

DOT-TSC-RSPA-79-5

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BOOK

# TRANSPORTATION SYSTEMS CENTER BIBLIOGRAPHY OF TECHNICAL REPORTS JANUARY - DECEMBER 1978

MARCH 1979



U. S. DEPARTMENT OF TRANSPORTATION  
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Transportation Systems Center  
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## PREFACE

This bibliography lists unlimited distribution reports released by the Transportation Systems Center from January through December 1978. It updates Transportation Systems Center Bibliography of Technical Reports, July 1970 - December 1976 (DOT-TSC-OST-77-17) and January - December 1977 (DOT-TSC-OST-78-14).

The following indexes are included: subject, personal author, corporate author, and report number. The indexes were compiled by Janice Bilsback of the Technical Reference Center of the Transportation Systems Center.

## ARRANGEMENT OF THE BIBLIOGRAPHY

Reports are listed by sponsoring agency and arranged by DOT-TSC report number within each agency. A Department of Transportation Report Number/Transportation Systems Center Report Number Index is provided for cross reference.

For each entry, the following information is given:

DOT-TSC report number.

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Abstract (written by author of report).

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UNITED STATES COAST GUARD

**DOT-TSC-USCG-77-3**  
**THE CUTTER RESOURCE EFFECTIVENESS**  
**EVALUATION (CREE) PROGRAM – A GUIDE FOR**  
**USERS AND ANALYSTS**

Transportation Systems Center

David S. Prerau

CG-D-48-78

Final Report March 1978 174p.

Operations research – Data processing  
United States – Government vessels – Mathematical models

The Cutter Resource Effectiveness Evaluation (CREE) project has developed a sophisticated, user-oriented computer model which can evaluate the effectiveness of any existing Coast Guard craft, or the effectiveness of any of a number of proposed alternative craft (such as a hydrofoil or an air cushion vehicle), in the performance of a selected set of Coast Guard missions, in a given location under specified environmental conditions. The first part of this report describes the CREE Model computer program from the user's viewpoint, and includes complete details on the use of the program. The second part of the report discusses for analysts the structure of the CREE program and some of the difficult theoretical concepts behind it.

**DOT-TSC-USCG-77-4**  
**SINGLE-CYLINDER DIESEL ENGINE TESTS WITH**  
**UNSTABILIZED WATER-IN-FUEL EMULSIONS**

Southwest Research Institute. Dept of Engine and Vehicle Research.

J. O. Storment and C. W. Coon

CG-D-13-78

DOT-TSC-920

Final Report August 1978 91p.

Diesel fuel  
Diesel motor – Technological innovation  
Diesel motor exhaust gas  
Diesel motor – Fuel consumption

A single-cylinder, four-stroke cycle diesel engine was operated on unstabilized water-in-fuel emulsions. Two

prototype devices were used to produce the emulsions on-line with the engine. More than 350 test points were run with baseline diesel fuel and emulsified water-in-fuel. Water content of the emulsified fuel varied from about 2% to 23% by volume. Statistically significant decreases in fuel consumption, ranging from 1.2% to 5.1% were obtained with emulsified fuels in 20 out of 36 test conditions. An increase of 2.5% was measured at one condition only. Use of the emulsified fuels decreased oxides of nitrogen by up to about 60% and Bosch smoke numbers by up to almost 70%, whereas unburned hydrocarbons increased up to over 130%. Carbon monoxide changes with emulsified fuel varied from a decrease of 52% to an increase of over 170%, depending on engine speed and power, and water content of the fuel. No problems were encountered in engine operation at any test condition with the water-in-fuel emulsions.

**DOT-TSC-USCG-78-1**  
**THE EMISSIONS AND FUEL ECONOMY OF A**  
**DETROIT DIESEL 6-71 ENGINE BURNING A 10-**  
**PERCENT WATER-IN-FUEL EMULSION**

Transportation Systems Center

R. A. Walter

AD-A058-550

CG-D-10-78

Final Report July 1978 82p.

Diesel fuel  
Diesel motor exhaust gas  
Diesel motor – Fuel consumption  
Diesel motor – Technological innovations

Stabilized water-in-fuel emulsions were run in a marine-configured Detroit Diesel 6-71 engine on a dynamometer test stand. Measurements were made of engine performance, fuel consumption, and emissions. The engine was operated at variable speed, variable load conditions to simulate generator loading. In addition, the injection timing was varied from normal to 7.2° of retard and 7.2° of advance in 3.6° intervals. At all test points the engine was run with both normal fuel and emulsion. The emulsion used was 10% water in fuel with 2.5% stabilizer which produced an average droplet size

## UNITED STATES COAST GUARD

of watchstander activities for a total of fifteen hours of observation, timed measurements of typical watchstander activities and computer delays, records of twelve in-depth interviews with center personnel, stress questionnaires administered to nine watchstanders, and photographs of equipment and workspace layout. Analysis of the data yielded tentative models of time utilization and the relationship of activity to traffic load and sixteen suggestions for improving operations.

### **DOT-TSC-USCG-78-7 VHF-FM EMERGENCY POSITION INDICATING RADIO BEACON**

Transportation Systems Center  
Peter D. Engels, Editor  
AD-A061 678  
CG-D-29-78  
Final Report      October 1978      94p.

Distress signals  
Radio beacons  
Radio in navigation

This report describes the development and testing of an Emergency Position Indicating Radio Beacon (EPIRB) which operates on Channels 15 and 16 of the Maritime Mobile VHF Band. It provides functions necessary to ensure that distress alerting and locating can be quickly and reliably provided for small craft in distress, in coastal maritime regions. When energized by a person in distress, the EPIRB will emit a radio signal which alternates between Channels 15 and 16 using international distress tones for modulation. Between transmissions, the EPIRB will turn off so as to conserve battery power.

The EPIRB has been tested under actual distress conditions. It has been demonstrated to provide a reliable distress alert to Coast Guard stations within a range of 20 nautical miles.

### **DOT-TSC-USCG-78-8 AN EVALUATION OF SHORE-BASED RADIO DIRECTION FINDING**

Transportation Systems Center  
Charles J. Murphy, Peter D. Engels  
Elie J. Baghdady (Info Systems, Inc.)  
AD-AO60 474  
CG-D-28-78  
TS 13651  
Final Report      September 1978      90p.

Radio direction finders  
Aids to navigation  
Search and rescue operations

This report describes an evaluation of Radio Direction Finding (RDF) techniques for shore-based position location performed by the Transportation Systems Center (TSC). The evaluation consisted of the following three phases:

- (1) A preliminary survey to identify and classify available direction-finding techniques which could meet Coast Guard requirements;
- (2) An analytical modeling and error analysis of the equipment types identified in (1);
- (3) Field testing and demonstration of representative equipment.

Major system characteristics considered in the study were:

1. Operational utility of such a system.
2. Cost to implement the system throughout the USCG.
3. Operational impact on the group level – manning and maintenance.
4. Compatibility with existing land lines and VHF-FM remoting capability.
5. Operation in a VHF-FM maritime mobile band.
6. Location of the DF antenna.
7. Ability to home on both voice and EPIRB.
8. Interference effects.

