTC
- 4 Figure 3. NCTRP research fields and areas

TABLES

- 4 Table 1. Distribution of Project Panel Membership with Respect to Affiliation
- 5 Table 2. Number of Proposals Submitted
- 5 Table 3. Number of Agencies Submitting One or More Research Proposals
- 5 Table 4. Types of Agencies Submitting Proposals
- 6 Table 5. Summary of Status Through December 31, 1984, for FY '80 Through FY '84 Projects
- 8 Table 6. Agency Distribution of FY '80 Through FY '82/'83 Projects
- 10 Table 7. Published Reports of the National Cooperative Transit Research & Development Program
- 10 Table 8. NCTRP Research Results Digests

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

SUMMARY OF PROGRESS THROUGH 1984

INTRODUCTION

At the 1976 UMTA/APTA R&D Priorities Conference there was consensus among spokesmen for the Office of Management and Budget, Congress, and the transit industry that the Urban Mass Transportation Administration, U.S. Department of Transportation, should undertake a cooperative program of R&D to attack near-term problems in transit operations and equipment. This was the genesis of the National Cooperative Transit Research and Development Program (NCTRP) that got under way in November 1980 under the authority of Section 6(a) of the UMTA Act of 1964, as amended (49 U.S.C. 1605(a)). Thereby provided is a mechanism for addressing problems that impede operational effectiveness or productivity, but are not of the character to justify a centrally managed, Federally directed, R&D effort. This mechanism not only enables UMTA's principal client groups to join cooperatively in attempts to resolve near-term public transportation problems through applied research, development, testing, and evaluation, but it also provides them with a channel through which they can directly influence a limited portion of UMTA's annual activities in transit technology development and deployment. Consequently, the NCTRP's overall objectives are:

- To identify problems commonly agreed to be in need of R&D investigation and to establish a priority ordering among them.
- To provide an opportunity for many constituencies, including transit operators and local government officials, to identify problems and participate in developing solutions to them.
- To improve communication and technical information exchange.
- To provide a means of addressing near-term transit problems without requiring detailed, formal involvement of the Federal Government in the execution of R&D projects designed to provide solutions.

The NCTRP operates by means of agreements between UMTA as the sponsor and (1) the National Academy of Sciences NAS, a private, nonprofit institution, as the Primary Technical Contractor (PTC) responsible for administrative and technical services, and (2) the American Public Transit Association responsible for operation of a Technical Steering Group (TSG) comprised of representatives of transit operators, local government officials,

State DOT officials, and officials from UMTA's Office of Technical Assistance.

Research programs for the NCTRP are developed annually by the Technical Steering Group, which identifies key problems, ranks them in order of priority, and establishes programs of projects for UMTA approval. Once approved, they are referred to the PTC for administration through the Transportation Research Board (refer to Figures 1 and 2). There, they are assigned to seven broad research fields under which panels or committees of experts are organized to deal with research in specific problem areas under the broad fields. They analyze the problems, outline particular projects and their objectives, and then prepare research project statements by which a wide solicitation is made for proposals from qualified private and public research agencies. They review the proposals, recommend subcontract awards on the basis of research plans offering the greatest probability of success, and provide counsel to the NCTRP staff responsible for surveillance of work under the research subcontracts. Finally, they review final reports for acceptability, decide if the reports evidence reasonable accomplishment by the agencies of the projects' research plans, and assist staff in determining the warrants for publishing the reports in a regular NCTRP series and distributing them through standing Board processes.

Panel membership is reported both herein and in the TRB Directory and includes persons from state and federal agencies, the UMTA client groups, universities, national associations, institutions with related interests, industry and other agencies. Members are appointed as individuals possessing expertise in specialized areas and not as representatives of the organizations by which they are employed. Because rarely is it possible to acquire members with the required knowledge and judgment who do not have technical biases, concerted attention is given to maintaining a balance of such biases. However, prejudicial biases, along with organizational and personal biases, are scrupulously avoided.

The Board's authority for administration of the Program rests with its Executive Committee from which is drawn the Subcommittee for the NCTRP, the body providing counsel on all matters relating to policies and procedures for the planning and administration of the Program. The day-to-day activities are carried out by professional staff assigned by the Board. Projects engineers with broad experience in transportation research

are responsible for administrative and technical surveillance of the subcontracts. In addition to reviewing quarterly progress reports and monthly progress schedules and maintaining telephone contacts, each engineer regularly visits his assigned projects throughout their subcontract periods. He discusses with each principal investigator the project's status to learn if the research is being pursued in line with the approved research plan. If necessary, frequent meetings involving the staff, panel, and agency personnel are held to review project progress and provide guidance for continuing work. Finally, the projects engineer and the panel evaluate the completed research to determine the degree of technical compliance with the subcontract and the acceptability of the final report to the Board and the Academy.

The research findings are published in either of two regular NCTRP report series, and copies are formally distributed through the Transportation Research Board's selective distribution system.

Although research in the NCTRP is presently spon-

sored by UMTA, the administrative mechanism is applicable to other agencies' programs as well. However, the following description of how research is administered applies specifically to research sponsored by the UMTA.

PROGRAMS AND FINANCING

Three programs have thus far been referred to the PTC for administration, and a fourth is pending. Referred on November 7, 1980, was the FY 1980 program, the first. Totalling \$1,040,000, it consisted of eight problems ranging in funding from \$40,000 to \$300,000. Two of these were designated for TRB syntheses; the remaining six were scheduled for contract research (see Table 5 for status).

The FY 1981 program, totalling \$985,000, was formulated on October 7, 1981, by the Technical Steering Group and referred by UMTA to the PTC on March 30, 1982. It consists of eight problems ranging in funding from \$30,000 to \$300,000. Two of these were designated

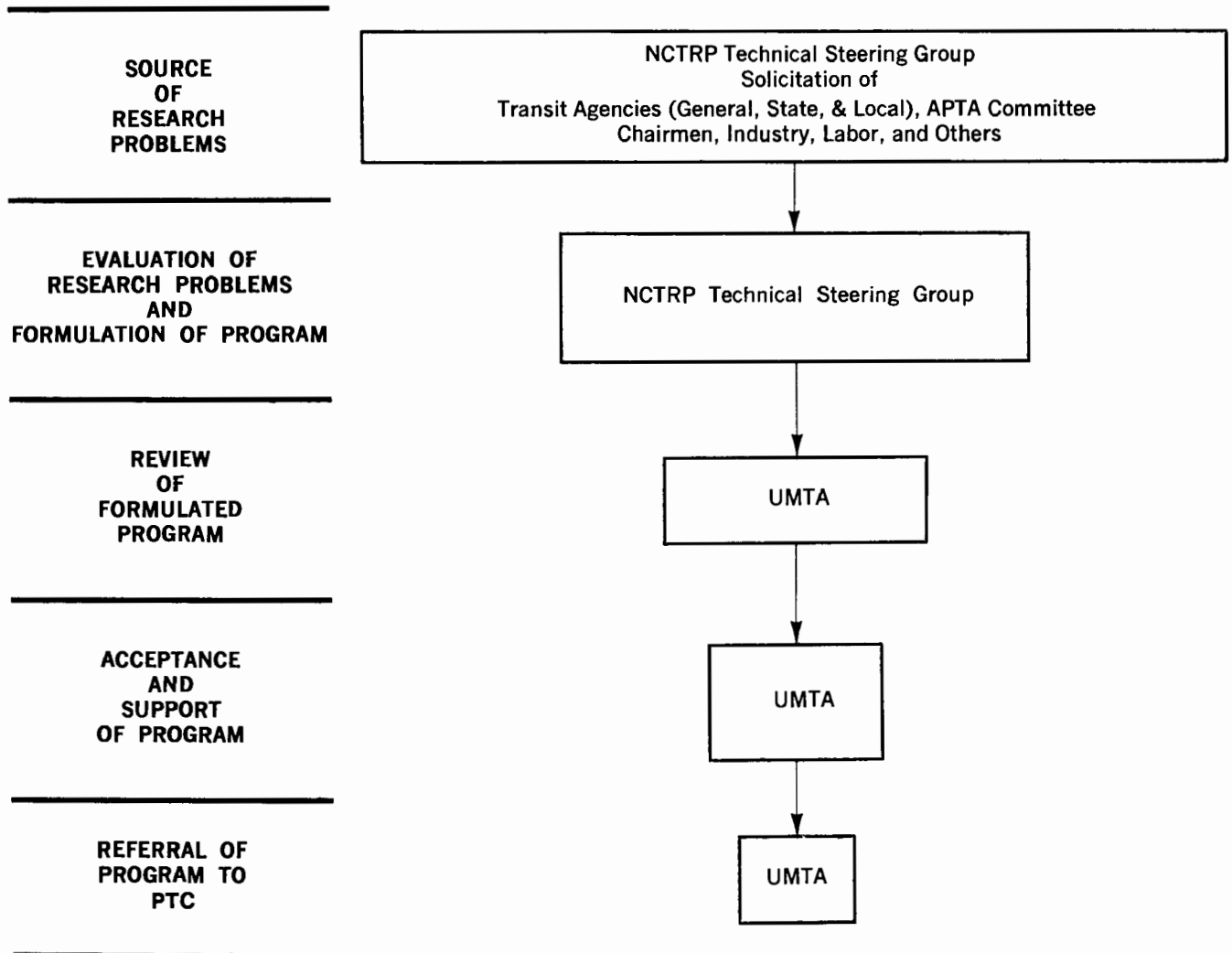


FIGURE 1

Flow diagram for each program from initiation to referral by UMTA for administration by the PTC

for TRB syntheses; the remaining six were scheduled for subcontract research (see Table 5 for status).

The FY 1982/1983 program was developed on October 21, 1982, by the Technical Steering Group and forwarded on November 18 for UMTA approval. Officially referred on January 13, 1983, to the PTC at a total funding level of \$1,000,000 were two continuations of earlier projects and ten new projects, four of which are designated for TRB syntheses and to which a fifth was added by project panel action.

The FY 1984 program was developed by the Technical Steering Group on February 1, 1984. Officially referred on May 10, 1984, to the PTC for administration at a project funding level of \$550,000 were six new projects, two of which were designated for subcontracting. The remaining four were slated for TRB syntheses. Incorporated later by agreement with the Associate Administrator, Office of Technical Assistance, was a \$30,000 allocation for follow-up work on Project 30-1. Because a modification to the prime contract was needed to provide the FY '84 funds, the May 10 referral restricted activity to only administrative functions until such time as the modification was effected. This occurred on August 15, 1984, and increased the contract funds by \$975,000, subsequent to which steps were taken toward initiation of technical work.

The FY 1985 program was developed on December 14 by the Technical Steering Group. It is projected at a funding level of \$800,000 and consists of three new projects, two continuation projects, and two syntheses. UMTA will next review the recommended projects for approval, following which action the projects will be referred to the PTC for administration. PTC subcontracting for research will not be possible until funds to support the program year have been made available by UMTA.

Funding to support all research to date is provided from UMTA's Section 6 funds for R&D activity. Although initiation of the NCTRP was accomplished solely with UMTA funds, the planning leading to inception of the Program envisioned that, given the multitude of problems facing them, UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a larger number of problems each year. Presently, the funds available to the NCTRP are sufficient to address but a fraction of the total need represented by problem submittals to the Technical Steering Group.

HOW THE NCTRP IS ORGANIZED TO ADMINISTER RESEARCH PROGRAMS

In line with the Board's responsibility for administering the NCTRP, a TRB Executive Committee Subcommittee for the NCTRP considers all matters relating to policies and procedures required for the planning and administration of the Program. Members of the Executive Committee make up this committee.