It was concluded that shore-based DF is a valuable potential tool in the accomplishment of SAR mission requirements. Properly implemented shore-based DF can improve reliability and safety of the SAR function

## UNITED STATES COAST GUARD

casualties are addressed in the study: groundings, collisions, and rammings. Vessels included in the study are tank vessels (tankers and tankbarges) over 1,000 gross tons.

The analysis of the causes of tank vessel casualties is performed mainly with the Coast Guard Merchant Vessel Casualty Report (MVCR) data base covering the period from July 1971 to October 1977. Other data sources surveyed include: the Lloyds Weekly Casualty Reports, the Tanker Casualty Library of Marine Management Systems, Inc., and the Coast Guard Pollution Incident Reporting System. The nature and characteristics of tank vessel casualties that occur in the U.S. offshore waters are described. Systems and techniques considered as alternatives for preventing these casualties are identified, evaluated against each casualty and given an overall rating of casualty prevention effectiveness based on criteria which are defined. The promising systems are selected and conceptual descriptions are presented including the operational features, technical description, cost, staffing and training required, and legal implementation considerations.

The report is organized in three volumes: Volume I – Executive Summary, Volume II – Technical Analyses, and Volume III – Appendixes.

### **DOT-TSC-CG-78-11.II OFFSHORE VESSEL TRAFFIC MANAGEMENT (OVTM) STUDY**

#### **Volume II: Technical Analyses**

Transportation Systems Center  
R. Bland, R. Kalafus, R. Wisleder, et al.  
AD-A060 476  
CG-D-55-78  
Final Report August 1978 278p.

Petroleum – Transportation – Safety measures  
Tankers – Accidents  
Tankers – Safety measures

### **DOT-TSC-CG-78-11.III OFFSHORE VESSEL TRAFFIC MANAGEMENT (OVTM) STUDY**

#### **Volume III: Appendixes**

Transportation Systems Center  
R. Bland, R. Kalafus, R. Wisleder, et al.  
AD-A060 503  
CG-D-55-78  
Final Report August 1978 278p.

Petroleum – Transportation – Safety measures  
Tankers – Accidents  
Tankers – Safety measures

### **DOT-TSC-USCG-78-12 PROCEEDINGS OF SYMPOSIUM ON WATER-IN- FUEL EMULSIONS IN COMBUSTION**

Transportation Systems Center  
Robert Walter and James White, Editors  
AD-A061 503  
CG-D-12-78  
Final Report August 1978 230p.

Diesel fuel – Congresses  
Diesel motor – Fuel consumption – Congresses  
Boilers – Fuel consumption – Congresses  
Gas-turbines – Fuel consumption – Congresses  
Fuel – Research – Congresses

This volume contains the proceedings of a symposium on water-in-fuel emulsions held at the DOT Transportation Systems Center April 20 and 21, 1977. This symposium, sponsored by the DOT's U.S. Coast Guard and Office of the Secretary, provided a forum for researchers involved in the use of water-in-fuel emulsions in combustion. Participants from academia, industry and government contributed papers and discussed the properties, production and utilization of water-in-fuel emulsions in boilers, diesels, and gas turbines. These proceedings contain the abstracts of 18 papers as well as the discussions on these papers and recommendations for needed research in emulsified fuel technology. Also included are a list of attendees and a bibliography on the subject of emulsified fuels.



## FEDERAL AVIATION ADMINISTRATION

### **DOT-TSC-FAA-75-28**

#### **DOPPLER ACOUSTIC VORTEX SENSING SYSTEM**

Avco Corporation, Systems Division.

Richard P. McConville

FAA-RD-76-41

DOT-TSC-710

Final Report      October 1978      210p.

Vortex-motion

Wakes (Aerodynamics)

This is the final report on the Doppler Acoustic Vortex Sensing System (DAVSS) program carried out by Avco Corporation's Systems Division for the U.S. Department of Transportation, Transportation Systems Center.

This program was carried out under Contract DOT-TSC-710, dated 12 November 1973. The objective of the program was the design of an engineered DAVSS capable of real-time detection, tracking, recording, and graphic display of aircraft trailing vortices. Problems related to such vortices are currently under intensive study by the U.S. Department of Transportation for the Federal Aviation Administration.

This report presents hardware and software design aspects of the system. The design of the acoustic antennas and transducers is described. System control, computer hardware and software, and system/subsystem interfaces are discussed.

### **DOT-TSC-FAA-77-5**

#### **WIND SHEAR REQUIREMENTS AND THEIR APPLICATION TO LASER SYSTEMS**

Transportation Systems Center

Rudolph M. Kalafus

AD-A054 174

FAA-RD-77-123

Final Report      February 1978      140p.

Vertical wind shear

Winds

Lasers in aeronautics.

The requirements for a ground-based wind shear sensing system are developed. System coverage, accuracy, resolution, and data update rate are treated in detail. The

differing requirements for synoptic shear conditions and thunderstorm-associated shears are discussed. Several candidate sensing systems are considered. The hybrid CW/pulsed laser is discussed in detail because of its potential for providing advance warning for all shear conditions. Propagational characteristics of laser beams are treated and equipment design implications are developed. A system concept is outlined which provides the framework for a future operational system.

### **DOT-TSC-FAA-77-12**

#### **PROCEEDINGS OF THE AIRCRAFT WAKE VORTICES CONFERENCE**

Transportation Systems Center

J. N. Hallock, Editor

FAA-RD-77-68

Conference Proceedings      June 1977      352p.

Vortex-motion — Congresses

Wakes (Aerodynamics) — Congresses

This volume contains the proceedings of a conference on aircraft wake vortices held at the DOT Transportation Systems Center on March 15-17, 1977. The contributed papers discuss technological advances in the knowledge of the phenomenon, its effects on aircraft, alleviation techniques, and vortex avoidance systems designed to permit decreases in delays at major airports.

### **DOT-TSC-FAA-77-17**

#### **VERY-HIGH-FREQUENCY AEROSAT AIRBORNE TERMINAL**

Bendix Avionics Division

E. O. Kirner, D. Kuntman, and J. Wilson

AD-A053-206

FAA-RD-77-156

DOT-TSC-1121

Final Report      December 1977      102p.

AEROSAT satellites

Satellites in navigation

Satellites in telecommunication

This report summarizes the results of a study aimed at defining the airborne VHF terminal for the experimental

## FEDERAL AVIATION ADMINISTRATION

Air traffic control  
Electronics in aeronautics  
Radar air traffic control systems  
Wakes (Aerodynamics)  
Vertical wind shear  
Microwave landing systems

This report is devoted to the present and near future states of the tower cab environment, addresses those MSDP systems which may have an impact on the current tower cab environment, systems and/or operations. The systems included are: Discrete Address Beacon System (DABS), Airport Surface Detection Equipment III (ASDE III), Tower Airport Ground Surveillance (TAGS), Terminal Information Processing System (TIPS), ARTS II and ARTS III enhancements, Flight Service Station Automation (FSSA), Vortex Advisory System (VAS), Wake Vortex Avoidance System (WVAS), Wind Shear Detection system (WSD) and Microwave Landing System (MLS). Each system is described in terms of its functional objectives, planned equipment, interfaces with other systems and with controllers, failure modes, and current development/deployment status.