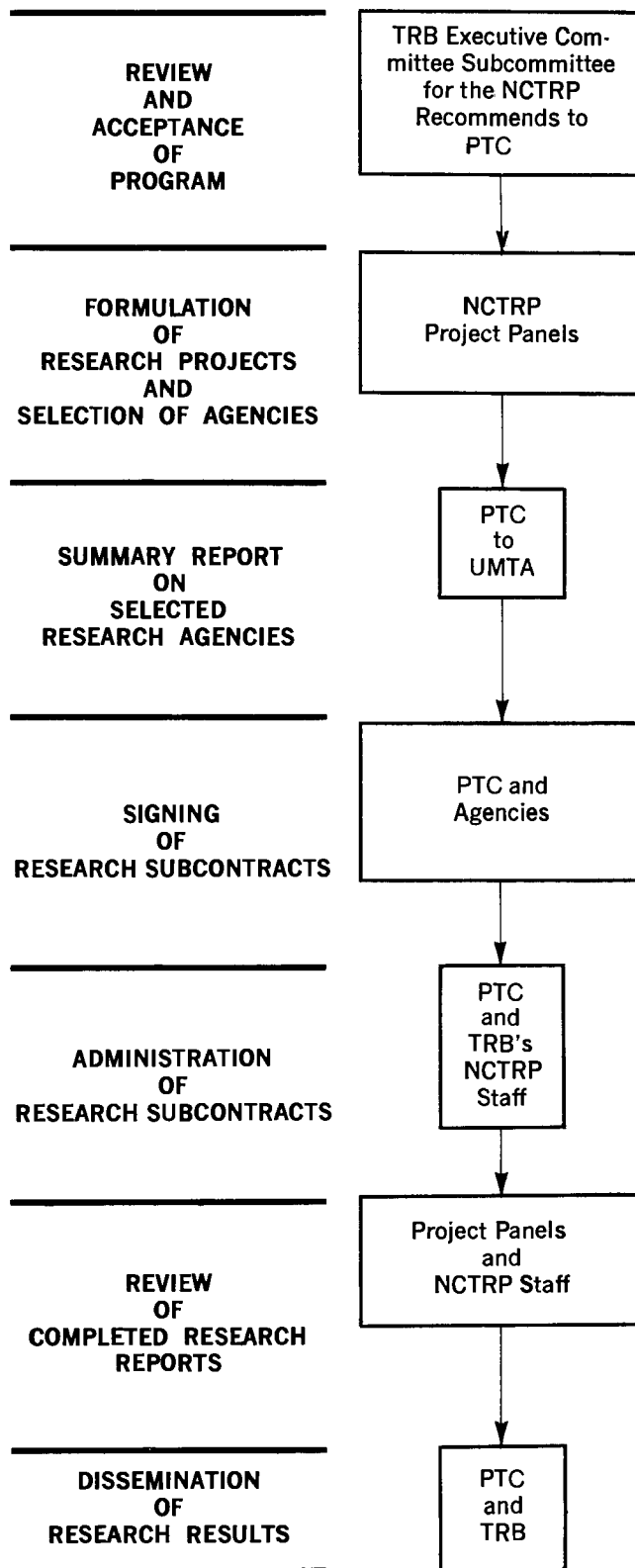


FIGURE 2

Flow diagram for each program after referral to the PTC

NCTRP RESEARCH FIELDS AND AREAS

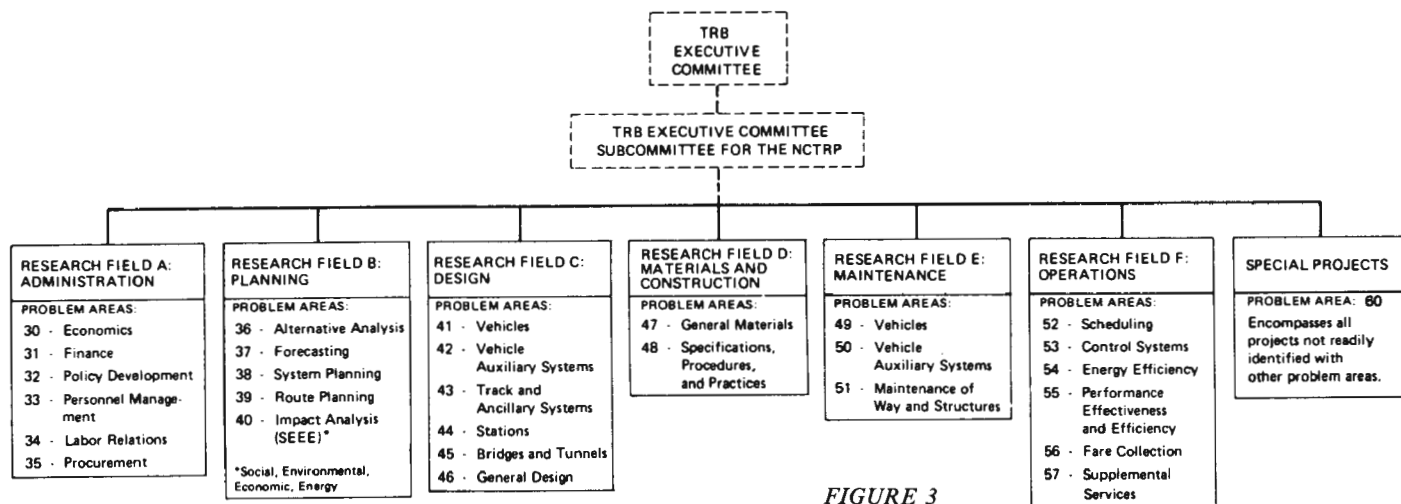


FIGURE 3

In addition, the Board has established seven broad research fields under which project panels are organized to deal with research in specific problem areas under the broad fields (refer to Figure 3). For example, in the broad subject field of Operations, each project falling within the more specific subject area of Energy Efficiency—area 54—is assigned a panel comprised of outstanding individuals who are knowledgeable in the specifics of the particular project and who are looked to for technical guidance while research is in progress. Those projects that do not conveniently fit under one of the first six general fields are assigned to the seventh one, Special Projects.

Members of the project panels do not act as consultants or advisors to project investigators. Some 127 individuals serve without compensation on these project panels, and their total yearly contribution to the Program is an impressive and laudatory effort by volunteer professionals. Members are drawn from the agencies given in Table 1, and they come from 26 States, the District of Columbia, and Canada. Employees of transit operating agencies presently constitute 29 percent of panel membership. The duties and responsibilities of the membership include:

- Developing an operation plan geared to reaching the major problem area objective, including estimates of total cost and time to achieve the objectives.
- Drafting definite statements of objectives for projects within the problem area and within the funds allotted.
- Reviewing research proposals and making recommendations regarding selection of research agencies.
- Reviewing research progress.
- Providing guidance regarding technical aspects of the research.
- Reviewing and evaluating project reports as to the accomplishment of objectives and suitability for publication.
- Making recommendations as to whether or not studies of problems included in prior fiscal year programs should be continued.

Following the NCTRP staff review made after program

referral to the PTC, the recommended program is referred to the TRB Executive Committee Subcommittee for the NCTRP for comments as to the critical need for the research, the availability of other suitable sponsors, and whether or not the research items are appropriate to be identified with the NAS/NRC. Unacceptable problems are returned by the PTC to UMTA with the reason for rejection and, when appropriate, with a recommendation for disposition.

HOW THE PROJECTS ARE PLACED UNDER CONTRACT

It is important to note that the NCTRP is not in the business of awarding grants for basic research. Rather, the Program calls for subcontract research with specific objectives that, if achieved, will result in solutions that are practical and readily usable. As the NCTRP officially gets each year's program under way, the project panels

TABLE 1
 DISTRIBUTION OF PROJECT PANEL
 COMMITTEE MEMBERSHIP WITH
 RESPECT TO AFFILIATION

AFFILIATION	NO. OF MEMBERS	POSITIONS INVOLVED
Transit Systems	37	39
State DOTs and Other Local Governmental Agencies	25	27
Urban Mass Transportation Administration	13	17
Other Federal Agencies	9	9
Educational Institutions	11	11
Research Institutes	0	0
Industry, Consultants, and Trade Associations	23	23
Professional Societies and Service Organizations	3	3
TRB Liaison Representatives	6	15
All	127	144

TABLE 2
NUMBER OF PROPOSALS SUBMITTED

ITEM	1981	1982	1983*
No. of projects advertised	6	6	5
Proposals submitted	77	71	52
Proposals rec'd per project (ave.)	13	12	10

* Calendar year

meet to write research project statements based on the research problems referred by UMTA.

These statements are then sent automatically to a mailing list of more than 3,000 interested individuals and research agencies. Because of deadlines the NCTRP must meet, proposals must be submitted according to fixed deadlines, and extensions simply cannot be granted.

In line with this process, submittals for the first three program years (FY '80, FY '81, and FY '82/'83) ranged from 6 to 25 per project, the average rate of return per project being 13, 12, and 10, respectively (refer to Table 2). One agency submitted four proposals in one of the years; however, most agencies submitted only one each (refer to Table 3).

The types of agencies responding with proposals for the two programs are given in Table 4. The TRB, which through its Special Projects Division produces the NCTRP's synthesis of transit practice reports, is not included. Projects making up the three programs are given in Table 5, and the types of agencies selected to carry out the projects are given in Table 6.

The opportunity to propose is open to anyone possessing extensive, demonstrated capability and experience in the problem areas in question; never are projects developed with the intent that they go to particular agencies. Because the projects are seeking practical remedies for pressing operational problems, it is expected that only the highest level of agency capability will be applied in meeting the commitments of the proposal—capability cannot be developed at project expense. Consonant with the goal

TABLE 3
NUMBER OF AGENCIES SUBMITTING
ONE OR MORE RESEARCH PROPOSALS

NO. OF PROPOSALS SUBMITTED	NUMBER OF AGENCIES SUBMITTING PROPOSALS		
	1981	1982	1983*
1	59	43	41
2	9	9	4
3	0	2	1
4	0	1	0
All	68	55	46

* Calendar year

TABLE 4
TYPES OF AGENCIES
SUBMITTING PROPOSALS

TYPE OF AGENCY	NO. OF AGENCIES SUBMITTING		
	1981	1982	1983*
Educational institutions	20	11	15
Research institutes	7	4	3
Industry, consultants, and trade associations	40	39	28
Professional societies and service organizations	0	0	0
State DOTs and other governmental agencies	1	1	0
All	68	55	46
No. of projects advertised	6	6	5

* Calendar year

of providing practical, readily usable solutions to pressing problems, there are fairly stringent specifications for proposals and agency attributes that are acceptable to the mission-oriented nature of the NCTRP.

The staff and panel members evaluate all proposals in a uniform manner, with primary consideration given to:

- The understanding of the problem and the merit of the research plan and approach.
- The experiment design and the promise of fulfilling the objectives of the project statement.
- The qualifications of the principal investigator(s).
- The adequacy of the facilities.

The proposed budget is not one of the primary factors because the funds available for research are given in the project statement. The budget does not enter the evaluation process leading to agency selection, except when specific items are reviewed to better determine manpower allocations. When the proposed cost exceeds the funds available, the proposal is rejected on receipt.

A panel meeting is held to select an agency, and a review is made of all known aspects of agency performance on other research projects under NCTRP or elsewhere. The successful proposals are retained by the panel members for use in monitoring the research. Proposals are considered to be privileged, and the information in them is not released by the PTC unless explicit approval is obtained from the agency. Policy also holds that panel notes, deliberations, etc., are privileged.

Following the selection meeting, a summary report on the recommended research agencies is sent to UMTA, and subcontract negotiations follow in due course, as does subcontract execution and commencement of research. Again, it should be emphasized that the NCTRP is a program of subcontract research—it does not operate on

TABLE 5
SUMMARY OF STATUS THROUGH DECEMBER 31, 1984, FOR FY '80 THROUGH FY '84 PROJECTS

PROJECT NO.	TITLE	RESEARCH AGENCY	SUBCONTRACT AMOUNT OR SUBCONTRACT COST (\$)
AREA 30: ADMINISTRATION—ECONOMICS			
30-1	Small Transit Buses: A Manual for Improved Purchasing, Use, and Maintenance	Arthur D. Little	\$299,378
AREA 31: ADMINISTRATION—FINANCE			
31-1	The Impacts of Federal Grant Requirements on Transit Agencies	Booz-Allen	49,522 ¹
31-2	Controlling Rising Operating Deficit Through Capital Investments	—	150,000
AREA 33: ADMINISTRATION—PERSONNEL MANAGEMENT			
33-1	Transit Bus Operator Selection and Training for Dealing with Stress	GAMS Inc.	150,000
33-2	Assessment of Job Enrichment Programs for the Transit Industry	Public Admin. Service	97,821 ⁴
33-2(2)	Quality-of-Work Life Programs for the Transit Industry—Regional Seminars	Public Admin. Service	49,454
33-3	Public Transit Bus Maintenance Manpower Planning	Fleet Maintenance	100,000
AREA 36: PLANNING—ALTERNATIVE ANALYSIS			
36-1	Improving Decision-Making for Major Urban Transit Investments	System Des. Concepts	200,000
AREA 38: PLANNING—SYSTEM PLANNING			
38-1	National Transit Computer Software Directory	COMSIS Corp.	100,000
AREA 39: PLANNING—ROUTE PLANNING			
39-1	A Modular Approach to On-Board, Automatic Data Collection Systems	The MITRE Corp.	148,787
AREA 40: PLANNING—IMPACT ANALYSIS			
40-1	Simplified Guidelines for Evaluating Transit Options in Small Urban Areas	Barton-Aschman	149,960
40-2	Estimating Incremental Costs of Bus-Route-Service Changes	System Des. Concepts	150,000
40-3	Strategies to Implement Benefit-Sharing for Fixed Transit Facilities	SG Associates	99,957
AREA 43: DESIGN—TRACK AND ANCILLARY SYSTEMS			
43-1	Detection of Low-Level Fault Currents on Rail Transit Systems	Chas. T. Main, Inc.	99,953
AREA 46: DESIGN—GENERAL DESIGN			
46-1	Single Cable Communications Technology for Rail-Transit Systems	Poly Inst of NY	150,000
AREA 47: MATERIALS AND CONSTRUCTION—GENERAL MATERIALS			
47-1	Improved Service Life of Urban Transit Coach Brakes	Battelle Mem Inst	300,000
AREA 48: MATERIALS AND CONSTRUCTION—SPECIFICATIONS, PROCEDURES, AND PRACTICES			
	Electrolytic Corrosion in DC Powered Transit Systems	—	200,000
AREA 54: OPERATIONS—ENERGY EFFICIENCY			
54-1	Improve Transit Bus Energy Efficiency and Productivity	Booz-Allen	39,976 ⁴
54-2	Energy Management of Electric Rail Transit Systems	Carnegie-Mellon	150,000
AREA 55: OPERATIONS—PERFORMANCE, EFFECTIVENESS, AND EFFICIENCY			
55-1	Conversion to One-Person Operation of Heavy-Rail Rapid-Transit Trains	Battelle Mem Inst	150,000
AREA 60: SPECIAL PROJECTS			
60-1	Synthesis of Information Related to Transit Problems	TRB	660,000 ^a
	TS-1: Cleaning Equipment and Procedures for Transit Buses	ATE Mgmt	75,000 ^b
	TS-2: Priority Treatment for Buses on Urban Streets	PAWA	75,000 ^b
	TS-3: Effects of Fuel Additives and Alternative Fuel Grades for Transit Buses	Southwest Res Inst	30,000 ^b
	TS-4: Guidelines for Allocation of Time for Transit Coach Maintenance Functions	XYZYZ Info Corp.	30,000 ^b
	TS-5: Extraboard Management Procedures and Tools	L. C. McDorman	40,000 ^b
	TS-6: Traffic Control and Regulation at Transit Stops	W. W. Rankin	45,000 ^b
	TS-7: Bus Communications Systems	Mitre	45,000 ^b
	TS-8: Passenger Information Systems for Transit Transfer Facilities	J. J. Fruin	45,000 ^b
	TS-9: Transit Fare Collection: Problems and Alternatives to Paper Currency	Mitre	75,000 ^b
	TS-10: Use of Part-Time Operators	L. C. McDorman	50,000
	TS-11: Transit Marketing: Success and Failures	Richard L. Oram	50,000
	TS-12: Use of Incentives to Attain Specified Performance Standards in Collective Bargaining for Mass Transit	Darold T. Barnum	50,000
	TS-13: Bus Inspection Guidelines	C. I. Giuliani	50,000

¹ Final Subcontract cost.

² Continuing activity through FY '84. Annual amount varies; total to date shown.

³ Allocated—Balances are carried forward to support future synthesis studies.

STARTING DATE	EXPECTED COMPLETION DATE	PROJECT STATUS (for details, see latest Summary of Progress)	PROJECT NO.
11/8/82	8/7/84	Completed—Published as NCTRP Report 11	30-1
1/30/81	12/15/82	Completed—Published as NCTRP Report 2	31-1
—	—	In developmental stage	31-2
0/15/81	4/14/84	Completed—Report in review process	33-1
11/1/82	2/29/84	Completed—Published as NCTRP Reports 5 and 6	33-2
12/1/84	3/1/86	Research in progress	33-2(2)
11/1/83	10/31/84	Completed—Published as NCTRP Report 10	33-3
11/2/81	11/1/83	Completed—Published as NCTRP Report 4	36-1
1/3/83	1/31/85	Research in progress	38-1
11/1/82	8/31/84	Completed—Published as NCTRP Report 9	39-1
0/25/82	10/23/84	Completed—Published as NCTRP Report 8	40-1
1/15/83	8/14/85	Research in progress	40-2
11/1/83	2/1/85	Research in progress	40-3
1/3/83	9/30/84	Report in review stage	43-1
5/1/84	7/31/85	Research in progress	46-1
12/1/81	12/31/84	Report in review stage	47-1
—	—	In developmental stage	48-1
10/1/81	6/30/82	Completed—Published as NCTRP Report 1	54-1
10/1/81	12/31/83	Completed—Published as NCTRP Report 3	54-2
3/5/84	7/8/85	Research in progress	55-1
11/7/80	*	Research in progress	60-1
2/16/81	12/31/81	Completed—Published as NCTRP Synthesis 1	(TS-1) 60-1
3/16/81	12/31/81	Completed—Published as NCTRP Synthesis 2	(TS-2) 60-1
10/1/82	9/30/83	Completed—Published as NCTRP Synthesis 3	(TS-3) 60-1
12/9/82	11/30/83	Completed—Published as NCTRP Synthesis 4	(TS-4) 60-1
11/31/83	10/31/84	Completed—Report in review stage	(TS-5) 60-1
12/27/83	12/31/84	Research in progress	(TS-6) 60-1
11/21/83	12/31/84	Research in progress	(TS-7) 60-1
11/21/83	12/31/84	Research in progress	(TS-8) 60-1
12/2/83	12/31/84	Research in progress	(TS-9) 60-1
11/15/84	9/30/85	Research in progress	(TS-10) 60-1
11/15/84	9/30/85	Research in progress	(TS-11) 60-1
12/1/84	11/30/85	Research in progress	(TS-12) 60-1
1/15/84	10/31/85	Research in progress	(TS-13) 60-1

TABLE 6
AGENCY DISTRIBUTION OF FY '80 THROUGH
FY '82/'83 PROJECTS

TYPE OF AGENCY	PROJECTS AND CONTINUATIONS	
	NO.	%
Educational institutions	2	11
Research institutes	3	17
Industry, consultants, and trade associations	12	66
Professional societies and service organizations	1	6
State DOTs and other governmental agencies	0	0
All	18	100

a grant basis. Further, proposals can be received only in response to advertised project statements, as the funds available each year to the Program are earmarked in their entirety for research problems specified by the sponsor—UMTA.

The policy of the NCTRP is to provide a debriefing to unsuccessful proposers. The initiative for obtaining a debriefing lies with the proposers and must be requested in writing. The debriefing is intended to indicate to the proposers the technical areas in which their proposals were judged weak and deficient and how the weaknesses or deficiencies were factors in their not having been selected. All debriefings are conducted in a scrupulously fair, objective, and impartial manner, and the information given the unsuccessful proposers is absolutely factual and consistent with the evaluations by the NCTRP panels. The factors constituting the basis for selection of the successful agency are identified, but the debriefing does not include a point-by-point comparison of all the elements considered in the evaluation criteria. Neither is there any revelation of confidential business information, trade secrets, techniques, or processes of the other proposers, nor is there any indication of the relative merits or technical standings of the unsuccessful proposers.

The PTC's research subcontract is either:

- Cost-Reimbursement (CR)
- Cost-Plus-Fixed-Fee (CPFF)
- Fixed Price (FP)

The research agency's proposal is made a part of the subcontract with the PTC. Thus, in addition to the specific research objectives outlined in the subcontract, the research agency's cost estimates are also recognized as being part of the agreement. However, the principal investigator

does have flexibility in conducting the research, if it is consistent with the general scheme of the proposal.

KEEPING TRACK OF RESEARCH IN PROGRESS

A professional staff is assigned to NCTRP by the Board. Currently, five projects engineers with wide-ranging expertise are responsible for administrative and technical surveillance of the contracts. In addition to reviewing quarterly progress reports and monthly progress schedules and maintaining telephone contacts, each engineer visits his assigned research agencies throughout their subcontract periods. He discusses with each principal investigator his project's status to learn if the research is being pursued in line with the approved research plan. Finally, the engineer and cognizant project panel evaluate the completed research to determine the degree of technical compliance with the subcontract.

SYSTEMATIC PLANNING FOR GETTING RESEARCH RESULTS FROM NCTRP PROJECTS INTO PRACTICE

Promoting Useful Results

Previous narrative substantiates the fact that many activities take place between initiation of research programs and execution of research contracts. Many additional ones take place before formal publication of the final report is realized. At the milestones of the process network reflecting all activities, NCTRP concentrates on the opportunities to increase the odds for acquiring useful research results and to increase the probability that useful results will find their way into practice more quickly. Beyond the sponsor's first weighting of the odds by setting the goals for a program of applied research dedicated to solving pressing operational problems, the NCTRP tries to further weight the odds favorably by:

- Establishing the agency and personnel qualifications that are mandatory if the goals are to be achieved. Emphasis is placed on the importance of a record of successful past performance in endeavors similar to those to be undertaken. Further, it is also stipulated that proposals are not acceptable if they do not contain specific statements as to how the contemplated results can be used to improve practice.
- Utilizing persons who are not only experts in the particular problems area but who also have a complete understanding of the needs of the practitioners to define the research problem and its objectives in the form of a precise project statement on which fully responsive research proposals can be based. Experts drawn from transit agencies play a major role in this task.
- Exercising extreme care in the process of selecting research agencies to ensure not only that the proposed research plan is the best possible in addressing the specifics of the objectives but that it also culminates in the best promise for providing the practitioner with a product that is both usable and readily implementable.