This report is a continuation of report No. FAA-EM-77-10/(DOT-TSC-FAA-77-19) entitled: "Characterization of Current Tower Cab Environments," dated November 1977 (240 pages).

### **DOT-TSC-FAA-78-3 BEACON COLLISION AVOIDANCE SYSTEM (BCAS) AIRBORNE ANTENNA DIVERSITY STUDY**

Transportation Systems Center  
John H. Kraemer  
FAA-RD-78-2  
Final Report    April 1978    156p.

Radar air traffic control systems  
Radar beacons  
Radar in aeronautics

The potential need for antenna diversity on the intruding aircraft was examined. The BCAS system was used

for determining airborne antenna diversity requirements for general aviation aircraft approaching a BCAS equipped aircraft from various angles. The BCAS system was operated in the forced active pulse passive mode. Air Traffic Control Radar Beacon System (ATCRBS) replies to the BCAS interrogator (forced active mode) and to a secondary surveillance radar, SSR (passive mode), were recorded and used as a measure of the adequacy of the air-to-air and ground-to-air radio links for some selected critical situations. The intruding general aviation aircraft was equipped with top- and bottom-mounted ATCRBS antennas (with independent transponders) during one series of encounters. The second series of encounters was flown with an aircraft equipped with a single bottom-mounted transponder antenna.

### **DOT-TSC-FAA-78-4 PERFORMANCE RESULTS OF SOME CANDIDATE FRENCH MODEMS FOR THE AERONAUTICAL SATELLITE COMMUNICATION CHANNEL**

Transportation Systems Center  
C. B. Duncombe  
FAA-RD-78-38  
Interim Report    May 1978    76p.

Satellites in telecommunication  
Electronics in aeronautics  
AEROSAT satellites  
Air traffic control

Five candidate data, voice, and ranging modems were evaluated by the AEROSAT channel simulation facility to determine applicability for use in the aeronautical satellite communication channel for air traffic control. The modems were supplied by Telecommunications Radioelectriques et Telephoniques of Paris, France. The modems' performance were evaluated as a function of carrier to noise ratio, carrier to multipath ratio, doppler frequency, and relative doppler frequency. The results are presented herein.

## FEDERAL AVIATION ADMINISTRATION

### **DOT-TSC-FAA-78-8 LASER DOPPLER RADAR SYSTEM CALIBRATION AND RAINFALL ATTENUATION MEASUREMENTS**

Raytheon Company, Equipment Division.  
FAA-RD-78-40  
DOT-TSC-1218  
Final Report      October 1978      40p.

Doppler radar — Testing  
Optical radar — Testing  
Backscattering  
Attenuation

The atmospheric attenuation and backscatter coefficients have been measured at the 10.6- $\mu$ m wavelength of the CO<sub>2</sub> laser in rainstorms. Data are presented to show the increase in attenuation coefficient with rainfall rate. Backscatter coefficients in rain and clear air are also presented. Data were collected on a 460-meter test range at Sudbury, Massachusetts. The experimental results can be used to evaluate the performance capabilities of CO<sub>2</sub> coherent laser systems for making atmospheric velocity measurements.

### **DOT-TSC-FAA-78-9 EXPERIMENTAL BCAS PERFORMANCE RESULTS**

Transportation Systems Center  
Janis Vilcans, Edward Quish, Juris G. Raudseps, Herbert Glynn, Benjamin S. Goldstein, Frederick Woodfall, Robert Wisleder  
FAA-RD-78-53  
Interim Report      July 1978      420p.

Aeronautics — Safety measures  
Radar beacons  
Electronics in navigation

The results of the (Litchford) Beacon-based Collision Avoidance System concept feasibility evaluation are reported. Included are a description of the concept, analysis and flight test results. The system concept is based on the range and bearing measurements for detecting and resolving a threat. The experimental hardware, developed under Contract No. DOT-TSC-1103,

Task 1-8, did not implement the automatic radar selection and lock-on mode and the capability to compute target range and bearing in real time which the concept requires. These enhancements are currently being implemented. All three generic modes of the BCAS were evaluated. These are: the passive (listen-in), the active (interrogate by on-board transmitter), and the combined (active-passive). Also, reported are results of the comprehensive in-house study effort conducted on the azimuth signal requirements and on single-site feasibility. It is concluded that the BCAS is a technically feasible concept and that the passive mode with an azimuth reference signal would be more accurate and less troublesome than other BCAS alternatives. For each operating mode there are geometries in which system performance fails or is degraded to some degree. System reliability may therefore require the implementation of various operating modes.

### **DOT-TSC-FAA-78-11 AIRPORT GROUND ACCESS STUDY**

Transportation Systems Center  
Mark Gorstein, Richard Marek  
FAA-EM-78-12  
Interim Report      March 1978      56p.

Access to airports  
Airports — Access roads

In response to a request by Congress, the FAA and TSC have undertaken a study to determine the extent to which inadequate (off-airport) ground access to airports constrains airport capacity and air travel. Presently, TSC is preparing case studies of 17 commercial airports of various sizes and locales. This report describes the initial phases of a study on airport access which includes:

- A methodology for evaluating airport ground access capacity. Data availability and requirements for the application of capacity analysis to any airport access system have been established,
- A look at the airport access problem as perceived by the operators of large, medium, and small hub airports, as well as a non-hub airport. Information on access conditions was collected and categorized,

## FEDERAL AVIATION ADMINISTRATION

behavior, the analysis indicates that such reduced inter-arrival separations may be used safely by Large and Heavy aircraft following Heavies. When the analysis is expanded to include an as-yet unproven cross-winds aloft model, the results indicate that the reduced separations may be used by all aircraft regardless of leader/follower aircraft type. Volume I addresses the safety problem from an analytic point of view; Volume II (to be published at a later date) will examine the Problem using data collected specifically to verify the analytical model; and Volume III (to be published at a later date) will contain a detailed sensitivity analysis of the model predictions and a critique of the assumptions.

### **DOT-TSC-FAA-78-16 FUNCTIONAL UTILIZATION OF DABS DATA LINK DISCRETE ADDRESS BEACON SYSTEM**

Transportation Systems Center  
J. Canniff, J. Golab  
FAA-RD-78-159  
Final Report      October 1978      34p.

Air traffic control  
Radar beacons  
Navigation (Aeronautics)

The report describes the output of a Task Force established by FAA Headquarters, SRDS, Robert Wedan, in June 1977 to study and recommend potential applications for Data Link to the DABS Experimentation Program.

### **DOT-TSC-FAA-78-19 BEACON COLLISION AVOIDANCE SYSTEM (BCAS) ALTERNATIVE CONCEPTS FOR DETERMINING TARGET POSITIONS**

Transportation Systems Center  
J. G. Raudseps, M. D. Menn, and J. Vilcans  
FAA-RD-78-34  
Interim Report      September 1978      208p.