- Establishing—on the basis of staff and project panel review of and suggested modifications to the research plan—a clear meeting of the minds as to what specifically is expected from the research and the personnel carrying it out in order to meet the needs of practitioners.

- Acquiring an amplified research plan that is intended to detail comprehensively the approved research plan and to include a specific schedule of events for the major tasks. This document is used by the staff in the day-to-day surveillance of the project's progress and by the project panel as required.

- Carrying out project surveillance sufficient to keeping the research in line with the approved research plan, constantly keeping the researchers aware of the needs of practitioners, and insuring that all project developments through final reporting center around these needs.

- Requiring research reports in a format that is designed specifically to ease the burden of the busy practitioners in assimilating what has resulted from the research and how it can be used. Different treatment is given to the material that would be of interest to other researchers.

NCTRP Reporting of Research Results

In an applied research program such as the NCTRP, the sponsor rightfully expects not only results that are accurate but also findings that can be readily put into practice. This means that the final research reports (refer to Tables 7 and 8) must be presented in language understandable to practitioners and in such format as to permit easy assimilation. Too many of today's research reports are frequently so clouded by obscure language and format that the reader must spend precious time and effort in translating them into concise and readily usable working documents.

Research agencies for the NCTRP are required to report their results in a form that succinctly summarizes the findings and likewise informs the reader of the application of the findings. These objectives are accomplished through a "Summary of Findings," and a chapter on "Interpretation, Appraisal, and Application of Results." The detailed research techniques and analyses in which a researcher would be interested are presented in appendices and do not have to be labored through to extract the findings. The Program specifies style and organization of all reports to guide the researcher in his writing to provide a document of maximum use by the sponsors and others.

Prior to publication, extraordinary measures are taken to ensure that useful research results are made immediately available to the appropriate personnel. One means consists of forwarding copies of the research agency drafts of final reports. According to the urgency of the particular circumstances, these drafts may be either uncorrected or corrected on the basis of an acceptance review. Several copies of unedited drafts of the agency reports are retained until formal publication in either of the two regular

NCTRP series (Reports or Syntheses of Transit Practice) and are available, on a loan basis, to others having an interest in the research. Once published in their entirety, the drafts are destroyed.

After publication in the NCTRP series, each report or synthesis is distributed immediately through the Transportation Research Board's selective distribution system. Copies go automatically to about 100 libraries, Board transit representatives, educational institutions, liaison representatives, appropriate panels and committees of the Board, and individual members who have selected publications in the particular subject area of the report. Special distribution lists are developed as appropriate to ensure receipt by all segments of the operating agencies of information helpful to their operations. As a further means of disseminating the research reports, announcements of their availability are made to the trade press. Each of these reports contains a staff-prepared foreword that directs the attention of the busy reader to the persons who would be most interested in the results and, also, to how the results fit into present knowledge and practice. Also, during the conduct of the work, periodic progress reports are prepared by the staff and sent to UMTA as a measure of providing a current awareness of on-going work. In addition, the Board's Technical Activities Staff personnel follow the progress of the work throughout its conduct and consequently are able, in their activities, to discuss application of the research results with those best able to use them. Research findings not published in the NCTRP series are stored on microfiche by the PTC. On an interim basis, the findings are sometimes reported in a *Research Results Digest*, described next.

The *NCTRP Research Results Digest* series—flyers published at frequent intervals—is a means for providing practitioners with an early awareness of the research results emanating from NCTRP projects. By making results known as they are developed and prior to publication of the final reports in the regular NCTRP series, it is hoped that their early use in practice will be encouraged. For the most part, each Digest is intended to be very brief in summarizing specific findings—they do not deal with research methodology—and require the reader to expend very little time in determining how the research results may be of use to him. The basic format is couched in terms of the problem and the solution to it, the findings, and applications. Practitioners should find them of direct assistance in serving the intermediary, or interpretive, position between research and operating personnel, for each Digest speaks directly to the vital factors of:

- Whether the research stands alone or whether it has to be combined with results from other research in order to be useful.
- Whether the results are defined explicitly enough to permit direct application to practice.
- Whether the results have to be translated into the working tools with which the practitioner is familiar.

- Whether the research findings have been evaluated sufficiently to make some reasonable determination of the probability of their success when applied to practice.

IMPLEMENTING RESEARCH RESULTS

Emphasis has been given in the foregoing to the devices employed to obtain solutions that are directly applicable to practice. Because the NCTRP process does not include an implementation activity, the initiatives for incorporating the solutions in practice must be taken by the UMTA and transit agencies. To this end, the Program's final concentration is on the reporting of research findings in one or more of the variety of publications described earlier and, as will be done in future annual reports, providing whatever details are available on the experiences of the States and transit agencies in using the products from NCTRP research. With this objective, the Program will be grateful for any information on actual application of results and associated benefits. Because the research addresses critical, national problems, the assumption is that documented use and payoff to any one agency should attract others to give the results a try in whatever degree they see fit. Only if the results get around and are used can it be said that UMTA truly is capitalizing

on its investment. Otherwise, projects that were highly successful might just as well have been failures; the end result is the same—the money will have been spent in vain.

SUMMARY

The National Cooperative Transit Research and Development Program is a unique subcontract research effort designed to respond quickly and efficiently to the needs of UMTA and the transit industry through solution of near-term public transportation problems. Although the Transportation Research Board administers the Program, the research content is solely the prerogative of the Urban Mass Transportation Administration. The Program is one of applied (rather than basic) research, and every possible effort is made to help administrators and engineers put the findings to early use. Program policy ensures maximum exposure of the research while in progress in the hope that research results will, in fact, more quickly find their way into practice in the form of policies, procedures, specifications, and standards of the operating agencies.

TABLE 7
PUBLISHED REPORTS OF THE NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

<i>Rep. No.</i>	<i>Title, Project, Pages, Price</i>
1	Transit Bus Energy Efficiency and Productivity—Bus Equipment Selection Handbook (Project 54-1), 55p., \$7.20.
2	Impacts of Federal Grant Requirements on Transit Agencies (Project 31-1), 73 p., \$7.60
3	Reduction of Peak-Power Demand for Electric Rail Transit Systems (Project 54-2), 142 p., \$10.40
4	Improving Decision-Making for Major Urban Transit Investments (Project 36-1), 47 p., \$7.20
5	Assessment of Quality of Work-Life Programs for the Transit Industry—Research Report (Project 33-2), 99 p., \$8.80
6	Assessment of Quality-of-Work-Life Programs for the Transit Industry—Model Programs (Project 33-2), 37 p., \$6.80
7	Predicting and Dealing with Transit Bus Operator Stress (Project 33-1), (In Preparation)
8	Simplified Guidelines for Evaluating Transit Service in Small Urban Areas (Project 40-1), 119 p., \$10.40
9	Modular Approach to On-Board Automatic Data Collection Systems (Project 39-1), (In Press)
10	Public Transit Bus Maintenance Manpower Planning (Project 33-3), 56 p., \$8.00
Synthesis of Transit Practice	
<i>No.</i>	<i>Title, Pages, Price</i>
1	Cleaning Transit Buses: Equipment and Procedures (Proj. 60-1, Topic TS-1), 39 p., \$6.80
2	Enforcement of Priority Treatment for Buses on Urban Streets (Proj. 60-1, Topic TS-2), 30 p., \$6.40
3	Diesel Fuel Quality and Effects of Fuel Additives (Proj. 60-1, Topic TS-3), 62 p., \$7.60
4	Allocation of Time for Transit Bus Maintenance Function (Proj. 60-1, Topic TS-4), 24 p., \$6.40

TABLE 8
NCTRP RESEARCH RESULTS DIGESTS ^a

DIGEST NO.	PROJ. NO.	TITLE, PAGES, PRICE
1	33-1	Review of Literature Related to Bus Operator Stress, 15p., \$3.00

^a See Table 5 for project titles. See final page of this document for ordering information.

PROGRESS BY PROJECT

Only those areas are listed in which there are projects. For a complete list of project areas, refer to Figure 3.

AREA 30: ECONOMICS

Project 30-1 FY '81

Small Transit Buses: A Manual for Improved Purchasing, Use, and Maintenance

Research Agency: Arthur D. Little, Inc.
Principal Invest.: R. Nayak
Effective Date: November 8, 1982
Completion Date: August 7, 1984
Funds: \$299,378

An important decision facing many transit managers in small urban or rural areas is how to choose from among several types of small buses. Several factors can influence the choice: the trade-off between capital cost and operating cost; the ease with which the buses can be operated; and their maintenance requirements, among others. The general objective of this research was to develop a work-book style manual for local transit operators. As a basis for the manual, the research called for the development of a data base as well as an analysis framework for deciding how one should buy and maintain small buses.

This analysis of data showed that maintenance costs can vary from a low of 0.17 labor-hours per 100 bus-miles to a high of 1.69 labor-hours per 100 bus-miles, combined with a materials cost ranging from \$1.20 per 100 bus-miles (in 1983 dollars) to \$9.80 per 100 bus-miles. The wide range in costs results from variations in the following factors: the type of bus (van, body on van chassis, body on truck chassis, or purpose-built); the make of the bus; the severity of the duty cycle that the buses are subjected to; the severity of the climate in which the buses operate; and the accumulated mileage of the bus. Detailed data are presented in this manual on the quantitative effect of these factors. In operations costs, the two significant elements are labor and fuel. Labor costs for operators can be easily estimated by each transit manager based on local labor wages and fringe benefits and are not, therefore, presented in the manual. Fuel consumption data, on the other hand, are not as easily available, and are presented in the manual. Fuel efficiency can vary from a low of 3.6 miles per gallon for purpose-built buses to a high of 8.9 miles per gallon for vans. Significant variations around these numbers can result from differences in duty cycle and engine type (gasoline or diesel).

The data described above are for use in a life cycle cost (LCC) analysis that is developed as a step-by-step, work-book procedure in the manual. The result of this LCC

analysis is one important factor to be taken into account in choosing a bus.

Additional factors that must be taken into account in buying a bus include the type of fuel that is to be used; the nature of auxiliary equipment that is desired (especially wheel-chair lifts); the maneuverability of the buses; the availability of spare parts; and the facilities needed to maintain the bus. Qualitative information and guidelines are presented in the manual on each of these factors.

The manual is expected to be published as NCTRP Report 11, "Small Transit Vehicles: How to Buy, Operate, and Maintain Them."

AREA 31: FINANCE

Project 31-1 FY '80

The Impacts of Federal Grant Requirements on Transit Agencies

Research Agency: Booz, Allen & Hamilton, Inc.
Principal Invest.: Subhash R. Mundle
Effective Date: November 30, 1981
Completion Date: December 15, 1982
Funds: \$49,522

As the federal transit program grew, the growth was accompanied by a proliferation of federally imposed requirements. The costs and effects of grant requirements caused increasing concern to transit agencies.

The general objective of this study was to determine the costs and effects of federal legislation, regulations, UMTA circulars, administrative letters and formal administrative guidelines for the Section 3 capital grant application process and to make recommendations for its improvement. The study results are useful to (1) transit agencies in their decision to apply for federal grants, (2) legislators drafting legislation, and (3) the Urban Mass Transportation Administration in amending requirements.

Because of the limitation on available funds, the research specifically excluded consideration of Section 13(c) and 504 requirements. Additionally, the research did not consider Section 5 capital and operating grants; applicability to fixed guideway systems; project management requirements for approved grants; and applicability to specialized transit services.

The study results showed that an application for a Section 3 grant requires from 20 to 30 exhibits of supportive documentation and assurances. The origin of these requirements was traced to the Urban Mass Transportation Act and UMTA promulgated regulations and administrative policies. Requirements varied primarily by project type, rather than by amount of funding request or urban area size. Impacts of compliance included: direct levels of effort; delays in project implementation, inflationary cost escalation and loss of management flexibility.