Aeronautics — Safety measures  
Radar beacons  
Electronics in aeronautics

The (Litchford) Beacon-based Collision Avoidance System concept requires the computation of target range and bearing relative to the BCAS aircraft. Techniques for determining target range and bearing under four different assumptions about the ground radar environment are reported. The systems considered are a fully passive BCAS system when there are two ground radars equipped with azimuth reference signals and a single target, two ground radars of which only one has azimuth reference signals and two targets, and two ground radars without ground reference signals and two targets, as well as a BCAS system using both active range measurements and signals from a single ground radar. The report includes the derivations of computational algorithms applicable to the different cases and the results of simulations. It is found that the error sensitivity of the solutions is a function of the geometry of the configuration. Multiple solutions are possible with systems involving only one target. A family of curves is derived and illustrated by examples to permit qualitative evaluation of the solution in any given configuration.

### **DOT-TSC-FAA-78-20 THE AIRPORT NETWORK FLOW SIMULATOR**

Transportation Systems Center  
Juan Bellantoni  
FAA-ASP-78-9  
Final Report      October 1978      134p.

Airports — Mathematical models  
Aeronautics — Mathematical models  
Aeronautics — Planning — Data processing

The Airport Network Flow Simulator is a FORTRAN IV simulation of the flow of air traffic in the nation's 600 commercial airports. It calculates for any group of selected airports (a) the landing and take-off (Type A) delays, and (b) the gate departure lateness (Type B delays) at the selected airports and at all other airports to which these delays propagate by means of scheduled commercial flights. The airports are selected by the user who must input hourly aircraft processing rates for each airport selected. The cost in lost passenger time and aircraft operating expense is also calculated.

FEDERAL HIGHWAY ADMINISTRATION

**DOT-TSC-FHWA-77-1  
RAILROAD GRADE CROSSING PASSIVE  
SIGNING STUDY**

Transportation Systems Center  
Joseph S. Kozioł, Jr., Peter H. Mengert  
FHWA-RD-78-34  
Final Report February 1978 70p.

Railroads — Crossings — Safety measures  
Traffic signs and signals

This report describes the results of a study to determine the effectiveness of new passive signing configurations in warning drivers of the potential hazards at railroad grade crossings. Experiments were conducted in two phases over a two-year period. The first phase was begun in March 1975 and evaluated seven sign configurations at five test sites in Ohio and one test site in Maine. The purpose of Phase I was to determine at a few crossings whether any of the new signs showed promise of being more effective than the existing sign configuration and to evaluate a variety of experimental variables. The results of Phase I were previously reported and indicated improved effectiveness for the new signs tested. The purpose of Phase II was to test and verify on a national level (18 sites in 14 states) the most effective signs as determined from Phase I and to concentrate on and refine, if necessary, the most important variables. In each phase, before-and-after data were collected at each site so that relative improvements provided by the new signs could be determined.

The results of Phase II confirmed the findings of Phase I in that drivers showed more awareness (that is, an increased percentage of head-movements or looking for trains) with the new signs at the crossing tested.

**DOT-TSC-FHWA-77-2  
HIGHWAY NOISE MEASUREMENTS FOR  
VERIFICATION OF PREDICTION MODELS**

See DOT-TSC-FHWA-78-1 for complete documentation.

**DOT-TSC-FHWA-78-1  
HIGHWAY NOISE MEASUREMENTS FOR  
VERIFICATION OF PREDICTION MODELS**

Transportation Systems Center  
Edward J. Rickley, David W. Ford, Robert W. Quinn  
PB-279 018  
DOT-TSC-OST-78-2  
DOT-TSC-OST-77-30  
DOT-TSC-FHWA-77-2  
Final Report January 1978 770p.

Traffic noise — Mathematical models  
Traffic noise — Measurement

Accurate prediction of highway noise has been a major problem for state highway departments. Many noise models have been proposed to alleviate this problem. Results contained in this report will be used to analyze some of these models, and to determine their accuracy over various areas of the United States.

Noise level data for this evaluation were obtained alongside highways and arteries in North Carolina, Florida, Washington, and Colorado. Results include statistical noise data and various other noise indexes for a variety of traffic volumes and speeds, and octave band noise data of individual truck passbys.

**DOT-TSC-FHWA-78-2.1  
SEVEN EXPERIMENT DESIGNS ADDRESSING  
PROBLEMS OF SAFETY AND CAPACITY ON  
TWO-LANE RURAL HIGHWAYS**

**Volume I: Introduction, Description of Experiments and  
Common Elements**

KLD Associates, Inc.  
G. F. King, P. Abramson, J. W. Cohen, M. R. Wilkinson  
PB-284 402  
DOT-TSC-992-1  
Final Report May 1978 38p.

Traffic safety

This is Volume I, an introduction to the results of a research project, "Design and Development of Seven Rural Traffic Related Experiments for Future Implementation at the Maine Facility." The specific objectives

## FEDERAL HIGHWAY ADMINISTRATION

studies have shown that as the speed differential between two vehicles traveling in the same direction increases, the accident rate soars. This speed differential is commonly found with a large vehicle ascending a grade being overtaken by a faster vehicle. In this volume, an experimental design was developed to evaluate a series of active and passive warning devices, including roadside and vehicle-mounted devices. A state-of-the-art survey and bibliography are included. A questionnaire, designed to appraise motorists' reactions to these devices, is appended.

### **DOT-TSC-FHWA-78-2.VI SEVEN EXPERIMENT DESIGNS ADDRESSING PROBLEMS OF SAFETY AND CAPACITY ON TWO-LANE RURAL HIGHWAYS**

**Volume VI: Experimental Design for Comparative  
Evaluation of Warning-Advisory and Regulatory  
Traffic Control Devices**

KLD Associates, Inc.

G. F. King, P. Abramson, J. W. Cohen, M. R. Wilkinson  
PB-284 408

DOT-TSC-992-6

Final Report      May 1978      54p.

Traffic signs and signals  
Traffic safety

This is Volume VI. The overuse of regulatory type signing on highways has been found to cause motorists to ignore all signing. In this experimental design, advisory-warning signs, regulatory signs and a combination of the two types will be tested in four experiments. The first experiment will compare curve signing; the second, intersection signing; the third, no passing zone signing; and fourth, signs for steep downgrades. A state-of-the-art survey and bibliography are included. A questionnaire for use in the no passing zone and downgrade experiments is appended.

### **DOT-TSC-FHWA-78-2.V SEVEN EXPERIMENT DESIGNS ADDRESSING PROBLEMS OF SAFETY AND CAPACITY ON TWO-LANE RURAL HIGHWAYS**

**Volume V: Experimental Design for Vehicle  
Equivalency and Capacity Including Effects of  
Commercial and Recreational Vehicles on Rural Non-  
Controlled Access Highways**

KLD Associates, Inc.

G. F. King, P. Abramson, J. W. Cohen, M. R. Wilkinson  
PB-284 409

DOT-TSC-992-5

Final Report      May 1978      62p.

Traffic flow

Two methods are proposed to measure equivalency and capacity: the Walker Method, used to compute the tables in the Highway Capacity Manual, and the mean cluster size method developed in Australia.

The object of the experiment is to update and extend Chapter 10 of the Highway Capacity Manual.

### **DOT-TSC-FHWA-78-2.VII SEVEN EXPERIMENT DESIGNS ADDRESSING PROBLEMS OF SAFETY AND CAPACITY ON TWO-LANE RURAL HIGHWAYS**

**Volume VII: Experimental Design to Develop and  
Evaluate Measure for Reducing the Effects of Roadside  
Friction on Traffic Flow**

KLD Associates, Inc.

G. F. King, P. Abramson, J. W. Cohen, M. R. Wilkinson  
PB-284 407

DOT-TSC-992-7

Final Report      May 1978      50p.

Traffic flow  
Highway engineering

FEDERAL RAILROAD ADMINISTRATION

DOT-TSC-FRA-77-15.II  
RAIL SAFETY/EQUIPMENT CRASHWORTHINESS

Volume II: Design Guide

Boeing Vertol Company  
M. J. Reilly, J. Shefrin, L. M. Patrick  
FRA/ORD-77/73, II  
DOT-TSC-821-2  
Interim Report July 1978 100p.

Railroads — Safety measures  
Railroads — Accidents

This Design Guide, the second of four volumes, has been prepared to assist design engineers in understanding the basic problems associated with the development of crashworthy interiors of locomotives, cabooses and passenger railcars. Rail vehicle accident conditions are presented with the resulting interactions that can occur between one car and another. Types of injuries to the occupants of the cars, and the mechanism causing the injury, are discussed.

DOT-TSC-FRA-77-15.IV  
RAIL SAFETY/EQUIPMENT CRASHWORTHINESS

Volume IV: Executive Summary

Boeing Vertol Company  
M. J. Reilly  
FRA/ORD-77/73, IV  
DOT-TSC-821-4  
Interim Report July 1978 76p.

Railroads — Safety measures  
Railroads — Accidents

This document, the fourth of four volumes, summarizes the activities and documentation conducted under this contract. The analysis of the accident data highlighted areas where improvements could be made to improve the occupant protection of passenger rail vehicles. Design criteria were determined and some suitable design changes proposed. For the proposed areas of change, typical Federal Standards documentation were prepared.

DOT-TSC-FRA-77-20  
FRACTURE RESISTANCE AND FATIGUE CRACK  
GROWTH CHARACTERISTICS OF RAILROAD  
WHEELS AND AXLES

Boeing Commercial Airplane Company  
C. S. Carter, R. G. Caton, and J. L. Guthrie  
FRA/ORD-77/50  
DOT-TSC-617  
Final Report November 1977 138p.

Car-wheels  
Railroads — Cars — Dynamics

The effects of chemical composition, temperature and loading rates on the plane strain fracture toughness  $K_{IC}$  of railroad wheels have been determined. Similarly, the effects of these variables were determined for grade U and F railroad axles. The carbon content was determined to be the principal factor controlling  $K_{IC}$ . Sensitivity to loading rate ( $K_{ID}$ ) was seen to be a function of the microstructure. Estimates have been made of the minimum size of crack, which could result in the failure of wheels and axles under adverse service conditions. Also investigated were the effects of chemical compo-

FC-FRA-77-15.III  
RAIL SAFETY/EQUIPMENT CRASHWORTHINESS

Part III: Proposed Engineering Standards

Boeing Vertol Company  
M. J. Reilly  
FRA/ORD-77/73, III  
DOT-TSC-821-3  
Interim Report July 1978 72p.

Railroads — Safety measures  
Railroads — Accidents

This document, the third of four volumes, contains recommended Engineering Standards prepared in the format of the standards published in the *Code of Federal Regulations* (Title 49, Transportation, Part 200). The standards proposed provide improved occupant protection in the secondary impact situation associated with railroad accidents.

FEDERAL RAILROAD ADMINISTRATION

Car-couplings  
Railroads — Cars — Safety measures

The purpose of this study is to provide an independent identification, classification, and analysis of significant freight car coupling systems concepts offering potential for improved safety and operating costs over the present system.

The basic method of approach was to make a comprehensive search as a prerequisite to establishing significant coupler concepts which would be used to formulate candidate coupling systems. The search program consisted of a literature search, a patent search, and railroad industry interviews.

Coupling development efforts have been decreased due to changing usage and profitability of the American railroads. The functional concepts of existing development efforts range in sophistication from increasing the gathering range of the present coupler system to providing automatic train air connection and a complete redesign of the mechanical coupler.

A sufficient number of new concepts were identified to derive coupling systems which represent a significant improvement over the present system.

This executive summary is the first of two volumes. Volume II presents detailed documentation of the project.

**DOT-TSC-FRA-77-30.II**  
**COUPLING SYSTEM DESIGN OPTIMIZATION — A SURVEY AND ASSESSMENT OF AUTOMATIC COUPLING CONCEPTS FOR RAIL FREIGHT CARS**  
**Volume II: Text and Appendices**

A. T. Kearney, Inc.  
A. E. Nyquist, G. D. Boydston, J. J. Chanoux,  
R. T. Halagera, R. K. Hall, D. Lawson  
PB-284 546  
FRA-ORD-78-11.II  
DOT-TSC-1087-2  
Final Report May 1978 446p.

Car-couplings  
Railroads — Cars — Safety measures

**DOT-TSC-FRA-78-1.I**  
**BRAKE SYSTEM DESIGN OPTIMIZATION**  
**Volume I: A Survey and Assessment**

A. T. Kearney, Inc.  
L. L. Eshelman, C. C. Shelleman, J. P. Henderson  
PB-284 080  
FRA/ORD-78/20.I  
DOT-TSC-1040  
Final Report June 1978 140p.

Railroads — Brakes — Technological innovations

**DOT-TSC-FRA-78-2**  
**ECONOMICS OF CONCRETE — AND WOOD-TIE TRACK STRUCTURES**

Battelle-Columbus Laboratories;  
Bechtel, Inc.  
D. W. White, R. C. Arnlund and R. H. Prause  
FRA/ORD-78/2  
DOT-TSC-1044  
Interim Report August 1978 76p.

Railroads — Track — Design and construction  
Railroads — Track — Maintenance and repair

This report presents results from an evaluation of the economic benefits of concrete- versus wood-tie track. The analysis includes the life-cycle capital, maintenance, and renewal costs for concrete- and wood-tie track for four specific test cases and traffic ranges from 15 to 40 annual million gross tons (MGT). The sensitivity of the justifiable first cost of concrete ties as a function of parametric changes in service and maintenance variables has also been determined.

**DOT-TSC-FRA-78-3**  
**A STUDY OF STATE PROGRAMS FOR RAIL-HIGHWAY GRADE CROSSING IMPROVEMENTS**

Transportation Systems Center  
Judith B. Gertler  
PB-279 774  
FRA-OPPD-78-7  
Final Report February 1978/Reprint June 1978 174p.



## FEDERAL RAILROAD ADMINISTRATION

(powered) and that of the Amcoaches (unpowered). These applications are used to indicate data requirements, to present the type of results obtainable from the technique, and to show how the results can be used. The relationship between the SCM and truck specifications is explored.