The magnitude and extent of these impacts varied significantly among transit agencies. Reasons for the differences were attributable to factors both within and beyond the control of the applicant agency.

By 1981 the transit industry viewed application procedures as routine. The assignment of a permanent grants function within local agencies has reduced preparation costs. In addition UMTA relaxed several of its reporting requirements. Yet areas for improvement remained. The most significant of these included the need for consolidated guidelines; the need for a streamlined application document; and the need for coordinated local, state, and federal capital programming efforts.

The study results were published as:

NCTRP Report 2, "The Impacts of Federal Grant Requirements on Transit Agencies."

Project 31-2 FY '84

Controlling Rising Operating Deficit Through Capital Investments

Research Agency:
Principal Invest.: In Developmental Stage
Effective Date:
Completion Date:
Funds: \$150,000

The newly reenacted Surface Transportation Act reduces the federal operating assistance available to urbanized areas in favor of seemingly unlimited capital dollars. These cuts come at a time when local areas like New Orleans have found it difficult to (1) reverse or contain annual increases in the transit operating deficit and (2) pass a permanent source of funding which is both reliable and predictable. Future capital expenditures for local area projects should be directed to capital improvement projects that can significantly reduce or help control operating cost in the immediate, short, medium and long run. Capital projects that have a positive impact on operating cost by (1) increasing ridership per hour and vehicle productivity, (2) reducing running time, (3) decreasing operating cost, e.g., labor, fuel, administrative cost, and (4) generating clear cut cost savings, should receive top priority. This study will inventory various capital projects in terms of their ability to impact trends in increasing operating deficits. Also to be studied with a view toward being a cost controlling measure is the matter of an optimum replacement cycle, by bus type and make, based on usage, costs, and performance considerations.

AREA 33: PERSONNEL MANAGEMENT

Project 33-1 FY '80

Transit Bus Operator Selection and Training for Dealing With Stress

Research Agency: Group Associated Management Services, Inc.
Principal Invest.: Dr. Brownlee Elliott
Effective Date: October 15, 1981
Completion Date: April 14, 1984
Funds: \$150,000

Some bus operators possessing the basic skills to operate the vehicle may still experience difficulties in performing their job satisfactorily because of inability to cope effectively with the public. Use of all possible training and disciplinary action does not help when the individual hired does not have the psychological strengths necessary to deal effectively with continuous public contact, and the resultant stress may lead to more workers' compensation claims for nonvisible physical injury (i.e., heart and psychological problems) as well as to more accidents, absenteeism, and personnel turnover.

Various selection and training methods are currently being used by individual transit agencies. Some of these methods have been developed specifically for application in the transit industry, some have evolved from practice within individual agencies, and others represent modifications to methods originally developed for agencies outside of the transit industry. At present, however, no single method of selecting or training bus operators from the viewpoint of their ability to deal with stress is considered to be generally acceptable for wide application by transit agencies. To ensure that methods have general applicability, the range of needs and capabilities of different size transit agencies, regional differences, and the makeup of the bus operator population (i.e., male/female and minorities) must be fully considered.

The objective of this research was to develop an evaluative device or questionnaire for use as part of the bus-driver-selection process that when validated will indicate the applicant's susceptibility to stress which is likely to affect job performance. The research also provided two training modules.

Reference literature and existing training programs were reviewed to identify the various environmental, psychological, and physiological factors commonly used in stress analysis. NCTRP Research Results Digest 1 provides a summary of the literature review.

Existing selection mechanisms were evaluated for general applicability in measuring an individual's tolerance for stress. Portions of these existing devices and new material developed in this research were combined into a preliminary stress prediction device. This device was pilot tested at 6 sites but was not validated for general use. The device treats stress factors individually and in groups such as passenger contact, environment, management/union/employee relations, personal problems, and equipment.

Two sample training modules were also prepared: one

for newly hired operator training (and perhaps for voluntary retraining) and one for supervisor training. The primary focus of the new operator training is to alert the driver to typical stress-causing situations and to provide specific guidance on how to cope with each situation. Typical situations include (1) passenger contacts, e.g., fights on the bus; (2) environmental factors, e.g., bad weather; (3) management/union/employee relations; (4) personal problems, and (5) equipment. The supervisor's training module focuses on the recognition of stress symptoms and tendencies (resulting from personal or job-related causes) and on the identification of appropriate courses of action. Both modules are adaptable by an individual transit agency so that through property-specific modifications they can be made part of existing training programs.

A listing was also developed of pertinent data and resources (films, videotapes, surveys, models, books, papers, etc.) identifying concomitant costs, sources, and transit agencies that are using such methods for selection and stress management training of bus operators and supervisors.

Research has been completed, and the final report is in the review process.

Project 33-2 FY '81

Assessment of Job Enrichment Programs for the Transit Industry

Research Agency: Public Administration Service
Principal Invest.: Dr. Susan G. Clark
Effective Date: November 1, 1982
Completion Date: February 29, 1984
Funds: \$97,821

The political and fiscal environment of transit agencies is in a period of significant change. Scarcity of funds will mean an emphasis on productivity and efforts to retain and motivate quality employees. New federal policies stressing local initiative will encourage management to be more sensitive to innovative ideas, and a changing work force will make different demands. Although the transit industry is highly labor-intensive, a great deal of emphasis has been placed in the past on capital development, financial controls, and transportation planning. Potentially, one of the most important areas for improving transit agency effectiveness is the development and management of human resources. Quality-of-work-life (QWL) programs can provide such an opportunity by stressing the importance of the individual as well as the productive gains to the agency.

Under this research, the feasibility of QWL programs for application by transit agencies was assessed. Although QWL programs may focus on particular employees and groups of employees, the initiation and success of a program many times depend on the attitude and environment created by upper management and, if unionized, the in-

teraction between management and the affected unions. Therefore, recommendations on the potential application of quality-of-work programs required consideration of both transit agencies as a whole and individual employees.

The results of this study have been published in two reports. NCTRP Report 5, "An Assessment of Quality-of-Work-Life Programs for the Transit Industry—Research Report," is the main research document and includes an overview of the summary of findings; a main text that thoroughly documents the study effort and recommendations; and several appendixes that provide a master list of references, a selected annotated bibliography, case studies and summary results of a survey of transit agencies. A single table conveniently documents current activity in various industries. *NCTRP Report 6*, "An Assessment of Quality-of-Work-Life Programs for the Transit Industry—Model Programs," provides specific guidance for initiating and maintaining programs within a transit agency.

Project 33-2(2) FY '82/'83

Quality-of-Work-Life Programs for the Transit Industry—Regional Seminars

Research Agency: Public Administration Service
Principal Invest.: George Greisinger
 Dr. Susan G. Clark
Effective Date: December 1, 1984
Completion Date: March 1, 1986
Funds: \$49,454

Under NCTRP Project 33-2, recommendations were made on the potential application of quality-of-work-life programs to transit agencies. These recommendations and the supporting research were documented in two reports: NCTRP Report 5, "Quality-of-Work-Life Programs for the Transit Industry—Research Report," and NCTRP Report 6, "Quality-of-Work-Life Programs for the Transit Industry—Model Programs." In order to ensure proper consideration of these findings and recommendations, a second project is needed to disseminate the results to the transit industry. After reviewing an array of strategies, NCTRP Project Panel A33-2 concluded that with the help of local sponsors, regional seminars would be the most productive means, given the financial resources anticipated for the project. Furthermore, the Panel judged that sufficient interest exists to warrant the seminar approach. The regional seminars are to be based on the previous research and will address issues facing management, practitioners, labor, and others concerned with the development of human resources.

The objective of Project 33-2(2) is to conduct at least four regional seminars at locations geographically distributed across the nation. Maximum use will be made of volunteer, local sponsors and support in arranging and conducting the seminars. To accomplish the project objective the agency is required to:

1. Provide the lead in organizing and conducting the seminars including arrangements with local sponsors for support. The selected agency will be responsible for preparing and making announcements to potential seminar participants with NCTRP approval.
2. Provide the agenda and prepare all seminar material, such as audio-visual aids, lesson plans, and handouts. Maximum advantage will be taken of the sequencing of seminars to appropriately modify the seminar material as needed.
3. Turn over to the NCTRP, at the conclusion of the project, all seminar materials and a brief summary description of the seminars conducted. The seminar material will be in a form suitable for use by others in conducting additional group seminars and as instructional information for individuals. The seminar material and summary will be treated as the final report for the project.

Project 33-3 FY '82/'83

Public Transit Bus Maintenance Manpower Planning

Research Agency: Fleet Maintenance Consultants, Inc.
Principal Invests.: Richard W. Drake
 Subhash R. Mundle
Effective Date: November 1, 1983
Completion Date: October 31, 1984
Funds: \$100,000

Proper manpower planning for bus maintenance is crucial to the efficient and economical operation of transit agencies. However, this crucial element is often determined by using such simple ratios as buses per mechanic or maintenance man-hours per miles of operation that are based heavily on past experience and guess work. Often they are not appropriate for transit agencies experiencing major changes in services, equipment, or facilities.

The principal objective of this project was to develop a methodology for establishing labor estimates required for maintaining specific vehicle systems.

The methodology developed accounts for the effects of miles of bus operation, accident rate, climate, type of bus, and type of transmission on maintenance labor-hour requirements for the following subsystems; servicing and cleaning, inspections, engine/fuel, braking, electrical, air/steering/suspension, air conditioning and heating, drivetrain, cooling, accessories, wheels and tires, fare-boxes, destination signs, and wheelchair lifts. Total maintenance manpower requirements are determined from a summation of subsystem labor hour requirements, modified by overtime and unavailable time considerations.

Labor-hour requirements found in the research, together with the methodology for estimating manpower

requirements will be published in NCTRP Report 10, "Public Transit Bus Maintenance Manpower Planning."

AREA 36: ALTERNATIVE ANALYSIS

PROJECT 36-1 FY '80

Improving Decision-Making for Major Urban Transit Investments

Research Agency: System Design Concepts, Inc.
Principal Invest.: Joseph R. Stowers
Effective Date: November 2, 1981
Completion Date: November 1, 1983
Funds: \$200,000

Since 1975, the Urban Mass Transportation Administration (UMTA) has required, as a condition for federal funding support, a structured process, termed "alternatives analysis," for proposed major investments in urban mass transit facilities. This process is used to identify priority corridors for possible major investments and to assess the cost-effectiveness of these investments in comparison to less costly transit improvements. Information generated in the process is used both by federal officials in administering a discretionary capital grant program and by state and local officials in determining priorities and identifying needed improvements in mass transportation services.

Since the advent of the alternatives analysis requirements, a significant number of urban areas have been involved in some aspect of the process. Concerns have been expressed with the process, particularly regarding the extensiveness of the study requirements, the delays caused in implementing transit improvements, the role that UMTA staff has played in managing the studies, and the use of the study results in UMTA's decision-making process. NCTRP Project 36-1 was initiated because of a recognized need to evaluate past experience with alternatives analysis and to recommend improvements in the process that will result in more effective local, state, and federal decision-making.

The general objective of this research has been to assess the federal, state, and local decision-making process for major urban mass transportation investments by evaluating recent alternatives analysis and related study experiences. The purpose of the assessment has been to identify potential improvements in policy, procedures, and use of technical information, and to formulate recommendations on planning procedures for use by federal, state, and local agencies.

The first part of the findings deals with the quality of the various components of the technical work programs with emphasis on their role in the decision-making process. Both the state of the art and general practice in

the field have improved enormously over the last several years. The relative levels of adequacy, however, differ significantly among the specific technical elements of the process.

Improvements in the quality of input data for demand analysis and in considering transit operations planning were identified as technical needs. On the other hand, environmental impact studies were thought to involve more work than necessary where environmental impact issues are not important in the decision-making process.

From examining the overall structure of the planning and decision-making process, it was recommended that Phase I system-planning studies be eliminated if urban areas can provide a well-supported basis for determining priorities among regions. With regard to Phase II studies and finding agreements, it is recommended that such finding agreements follow the local decision on a preferred alternative as soon as possible, notwithstanding that this would normally require some preliminary engineering work in Phase II.

Recommendations for federal programs were made in three categories: (1) changes in the alternatives analysis and related regulations, (2) administration of the program, and (3) possible changes in the grant program.

The need for immediate change in regulations was judged to be minimal. The existing policy statements and regulations were considered flexible enough to permit accomplishment of most, but not all of the recommendations without change.

It was recommended that UMTA clarify its policy regarding its own decision-making process and the way in which the results of alternatives analyses are used in this process. This should involve more clearly defined guidelines for overall evaluation, including the manner in which economic investment evaluation measures, benefit-cost ratios, or cost-effectiveness are to be developed. It should also involve a commitment by UMTA to state the basis on which its decisions are made in each grant application case.

Furthermore, it was recommended that consideration be given to the development of a policy statement that would place greater emphasis on long range transit system planning issues that might be important in alternatives analyses, including such factors as:

1. Operational plans for areawide transit systems.
2. Impacts of the transit development program on future operating costs and subsidy requirements.
3. Land development impacts.
4. Commitments of local officials to land development policies to enhance the transit-orientation of corridors.
5. Commitments of the private sector to major development projects in corridors in accord with policies adopted by local officials.
6. Areawide bus service needs and deficit implications.
7. Need for, and location of, maintenance facilities and other major systemwide considerations that may have

different solutions when seen from an areawide basis as compared to the corridor level.

With regard to administration of the program, it was recommended that greater effort should be devoted to achieving common FHWA and UMTA administration of major corridor studies. Far more could be done to train field staff to have common understanding of regulations and policy, and to be prepared to represent U.S. DOT as a whole.

With regard to possible changes in the grant program, a recommendation was made to combine earlier highway and transit capital grant programs into a single formula grant program so that highway/transit trade-offs can be made.

The results are published in NCTRP Report 4, "Improving Decision-Making for Major Urban Transit Investments."

AREA 38: SYSTEM PLANNING

Project 38-1 FY '81

National Transit Computer Software Directory

Research Agency: COMSIS Corporation
Principal Invest.: David M. Levinsohn
Effective Date: January 3, 1983
Completion Date: January 31, 1985
Funds: \$100,000

Over the past decade, computer (software) systems have gained widespread acceptance as important management and operating tools in public transit agencies. Representative software applications include planning (UTPS), scheduling (RUCUS), operations control, maintenance (SIMS), finance, and personnel. It is estimated that the public transit industry spends several million dollars each year on the design of software. Because there are great similarities in the structure and operation of transit agencies, software developed by one agency can often be adapted for use by other agencies with much less cost and effort than custom-designing completely new software. There was a need to develop and pilot test a methodology for the establishment and continuous updating of an automated directory of computer software useful to the public transit industry. The directory would have the capability of including (1) software suitable for use by transit agencies of all sizes, and (2) existing and future software for use on computers of all types and sizes.

A Directory in preliminary draft form has been developed as part of a Phase I for this project. It is in the form of a Catalogue, an Operating Manual, a Programming Guide, and a listing of program descriptions, all bound separately. The Directory in this form is not available. A Phase II is underway to recast the program de-

scriptions by type of hardware and to make them available upon request from the research agency. Furthermore, the Directory will be operated and augmented with additional programs, by the research agency during the course of Phase II.

AREA 39: ROUTE PLANNING

Project 39-1 FY '81

A Modular Approach to On-Board, Automatic Data Collection Systems

Research Agency: The MITRE Corporation
Principal Invest.: Lawrence E. Deibel
Effective Date: November 1, 1982
Completion Date: August 31, 1984
Funds: \$148,787

Current economic conditions require that a transit system improve productivity while making the best use of limited resources. Increasing emphasis is being placed on improving route productivity through such means as better schedules, on-time performance, and service allocation. These requirements place an increasing importance on good ridership and schedule adherence data so that responsible decisions on routing and scheduling can be made. In addition, fare-box revenue is becoming increasingly important to the stability of transit systems. Accurate fare payment information by fare category is needed to calculate effects of alternative fare adjustment proposals, including an analysis of the equity of fare structures. The need for ridership, schedule adherence, and fare information is expected to continue for the foreseeable future.

Currently the most predominant form of gathering ridership data in the transit industry is collecting data manually by ride checks or load (point) checks. Information gathered in this manner is expensive to collect and process, limited in scope, and usually infrequent because of the number of "checkers" required. For example, some systems have reported that a point check may provide accurate load data at one location, but may understate true route ridership by as much as 50 percent. Fare/revenue data are generally available only on a systemwide basis. Special efforts that usually rely on driver participation or cumbersome fare-box handling are required to collect route-level fare-payment information.

In recent years, a few transit systems have turned to automated methods to collect ridership, schedule adherence, and fare data. The levels of sophistication of these systems have varied from real-time data collection and analysis systems to more basic systems that provide information in summary form on an historical basis. Although, in general, transit properties that have used these automated systems have been satisfied, widespread use has not occurred.

There are several reasons why the majority of transit systems have not implemented automated technology: (1) a general lack of understanding of the options available in terms of hardware to provide the information; (2) an uncertainty as to how much of what type of hardware and software is needed; (3) the lack of commitment by transit management to implement the technology; (4) the difficulty in quantifying benefits, together with costs, and in determining the net benefit to the transit system; (5) the general unavailability of funding for much of this equipment at the federal level; and (6) the lack of standardization of functional requirements of the technologies, which, in turn, dampens the availability of hardware and discourages manufacturer participation.

The general objective of this research was to develop requirements and implementation guidelines for the use of automated on-board passenger/fare information collection systems. The system hardware had to be constructed on a modular basis so that one module or component is compatible with another regardless of manufacturer. Requirements for modules or components needed to depend on the decisions a transit property must make, which, in turn, determined the level of detail the data collection system must provide. The levels of detail ranged from systemwide information to detailed stop-by-stop information. The system was designed so that a transit property can choose, in modular fashion, the level and type of hardware needed for the data desired.

Research is complete; the final report has been published as NCTRP Report 9, "Modular Approach to On-Board Automatic Data Collection Systems." The final report documents the activities and findings on research to develop and deploy a standardized modular system including any possible constraints. An Appendix I contains an implementation manual to assist transit agencies in designing, selecting, and implementing a cost-effective automatic data collection system. An Appendix II contains technical specifications for the modules and a common interface. Appendix II should provide assistance in procuring systems and components.

AREA 40: IMPACT ANALYSIS

PROJECT 40-1 FY '81

Simplified Guidelines for Evaluating Transit Options in Small Urban Areas

Research Agency: Barton-Aschman Associates, Inc.
Principal Invest.: Dr. David R. Miller
Effective Date: October 25, 1982
Completion Date: October 23, 1984
Funds: \$149,960

Small transit systems, as well as larger systems, are caught in a continuing struggle of determining the impacts of transit system investment decisions on users as well as on the community at large. The actual impacts of a transit

system are difficult to determine. In addition to the obvious potential impacts, such as changes in vehicle-miles of travel, fuel consumption, pollution, etc., there is also a group of not-so-obvious impacts that relate to the costs and benefits of a transit investment (e.g., vehicle accidents, peak-hour congestion, traffic volume changes, commercial parking space requirements, and changes in future capital costs for street construction). Nonquantifiable impacts must also be considered, such as changes in mobility for the economically disadvantaged and for those who cannot drive (i.e., handicapped, elderly, and young people).

To ensure that city managers and councils have information on which to make intelligent and consistent appraisals pertaining to such investments, many types of factors must be fully considered. Typical factors are (1) socioeconomic (e.g., percentage of elderly population, minority population, existence of large institutions), (2) political (e.g., attitude of the "affected parties," social-economic advocate groups), (3) current local concerns (e.g., ecology, air quality, traffic congestion), (4) business decisions, and (5) geographic (e.g., climate, topography, proximity to major urban areas).

The objective of this research was to develop procedural guidelines for use by transit and municipal agencies in guiding their analysis of proposed transit and paratransit alternatives and in presenting their proposals to the decision-making bodies. Use of these guidelines will result in the public's better understanding of proposed investments for a new transit system or improving an existing system. Also, increased use of sound cost-benefit techniques to safeguard against inadequate analyses should result from the availability and use of these guidelines.

Guidelines were developed using the best available techniques to describe how to handle both priceable and non-priceable factors. Equity and distribution questions of who pays and who benefits are considered. The guidelines were designed for application by nontechnical persons and are directed to the types of decisions faced in urban areas up to 200,000 population. Such considerations as total costs, avoided costs, transportation alternatives, ridership, urban development factors, conservation of energy and other resources, and typical transit evaluation criteria are included.

Priceable and nonpriceable factors are included in the guidelines to address the specific concerns of small urban areas (i.e., the factors that are important to the community, city council, etc.). These factors cover the anticipated impacts on the transit system itself, on transportation in general, and on the community at large (nonuser impacts). Relevant resource materials were assembled that have applicability to the evaluation of alternatives for public transit. Information requirements, availability, and sources used in existing analysis techniques were assessed in relation to the actual needs of small areas.

In addition, a presentation package was developed for

use in demonstrating the analysis procedures and the factors considered in evaluating transit improvements and alternatives. The package is suitable for presentations to city councils and transportation planning boards and is adaptable to local situations.

The final report has been published as NCTRP Report 8, "Simplified Guidelines for Evaluating Transit Service in Small Urban Areas," and the presentation package is available from the NCTRP (see final page of this document for ordering information).

Project 40-2 FY '82/'83

Estimating Incremental Costs of Bus-Route-Service Changes

Research Agency: System Design Concepts, Inc.
Principal Invest.: Harry S. Cohen
Effective Date: November 15, 1983
Completion Date: August 14, 1985
Funds: \$150,000

In the face of continuing financial pressures on and within the transit industry it is increasingly important to allocate resources in the most effective manner. Accordingly, a better understanding of the cost changes accompanying both service expansions and reductions is required.

To this end, various costing techniques have been developed and used by transit agencies to estimate the incremental or extra transit costs that stem from either service reductions or increases. Thus far there is some doubt about the reliability, accuracy, and applicability of these techniques, especially with respect to bus *route* (as opposed to system) changes. As a consequence, there is a need to assess and validate available or improved techniques to provide simple, but more reliable and accurate, methods for estimating the incremental (or additional variable) costs stemming from service changes on bus routes.

The objective of this research is to develop simple, reliable procedures that permit transit agencies to estimate the incremental cost implications of various bus-route-service changes in a variety of operating environments (e.g., those of differing density, system size, and the like). In a broad context, it should provide a means for helping to address the question: If a specific service should be changed, what is the incremental change in cost? More specifically, it should provide procedures that identify the incremental short-run costs to transit agencies of changes in bus-route-service frequencies (seasonal, day of week, time of day), expanding, curtailing or eliminating routes, or changing periods of operation. The research should also build upon and extend previous cost-analysis studies.