### **DOT-TSC-FRA-78-8 EFFECT OF TORSIONAL FASTENER RESISTANCE ON THE LATERAL RESPONSE OF A RAIL-TIE STRUCTURE**

Princeton University, Department of Civil Engineering,  
Arnold D. Kerr  
FRA/ORD-78/35  
DOT-TSC-1149  
Interim Report                      September 1978                      28p.

Railroads — Track — Dynamics

The use of the classical beam bending equations for the analysis of the track response in the lateral plane is of questionable validity, when the used fasteners exhibit a noticeable torsional resistance. To remedy this situation, recently a variety of other track equations were proposed and used. The purpose of the present study is to establish the effect of fastener resistance on the lateral response of the rail-tie structure and also to determine whether a fourth order differential equation, which includes a rotational resistance term, is sufficiently accurate for describing its lateral response. To achieve this aim, deflection tests were conducted on a rail-tie structure with adjustable fastener rigidities, then this test-structure was analyzed using a fourth order equation with and without a rotational resistance term, and subsequently the analytical and tests results were compared. The test results revealed that with an increasing rotational resistance of the fasteners, the deviation of the test curves, from the case of zero fastener resistance, also increases; thus, the beam bending equation is not suitable, in general, for the analysis of the lateral track response. The comparison of the analytical and test result showed that the measured deflection shapes of the test structure, for a variety of fastener rigidities, agree closely with the deflection shapes obtained using a fourth order differential equation which includes a rotational resistance term, provided the coefficient of

this additional term contains the effect of the fastener rigidity and the bending rigidity of the cross-ties.

### **DOT-TSC-FRA-78-12. I SELECTED TOPICS IN RAILROAD TANK CAR SAFETY RESEARCH**

**Volume I: Fatigue Evaluation of Prototype Tank Car  
Head Shield**  
IIT Research Institute  
Milton R. Johnson  
FRA/ORD-78/32, I  
DOT-TSC-1043-1  
Final Report                      August 1978                      82p.

Tank-cars — Dynamics  
Tank-cars — Safety measures  
Tank-cars — Testing

The characteristics of a prototype head shield for hazardous material tank cars were evaluated with respect to the maintenance of its structural integrity under normal service conditions. The primary concern was with the resistance to fatigue damage of head shield connections to the tank car. The evaluation was conducted by performing tests on a tank car equipped with the shield. The shield and its supporting structure were instrumented to determine the principal forces acting within the structure and at points of attachment to the tank car. Both car-coupling impact and over-the-road tests were conducted. The impact tests were conducted at speeds of from 3 to 8 mph. The over-the-road tests included 432 miles of operation at speeds up to 55 mph. Evaluation of the data revealed that the car-coupling impact environment was the most severe. A finite fatigue life was indicated for the most severely stressed region of the supporting structure. The most severe over-the-road environment occurred with the loaded car at speeds above 45 mph when the main suspension bottomed out. The loads associated with this phenomenon were below those of the car-coupling impact environment.

## FEDERAL RAILROAD ADMINISTRATION

### DOT-TSC-FRA-78-16. III

#### RAILROADS AND THE ENVIRONMENT: ESTIMATION OF FUEL CONSUMPTION IN RAIL TRANSPORTATION

##### Volume III: Comparison of Computer Simulations with Field Measurements

Transportation Systems Center

J. Hopkins, M. Hazel, and T. McGrath

PB-288 866

FRA-OR&D-75-74. III

Final Report            September 1978            102p.

Railroads — Energy consumption — Mathematical models  
Railroads — Freight — Mathematical models

This report documents comparisons between extensive rail freight service measurements (previously presented in Volume II) and simulations of the same operations using a sophisticated train performance calculator computer program. The comparisons cover a variety of lengthy freight movements over a differing terrain, for TOFC, boxcar, and branchline operations. The simulation shows excellent agreement (within 2%) for aggregated data, although some specific runs or run segments show substantial deviations. Uncertainty is typically plus or minus 10% to 15%, a range equivalent to the scatter generally found within sets of measured data. The report also includes a full description of the simulation program and a general analysis of the major factors which bear upon the validity and accuracy of train performance calculations. Proposed modifications to conventional train resistance equations are suggested.

Volume I, Analytical Model, has 90 pp. Volume II, Freight Surface Measurements, has 46 pp.

### DOT-TSC-FRA-78-17

#### RETROFILLING OF RAILROAD TRANSFORMERS

General Electric Company. Power Delivery Technical Resources Operation.

S. D. Foss, J. B. Higgins, D. L. Johnston, J. M. McQuade

FRA/ORD-78/51

DOT-TSC-1293

Final Report            September 1978            56p.

Electric transformers

The objective of this program was to assess the effectiveness of retrofilling an Askarel transformer supplied by the United States Department of Transportation with a 50 centistokes silicone fluid. The work tasks included an assessment of the electrical and thermal characteristics of the transformer before and after retrofilling as well as an indepth evaluation of the retrofill concept.

As a result of this work it has been shown that:

- 1) The retrofilled transformer did not show any ill effects from the limited electrical testing.
- 2) Thermal tests revealed that the retrofilled unit ran 9.7° C hotter.
- 3) All but 107 lbs. of the original 2113 lbs. of askarel were removed from the transformer after 288 hours of flushing with 90° C silicone.
- 4) To reach the program objective of 58 lbs. of retained askarel an additional 3 months of flushing would have been required.
- 5) The mathematical model developed by General Electric in earlier studies as a predictive tool for estimating times to reach predetermined levels of PCB has been validated as a result of this study.

### DOT-TSC-FRA-78-19

#### SUMMARY STATISTICS OF THE NATIONAL RAIL- ROAD-HIGHWAY CROSSING INVENTORY FOR PUBLIC AT-GRADE CROSSINGS

Transportation Systems Center

John S. Hitz, Editor

FRA-OPPD-78-20

Final Report            September 1978            156p.

Railroads — United States — Crossings — Statistics

In response to the Federal Railroad Safety Act of 1970, a joint government/industry effort to compile a national inventory of railroad-highway crossings was initiated in 1972 and completed in 1976. The inventory contains data on the physical and operational characteristics of all 402,000 railroad-highway crossings in the United States of which approximately 219,000 are public at-grade, 142,000 are private, 37,500 are public grade separated and 3,500 are pedestrian. This report presents comprehensive statistical summaries of the characteristics for

## NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

### **DOT-TSC-NHTSA-77-6 AUTOMOBILE MARKETING STRATEGIES, PRICING, AND PRODUCT PLANNING**

John Z. De Lorean Corporation

Marc L. Hagerman

PB-281 513

HS-803 181

DOT-TS-13509

Final Report April 1978 46p.

Automobile industry and trade – Planning

Automobiles – Prices

The objective of this study was to determine the decision-making processes concerning major model year product introductions and alterations in the automotive industry as well as to investigate techniques of price positioning, product and image positioning, and the use of incentives and other promotional tools. The method used was to establish the new models introduced since the last traditional year (1959) in the automotive industry, and to discuss their features and positioning in the market place.

It can be concluded that the automotive industry reacts to competition, dealer influences, consumer preference and government regulations. Also each automotive manufacturer reacts differently in comparable situations.