The research approach will involve, but not necessarily be limited to, the following:

A. Identify and evaluate existing cost models (including those listed in the following citation: Booz-Allen Inc.,

“Bus Route Costing Procedures: A Review,” UMTA Report No. IT-09-9014-81-1, May 1981. Available from the National Technical Information Service, Springfield, Va. 22161, NTIS No. PB-82-105198, cost \$13.00).

B. Review/update current industry practice (this should consist of polling properties to determine the models (or rules of thumb) that they currently use).

C. Develop simplified incremental cost estimation procedures. Criteria suggested are:

1. Simplicity (emphasis should be on a reasonable level of accuracy with a limited number of variables, and be easy to compute and apply).
2. Minimization of data collection requirements.
3. Wide range application in terms of system size, type, route, and type of changes.
4. Easy update of the cost variables to reflect expected changes in component costs.
5. Design that facilitates the orientation of key staff (scheduling, maintenance, and others) to incremental costing methods.
6. Design that lends itself to intuitive interpretation of results so that it is easy to explain to decision-makers and is viewed as reflecting reality by transit staff.
7. Design that is disaggregate in nature so that it can be used to evaluate individual routes or frequency changes.
8. Consideration of the effects of fixed and variable costs, different management operating policies, different contract work rules, different service contracting procedures, and cost changes that occur both before and after rescheduling.

D. Prepare an interim report that summarizes the findings for review by the NCTRP.

E. Develop and implement a testing method for validating the proposed procedures(s) and comparing the results with those for existing procedures. Consideration should be given to existing procedures, such as the two-variable cost model (bus-hours and miles), the Adelaide model, the Booz-Allen model developed from the UMTA bus-route-costing study, and the procedure currently being used by the participating study agency. It is anticipated that the procedure will be tested at three transit agencies—a large agency (over 200 buses), a medium-sized agency (100 to 200 buses), and a small rural Section 18 agency (less than 100 buses). As a minimum the testing will address the following types of bus-service changes:

1. Effect of service changes at various times of day, days of week, and season.
2. Effect of route extensions or contractions.
3. Effect of route consolidations, additions, and deletions.
4. Effect of service frequency changes.
5. Effect of hours of service changes.

It is desirable that the incremental cost be measured both before and after run and driver assignments. Testing refinement should be done iteratively as appropriate.

F. Identify planning—policy implications and develop typical applications.

1. Show how procedures can help (a) assess service alternatives, including deficit / revenue implications; and (b) make strategic service change decisions.
2. Give sample prototypical applications of procedures.

G. Prepare a draft report for review by the NCTRP.

H. Revise the draft report and submit the final version in fulfillment of the technical obligations under the contract for the project.

Through December 31, 1984, Tasks A through D and part of Task E have been completed. Important cost concepts and their relationship to costing problems faced by transit agencies have been defined. An overview of available models, including those developed as part of a recently completed UMTA-sponsored study, has been provided. The results of a survey of transit agencies, which was conducted for Task B, have also been provided. Among other things, the survey developed information on methods currently in use, problems with these methods, and suggestions for improvements. Simplified procedures have been developed as part of Task C. These include three procedures for estimating the effects of bus route service changes on driver costs and a fourth procedure for estimating nondriver incremental costs associated with service changes. A testing plan for the four procedures, plus the operating agency's procedure, has been designed and is in the process of being implemented. Testing will be conducted at volunteer agencies who will not be supported by UMTA funds as previously planned. Consequently, tests for all models contemplated may not be possible.

Project 40-3 FY '82/'83

Strategies to Implement Benefit-Sharing for Fixed Transit Facilities

Research Agency: SG Associates
Principal Invest.: Jane A. Howard
Effective Date: November 1, 1983
Completion Date: February 1, 1985
Funds: \$99,957

Fixed transit facilities, such as transit terminals, rapid transit stations, and LRT lines and stops, generate substantial passenger traffic and improved accessibility. Consequently, space in the vicinity of such facilities may become more valuable because of its potential for higher intensity use. Opportunities for sharing benefits occur in

the development of new transit facilities, the direct connection of developments to transit facilities, the use of air rights over transit rights-of-way, and the development of other real estate holdings. Furthermore, as a consequence of building fixed transit facilities, various other public facilities and utilities are rehabilitated. These opportunities for benefit-sharing by transit agencies are frequently lost, however, because they are not an important consideration in the planning and design phases (i.e., in the location and design of routes and stations).

There is little quantitative information available to transit agencies to assist them in formulating benefit-sharing approaches and arriving at reasonable charges or other contributions for these transit benefits. Therefore, in order to assist operators in planning and financing transit facilities, there is a need to provide (1) information about existing practices, (2) insights into the development process, (3) guidance in relating to private and public sector beneficiaries, and (4) strategies for negotiating benefit-sharing.

The general objective of this research is to assist transit agencies in implementing benefit-sharing. To accomplish this objective, a synthesis of existing information on development-related benefits followed by case studies is required. The report will be written primarily for use by transit planners, operators, and designers, and will reflect the concerns of policy-makers (government officials) and business organizations.

Research is completed and the report is in the review process. Preliminary results suggest that benefit-sharing strategies generally fall into these types:

1. Provision of facilities or amenities to enhance the transit facility with no direct financial benefit, but with other benefits in terms of aesthetics, environment, security, convenience, and sound long-range planning;
2. Cost recovery, in which parties share construction or operating costs based on a proration of costs incurred by each;
3. Value capture, in which the transit agency seeks a financial return based on the *value* of the transit benefit provided, as opposed to measures of cost.

Of these types, most benefit-sharing experience has occurred in the first two categories. Furthermore, it is concluded that a transition from a philosophy of using federal funds as a catalyst for urban revitalization to using private funds to decrease the federal share is likely to be difficult in most urban areas. Consequently, major increases in funding for transit in the third area is judged to be unlikely. The report will include recommendations to transit agencies to increase private/public participation in the sharing of benefits.

AREA 43: TRACK AND ANCILLARY SYSTEMS

Project 43-1 FY '81

Detection of Low-Level Fault Currents on Rail Transit Systems

Research Agency: Chas. T. Main, Inc.
Principal Invest.: Navan S. Sagar
Effective Date: January 3, 1983
Completion Date: September 30, 1984
Funds: \$99,953

Devices presently in use by the rail transit industry can adequately detect and respond to overload fault currents. Detection of less than overload fault currents is particularly difficult because the fault current characteristics tend to resemble characteristics normally associated with train or power switching operations. Rapid and reliable detection of low-current electrical faults on direct-current rail transit systems would provide a significant improvement to safety and operation of these systems.

The objective of this research was to identify and evaluate detection methods and equipment to enhance transit system safety through reliable detection of electrical faults that are not detected by circuit breaker overload protection.

Research has been completed with accomplishment of the objective. Survey forms were used to collect information on low-level fault current detection practices and electrical system characteristics from rail transit systems and electrical industry organizations worldwide. Several types of equipment appear to be performing well on transit systems outside the United States. However, each of these devices has particular characteristics and operational constraints. A field test program is recommended to evaluate the performance and economics of the most promising equipment identified by this study for low-level fault current detection. The test program should be conducted in cooperation with one or more rail transit systems.

The final report is in the editorial and publication process.

AREA 46: GENERAL DESIGN

Project 46-1 FY '82/'83

Single Cable Communications Technology for Rail-Transit Systems

Research Agency: Polytechnic Institute of New York
Principal Invest.: Dr. Frank A. Cassara
Effective Date: May 1, 1984
Completion Date: July 31, 1985
Funds: \$150,000

Rail-transit systems vary from those that have been in existence since the early 1900's to systems presently under design. These systems have typically used, or are planning

the use of, multiple cables for the transmission of voice, data, and video information. The various cables provide for long-haul trunk facilities and access to local distribution networks. Additionally, the necessity for VHF or UHF-FM radio transmission in underground portions of the system may require a separate radiating (or leaky) coaxial cable.

The large numbers of multipair and special-use cables used are expensive to install and maintain. A reduction in the number of cables needed for the communication requirements of transit systems can result in reduced acquisition, installation, and maintenance costs. The ultimate goal of this research is to replace all special-use cables with a single, multipurpose cable.

The objective of this research is to identify and develop recommended system parameters that will permit use of a single, multipurpose, wideband cable to support all rapid-transit communications requirements including, but not limited to: voice, data, video as well as VHF or UHF-FM two-way radio signals. For reliability, the single-cable concept should allow for a backup cable and cable span switching equipment. This research proposes a nonsite-specific solution that considers retrofits and extensions to existing rail-transit systems as well as the requirements of new systems. Proposed solutions to the reduction in the number of cables should include consideration of coaxial cables, fiber optics, and other viable technologies. Any proposed solution must also take into account compatibility with existing communications equipment and systems, improved reliability and maintainability, reduced life-cycle costs, and system expansion (extension and spare capacity).

To accomplish the objective of this research, the following tasks are required:

Task 1. Survey the current communication systems and installation practices of rail-transit agencies to define the scope of the problem. Concurrently, survey the electronic industry for developments that offer potential solutions. Review the work of railroad, mining, and other industries that may be relevant to the problem and its solution.

Task 2. Establish the operational parameters that will be required for a single-cable communication system(s). Generate a range of technical characteristics that will define the nature of the proposed cable system(s) and its (their) configurations.

Task 3. Using the operational parameters and cable characteristics developed in Task 2, prepare design criteria to establish the technical and economic feasibility of the single-cable concept. Submit a fully documented feasibility study showing all alternatives studied and the recommended solution(s) for review and approval by the NCTRP.

Task 4. Using design criteria established in Task 3, prepare a system description in sufficient detail so that

user agencies can prepare procurement specifications for specific applications. In addition, prepare a sample system design for a hypothetical 10-mile rail-transit system (5 miles underground and 5 miles on the surface) that includes basic equipment elements, local distribution networks, and its attendant costs.

Task 5. Prepare a draft report for review by the NCTRP.

Task 6. Revise the draft report and submit the final version in fulfillment of the technical obligations under the contract for the project.

Work under Tasks 1 through 3 is complete. The Task 3 feasibility study has been submitted and is now being reviewed by the NCTRP. Agency copies of the feasibility study should be available for loan in early 1985 (see final page of this document for ordering information).

AREA 47: GENERAL MATERIALS

Project 47-1 FY '80

Improved Service Life of Urban Transit Coach Brakes

Research Agency: Battelle Memorial Institute
Principal Invest.: Dr. Allen T. Hopper
Effective Date: December 1, 1981
Completion Date: December 31, 1984
Funds: \$300,000

The operation and maintenance history of advanced design urban transit coaches shows a dramatic decline in brake life compared with early "new look" coaches. Major factors associated with this decline in brake life appear to be, but are not limited to: increased gross vehicle weight, increased operating speed, body configuration, and changed regulations.

The resultant increased brake temperatures are believed to be the cause of reduced brake life that has increased operational costs to unacceptable levels. Therefore, the need exists to identify and develop methods to increase brake life to previous levels.

The overall project objective is to develop methodologies for improving existing and future urban transit coach brake life. This will include quantification of in-service brake operating temperatures plus identification of methods of reducing brake operating temperatures and/or alternate friction materials.

Research has been completed with accomplishment of project objectives in terms of confirming the premise that increases in brake lining temperature have resulted in reduced brake life and of identifying procedures for reducing brake lining temperature on existing buses. However, the retrofitting of existing buses with air blowers to reduce brake temperatures was found to be only marginally cost effective and the further development of brake lining materials having better temperature wear properties

should continue to be explored. The final report is in the editorial and publication process.

AREA 48: SPECIFICATIONS, PROCEDURES, AND PRACTICES

Project 48-1 FY '84

Electrolytic Corrosion in DC Powered Transit Systems

Research Agency: Battelle Memorial Institute
Principal Invest.:
Effective Date: In Developmental Stage
Completion Date:
Funds: \$200,000

Structural damage to transit system properties due to electrolytic corrosion caused by stray DC currents is a recurring problem. Detection of the damaging stray currents is not, at present, within the expertise of most of the rail transit operators. No fixed procedures are available for detection and/or correction. The transit industry is in need of procedures to reduce damage to its equipment caused by these stray DC currents. To meet this need, the proposed objectives are to (1) identify probable causes of stray currents and relate the causes to (a) power system configuration, (b) track and structure construction, and (c) negative return and grounding; (2) establish methods of detecting stray currents and estimating the probable damages which could result; (3) establish practical methods of correcting power systems to reduce stray current magnitudes, (4) field test both the detection and correction methods at a transit property; and (5) prepare a methods manual for use by transit personnel.

AREA 54: ENERGY EFFICIENCY

Project 54-1 FY '80

Improve Transit Bus Energy Efficiency and Productivity

Research Agency: Booz, Allen & Hamilton, Inc.
Principal Invest.: Archie M. Riviera
Effective Date: October 1, 1981
Completion Date: June 30, 1982
Funds: \$39,976

Because of rapidly rising fuel prices and uncertain fuel availability, there is a critical need in the transit industry to improve energy efficiency. However, as a result of governmental regulation and other factors, the recent trend in bus technology has actually been toward poorer efficiency. For example, the Advanced Design Buses introduced in recent years require more energy than the buses replaced and, compounding the problem, also have

fewer seats. Energy efficiency losses are due to many causes including requirements to satisfy environmental considerations, safety, styling, accessibility, and the like.

The objective of this research was to develop guidelines for transit property managers to follow in specifying a new bus. The researchers cataloged the basic types of equipment and options available in 35-ft, 40-ft, and articulated transit buses. Equipment and options include power train features; special equipment; standard component options; basic design and safety features; and environmental controls. Estimates of the relative energy consumption levels of the various items of equipment and options were developed. For each bus type and size, a baseline equipment configuration was specified and the energy-consumption characteristics of each option were related to the baseline. An approach was developed for estimating energy-efficiency characteristics of buses over the full range of operating environments (e.g., terrain, altitude, climate, maximum operating speed, number of stops per mile).

Research has been completed, and the final report has been published as:

NCTRP Report 1, "Transit Bus Energy Efficiency and Productivity—Bus Equipment Selection Handbook." This report includes a concise set of guidelines for use by managers of individual transit properties in selecting and specifying buses for purchase. The guidelines focus on the energy efficiency and productivity of different bus types, equipment, and options and are applicable to properties of all sizes and geographic locations. Sample data for vehicle characteristics are provided for illustrative purposes, but current vehicle data should be obtained from the manufacturers when using the guidelines.

Project 54-2 FY '80

Energy Management of Electric Rail Transit Systems

Research Agency: Carnegie-Mellon University
Principal Invest.: Dr. Richard A. Uher
Effective Date: October 1, 1981
Completion Date: December 31, 1983
Funds: \$150,000

Rapidly increasing electric energy costs have resulted in a dramatic increase in operating expenses of transit authorities operating electric rail systems. This problem is further augmented by additional increases in rates being sought by electric utilities. The peak demand component of these rates is directly associated with the electric energy generation, transmission, and distribution facilities cost. As major electric energy consumers, transit authorities are subject to allocated costs associated with these facilities. If transit authorities can improve the management of peak demand on their systems, energy costs can be significantly reduced. Several transit authorities have developed strategies for: reducing peak energy consumption

(such as load management), improving vehicle energy efficiency, and more energy efficient operating practices.

The objective of this research was to provide guidelines for transit authorities to lower peak electric demand and, thereby, lower costs.

The preliminary draft final report has been submitted and reviewed, and comments have been forwarded to the principal investigator. Data were collected from four transit agencies and analyzed to determine probable peak power demand cause factors. Monitoring strategies were identified for controlling peak demand and the costs of the various strategies were determined. Load management techniques were evaluated using simulation models. The contract was amended to provide for the preparation of a slide presentation on the project findings and to make the presentation to officials of individual rail transit agencies. Comments received during the presentations were considered in revising the final report.

Research has been completed and the report has been published as:

NCTRP Report 3, "Reduction of Peak-Power Demand for Electric Rail Transit Systems."

AREA 55: PERFORMANCE EFFECTIVENESS AND EFFICIENCY

Project 55-1 FY '82/'83

Conversion to One-Person Operation of Heavy-Rail Rapid-Transit Trains

Research Agency: Battelle Memorial Institute
Principal Invest.: Joseph A. Hoess
Effective Date: March 5, 1984
Completion Date: July 8, 1985
Funds: \$150,000

There is increasing pressure to provide more cost-effective operation of heavy-rail rapid-transit trains. A major candidate for improving productivity is reduction of crew size to one person. This has been accomplished in the following systems:

- Lindenwold/Philadelphia—Port Authority Transit Corporation
- San Francisco—Bay Area Rapid Transit District
- Washington, DC—Washington Metropolitan Area Transit Authority
- Atlanta—Metropolitan Atlanta Rapid Transit Authority

The reduction will soon be implemented in Miami and Baltimore.

The older rapid transit systems, however, continue to require a second crew member aboard each train. These systems include the following:

- Boston—Massachusetts Bay Transportation Authority

- New York—New York City Transit Authority
- New York/New Jersey—Port Authority Trans-Hudson Corporation
- Philadelphia—Southeastern Pennsylvania Transportation Authority
- Cleveland—Greater Cleveland Regional Transit Authority
- Chicago—Chicago Transit Authority

To provide one-person operation on the older rapid transit systems, it will be necessary to address problems at least in the areas of:

1. Operational safety.
2. Operational practices.
3. Manpower/labor relations.
4. Regulatory matters.
5. Plant and equipment.

The objectives of this research are (1) to evaluate the issues that must be addressed in contemplating conversion of two-person systems to one-person operation including the identification of those issues unique to the particular system and (2) to develop a framework for an economic assessment of the effects of implementation of one-person operation. The research should include, but not be limited to, the following tasks:

Task 1. Perform a survey of each two-person heavy-rail rapid-transit system in the United States to determine the specific issues or problems that need to be addressed if such system were to be converted to one-person train operation. This survey shall be based on consultation with organizations including system management, employee representatives, regulatory agencies or advisory boards, and other appropriate organizations.

Task 2. Perform a survey of one-person conversions implemented by heavy-rail rapid-transit systems in Europe and identify the issues and problems addressed; the methods of solving them; and the effectiveness of such solutions as measured by such indicators as operational efficiency and reliability, safety statistics, and changes in the workforce. These systems shall include, but not be limited to, London, Paris, Hamburg, and Berlin.

Task 3. Evaluate the issues and problems identified in Tasks 1 and 2 as they would affect the conversion to one-person operation from the technological, operational, institutional, and human resource perspectives. The evaluation shall include the need for, and degree of, recommended application of closed-circuit TV, automatic train operation, radio communications, and other elements.

Task 4. Prepare a framework for an economic assessment of the effects of implementation of one-person operation. This framework shall include identification of cost elements that must be considered in a site-specific analysis and plan such as:

- a. Changes to car equipment.

- b. Changes to wayside and station equipment.
- c. Changes in workforce, such as reduction in train crews and additions to wayside equipment maintenance staff.
- d. Operating practice revisions.
- e. Changes in wage rates resulting from implementation of one-person operation.

Progress to December 31, 1984 includes completion of all site visits to systems, in the U.S. and abroad, having one- and two-man crews. In all but one instance, interviews have been conducted with both management and union representatives. These case studies will form the basis of a report that is anticipated to put forward the pros and cons of one-man/two-man operations without making generalized recommendations.

AREA 60: SPECIAL PROJECTS

Project 60-1 FY '80

Synthesis of Information Related to Transit Problems

Research Agency: Transportation Research Board
Principal Invest.: Thomas L. Copas
Effective Date: November 7, 1980
Completion Date: Continuing
Funds: \$660,000

Transit administrators, engineers, and researchers are continually faced with problems on which much information exists either in documented form or in terms of undocumented experience and practice. Unfortunately this information is often fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem is frequently not brought to bear on its solution. Costly research findings may be unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

In this project, particular transit problems, or sets of

closely related problems, will be selected by the NCTRP Technical Steering Group as topics for information synthesis.

For each topic the objectives are:

1. To locate and assemble documented information.
2. To learn what engineering practice has been used for solving or alleviating the problem.
3. To identify all ongoing research.
4. To learn what problems remain largely unsolved.
5. To organize, evaluate, synthesize, and document the useful information that is acquired.

Through December 1984, research has been completed on the first four assigned topics. The reports have been published as:

NCTRP Synthesis of Transit Practice 1, "Cleaning Transit Buses: Equipment and Procedures";

NCTRP Synthesis of Transit Practice 2, "Enforcement of Priority Treatment for Buses on Urban Streets";

NCTRP Synthesis of Transit Practice 3, "Diesel Fuel Quality and Additives"; and

NCTRP Synthesis of Transit Practice 4, "Allocation of Time for Transit Bus Maintenance Functions."

Research is in progress on the following five topics selected for study under the FY '82/'83 program: TS-5, "Extraboard Management: Procedures and Tools"; TS-6, "Traffic Control and Regulation at Transit Stops"; TS-7, "Bus Communication Systems"; TS-8, "Passenger Information Systems for Transit Transfer Facilities"; and TS-9, "Transit Fare Collection: Problems with and Alternatives to Paper Currency." Reports on these five topics are expected to be published during 1985.

Research is in progress on the following four topics selected for study under the FY '84 program: TS-10, "Rucus and Part-Time Assignments"; TS-11, "Marketing Techniques That Work"; TS-12, "Use of Incentives to Attain Specified Performance Standards in Collective Bargaining for Mass Transit"; and TS-13, "Bus Inspection Guidelines."

HOW TO ORDER

Items for Sale

1. NCTRP Series Reports, Syntheses, and Research Results Digests (see Tables 7 and 8 for prices).
2. Research agencies' final reports (see project summaries for prices).
3. Microfiche (\$5.00 per report).
4. Other TRB publications.

A check or money order, payable to *Transportation Research Board*, must accompany orders totalling \$20.00 or less. Mail to:

Publications Office
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Items for Loan

1. Some research agencies' final reports, manuals, videotapes, etc., are identified in the project progress reports and are available on a loan basis upon written request to the NCTRP, 2101 Constitution Avenue, N.W., Washington, DC 20418.
2. Loan requests for films and tapes should be directed to:

TRB Audio-Visual Library
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Mailing and handling charges may be assessed, especially where 1st-class delivery is requested; an invoice will accompany the loaned item.

THE TRANSPORTATION RESEARCH BOARD is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 200 committees, task forces, and panels composed of more than 3,300 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, the National Highway Traffic Safety Administration, and other organizations and individuals interested in the development of transportation.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine.

The National Academy of Sciences was established in 1863 by Act of Congress as a private, nonprofit, self-governing membership corporation for the furtherance of science and technology, required to advise the federal government upon request within its fields of competence. Under its corporate charter the Academy established the National Research Council in 1916, the National Academy of Engineering in 1964, and the Institute of Medicine in 1970.

TRANSPORTATION RESEARCH BOARD

National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

ADDRESS CORRECTION REQUESTED

NON-PROFIT ORG.
U.S. POSTAGE
PAID
WASHINGTON, D.C.
PERMIT NO. 8970

000701C
JOEL WOODHULL

S.C.R.T.D. LIBRARY