### **DOT-TSC-NHTSA-77-7 AUTOMOBILE MARKETING STRATEGIES, PRICING, AND PRODUCT PLANNING**

ASL Engineering, Inc.

H. M. Siegel, T. M. Burrows, C. J. LaCivita

HS-803-218

DOT-TS-13632

Final Report August 1978 82p.

Automobile industry and trade – Planning

Automobiles – Prices

This study examines the problems and practices of the U.S. automobile industry in three areas – product planning, pricing, and marketing. Each of these areas is analyzed from the viewpoint of how current procedures

inhibit or prevent the increased manufacture and sales of U.S. cars that are more efficient with respect to fuel economy. Some suggestions and recommendations are made as to how some of the obstacles may be overcome.

### **DOT-TSC-NHTSA-78-1 AUTOMOTIVE FLEET FUEL CONSUMPTION MODEL: FUEL FOR**

Transportation Systems Center

Jerry Horton

PB-280 760

HS-803-223

Final Report March 1978 56p.

Automobiles – Fuel Consumption – Data processing

A computer program has been developed which calculates potential fuel conservation benefits stemming from increases in automotive fuel economy. Inputs include:

- 1) a schedule of new car registrations by model year, both historic and projected;
- 2) a schedule of miles traveled annually by a car as a function of its age;
- 3) a schedule of vehicle survival probability as a function of age;
- 4) a description of average fuel economy, by model year, of the existing fleet;
- 5) a hypothetical baseline schedule of new car fuel economy by model year; and
- 6) a hypothetical improved schedule of new car fuel economy by model year.

Outputs include:

- 1) annual fuel savings;
- 2) cumulative fuel savings; and
- 3) discounted cumulative cash savings.

Impacts upon aggregate consumer outlay for fuel, upon lifetime operating cost (per auto), and upon federal and state excise tax revenues are also calculated.

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**DOT-TSC-NHTSA-78-5**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

First Series — Report No. 12  
1975 Perkins Diesel 247 CID (4.0 Liters), F.I.  
Bartlesville Energy Research Center  
W. F. Marshall and K. R. Stamper  
PB-281 777  
HS-803 278  
RA-75-10  
Interim Report      April 1978      36p.

Perkins diesel motor  
Diesel motor — Fuel consumption  
Diesel motor exhaust gas

Experimental data were obtained in dynamometer tests of a 1975 Perkins 247-CID diesel engine to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine-performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.

**DOT-TSC-NHTSA-78-6**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

First Series — Report No. 13  
1975 American Motors 258 CID (4.2 Liters), IV  
Bartlesville Energy Research Center  
W. F. Marshall and K. R. Stamper  
PB-281 778  
HS-803 279  
RA-75-10  
Interim Report      April 1978      38p.

American Motors automobile  
Automobiles — Motors — Exhaust gas  
Automobiles — Fuel consumption

Experimental data were obtained in dynamometer tests of a 1975 AMC 258-CID production IV engine to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine-performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.

**DOT-TSC-NHTSA-78-7**  
**NEAR TERM WEIGHT REDUCTION POTENTIAL IN**  
**A 1977 GENERAL MOTORS B BODY VEHICLE**

Arthur D. Little, Inc.  
Donald A. Hurter, Philip G. Gott, Jeffrey Staley  
PB-282 111  
HS-803 280  
DOT-TSC-1047  
Final Report      May 1978      68p.

Automobiles — Design and construction

This report presents an analysis of the potential for weight reduction through lightweight material and component substitutions in a 1977 General Motors Corporation B body vehicle. The changes were limited to those that appeared producible in the 1980 to 1985 time frame. The first portion of the analysis involved gathering weight data on selected components of a 1975 Chevrolet Impala 4-door sedan and a 1977 Chevrolet Impala 4-door sedan. The 1975 Impala data were used to illustrate the means used by General Motors to achieve a 650-pound weight reduction in the 1977 Impala. The second portion of the analysis involved the estimate of the potential weight reductions possible in the 1977 Impala through material and component substitutions. The vehicle's components were broken down into three different but interactive categories: the occupant compartment structure, the suspension/steering/braking system and the drive-train. Materials and component substitutions were conservatively carried out so as not affect the appearance, safety, or acceleration performance of the vehicle. However, the costs of the changes were not explicitly considered, and they would be expected to

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**DOT-TSC-NHTSA-78-11**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

First Series — Report No. 17  
1975 Buick 455 CID (7.5 Liters), 4V  
Bartlesville Energy Research Center  
T. W. Chamberlain, D. E. Koehler, K. R. Stamper,  
and W. F. Marshall  
PB-286 298  
HS-803 327  
RA-75-10  
Interim Report      May 1978      54p.

Buick automobile  
Automobiles — Fuel consumption  
Automobiles — Motors — Exhaust gas

Experimental data were obtained in dynamometer tests of a 1975 Buick 455 CID, 4V engine to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving transportation.

**DOT-TSC-NHTSA-78-12**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

First Series — Report No. 18  
1976 Ford 400 CID (6.6 Liters), 2V  
Bartlesville Energy Research Center  
W. F. Marshall and K. R. Stamper  
PB-286 299  
HS-803 328  
RA-75-10  
Interim Report      May 1978      56p.

Ford automobile  
Automobiles — Fuel consumption  
Automobiles — Motors — Exhaust gas

Experimental data were obtained in dynamometer tests of a 1976 Ford 400 CID, 2V engine to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.

**DOT-TSC-NHTSA-78-13**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

First Series — Report No. 19  
1975 Ford Windsor 351 CID (5.7 Liters), 2V  
Bartlesville Energy Research Center  
W. F. Marshall and K. R. Stamper  
PB-286 300  
HS-803 329  
RA-75-10  
Interim Report      May 1978      40p.

Ford automobile  
Automobiles — Fuel consumption  
Automobiles — Motors — Exhaust gas

Experimental data were obtained in dynamometer tests of a 1975 Ford 351 CID, 2V, Windsor engine to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

**DOT-TSC-NHTSA-78-17**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

Second Series — Report No. 6  
1976 Nissan Diesel 1978 CID (3.2 Liters), F.I.  
Bartlesville Energy Research Center  
D. E. Koehler, K. R. Stamper, and W. F. Marshall  
PB-286 295  
HS-803 333  
RA-76-23  
Interim Report      May 1978      34p.

Nissan automobile  
Diesel motor — Fuel consumption  
Diesel motor exhaust gas.

Experimental data were obtained in dynamometer tests of a 1976 Nissan diesel engine, Model SD-33 CN6-33, to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine character data required as input for engineering calculations involving ground transportation.

**DOT-TSC-NHTSA-78-18**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

Second Series — Report No. 7  
1977 Ford 171 CID (2.8 Liters), 2V  
Bartlesville Energy Research Center  
D. E. Koehler, K. R. Stamper, and W. F. Marshall  
PB-286 296  
HS-803 334  
RA-76-23  
Interim Report      May 1978      64p.

Ford automobile  
Automobiles — Fuel consumption  
Automobiles — Motor — Exhaust gas

Experimental data were obtained in dynamometer tests of a 1977 Ford 171 CID engine to determine fuel con-

sumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.

**DOT-TSC-NHTSA-78-19**  
**PERFORMANCE CHARACTERISTICS OF**  
**AUTOMOTIVE ENGINES IN THE UNITED STATES**

Third Series — Report No. 1  
1977 Volvo 130 CID (2.1 Liters), F.I.  
Bartlesville Energy Research Center  
D. E. Koehler, K. R. Stamper, and W. F. Marshall  
HS-803 335  
RA-77-07  
Interim Report      May 1978      44p.

Volvo automobile  
Automobiles — Fuel consumption  
Automobiles — Motors — Exhaust gas

Experimental data were obtained in dynamometer tests of a 1977 Volvo 130 CID engine to determine fuel consumption and emissions (hydrocarbon, carbon monoxide, oxides of nitrogen) at steady-state engine-operating modes. The objective of the program is to obtain engine performance data for estimating emissions and fuel economy for varied engine service and duty. The intent of the work is to provide basic engine characteristic data required as input for engineering calculations involving ground transportation.

**DOT-TSC-NHTSA-78-21.I**  
**MULTINATIONAL ACTIVITIES OF MAJOR U.S.**  
**AUTOMOTIVE PRODUCERS**

**Volume I: Summary**  
Robert C. Ronstadt Associates, Inc.  
Robert C. Ronstadt, William Casey, J. P. Jeannet, John Marthinsen, and Robert Whorf  
HS-803 542.I  
DOT-TSC-1387-1  
Final Report      September 1978      22p.

## NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

### **DOT-TSC-NHTSA-78-22 ANALYSIS OF FEDERAL STIMULI TO DEVELOPMENT OF NEW TECHNOLOGY BY SUPPLIERS TO AUTOMOBILE MANUFACTURERS:**

#### **An Exploratory Study of Barriers and Facilitators**

A. H. Rubenstein and Associates

A. H. Rubenstein and J. E. Ettl

PB-282 176

HS-803 291

TS 13215

Final Report      March 1978      82p.

Automobile industry and trade — Technological innovations

The role of suppliers to the auto industry in promoting innovation is explored. Thirty-two innovations are investigated, and information on their success/failure, area of impact, and key decision points is generated. Based on this data base, barriers and facilitators of the innovation process are identified. The most frequently mentioned barriers to innovation are: federal regulations, cost, technical reliability, market demand, and vehicle integrity impact. Identified as common facilitators are: federal laws, the incentive of solving a persistent problem, recognition of market potential, direct government R&D, and the technological capability of suppliers.

### **DOT-TSC-NHTSA-78-23 FIELD STUDY OF A VARIABLE-HEIGHT HIGHWAY-NOISE BARRIER**

Cambridge Collaborative, Inc.

J. E. Manning and C. N. Blair

PB-283 556

HS-803 290

DOT-TSC-1011

Final Report      March 1978      74p.

Traffic noise — Measurement

This study describes the design, construction, and evaluation of a variable-height highway-noise barrier. The barrier was constructed along a 1000-ft-long segment of Interstate 93 in Andover, Massachusetts. A test plan was

prepared, and measurements were taken at a number of points behind the barrier and at an adjacent open site by personnel using the DOT-TSC Mobile Noise Laboratory. Data were collected over a series of eight tests, each extending over a two-or three-day period, to determine the noise reduction provided by barriers of different heights with reflecting and absorbing surfaces. Test results are presented and compared with predictions. Based on the data, it concluded that existing design charts are inadequate for predicting the performance of highway-noise barriers. The design-chart corrections for finite-barrier length is believed to be too large.

### **DOT-TSC-NHTSA-78-24 ROADSIDE BARRIER EFFECTIVENESS: Noise Measurement Program**

Transportation Systems Center

E. J. Rickley, R. W. Quinn,

U. Ingard, Y. C. Cho (Sonotech, Inc.)

PB-282 045

HS-803 289

Final Report      April 1978      240p.

Traffic noise — Measurement

A field noise measurement program was conducted to assess the performance of a variable height highway noise barrier with and without an acoustic lining material. The barrier site on Interstate I-93 in Andover MA was located adjacent to an acoustically similar unobstructed site. The noise emissions from a common stream of vehicular traffic were measured at both sites simultaneously and compared to evaluate the performance of the barrier. A 1000-foot-long barrier at effective heights of 2.8, 6.8, 10.8 and 14.8 feet was measured and evaluated.

Included in this report is the statistical noise data from fourteen measuring systems for each barrier configuration along with spectral data, traffic information and meteorological conditions.

## NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

gation of motor vehicle standards by the U.S. government. The report examines three safety standards as evaluative cases:

MVSS 203 — Steering column impact

MVSS 212 — Windshield mounting

MVSS 215 — Exterior protection

The industry responses to the standards are discussed; there is an evaluation of the effects of the standards on industry; an analysis is made of the role of government in the promulgation process. There are conclusions and recommendations for further research.

### DOT-TSC-NHTSA-78-30

#### THE RELATIONSHIP OF AUTOMOBILE CHARACTERISTICS TO LIST PRICES AND PROFIT MARGINS — A PRELIMINARY ANALYSIS

EIC Corporation

M. A. Cassella and F. T. Rabe

PB-287 406

HS-803 367

DOT-TSC-1311

Final Report August 1978 58p.

Automobiles — United States — Prices

Automobile industry and trade — United States

Automobiles — United States — Design and construction

This report describes research on potential impacts of fuel economy regulations on the U.S. automobile industry. The study focused on the possible effects of auto "down-sizing" on manufacture profit margins. Historical price data were used to estimate variable profit margins. Estimated margins were strongly correlated with vehicle inertia weight and the price of the average options packages and, to a lesser extent, were negatively correlated with production volume. Regression analyses were also performed to relate list prices to vehicle characteristics believed to represent valuable attributes to consumers. The results, although ambiguous, suggest that vehicle roominess, fuel economy, and power-to weight ratio are positive influences on prices. However, the extent and quality of the data employed in the analyses were too limited to support firm general conclusions. Further study is required to anticipate the long term effects of the fuel economy regulations on price.

### DOT-TSC-NHTSA-78-33

#### REVIEW OF CHEST DEFLECTION MEASUREMENT TECHNIQUES AND TRANSDUCERS

Transportation Systems Center

G. R. Plank

PB-283 654

HS-803 350

Final Report June 1978 36p.

Automobile engineering — Safety measures

A summary is presented, based upon a search of the literature, the author's own work, and personal communications of the author, of measurement techniques and transducers that have been used, or are presently available and exhibit potential for use in the measurement of dynamic chest deflection. Various techniques and transducers are evaluated for their potential for use with dummies, cadavers, infra-human primates and living humans and those techniques and transducers found to have high potential for use with living humans are discussed in detail. Measurement requirements are summarized, inherent problems are pointed out, and recommendations for the solution of some of these problems and further investigation are given.

### DOT-TSC-NHTSA-78-36

#### THE POTENTIAL FOR AUTOMOBILE WEIGHT REDUCTION OUTLOOK AS OF 1975-1976

Dartmouth College, Thayer School of Engineering

Frederick J. Hooven, Francis E. Kennedy

HS-803 341

DOT-TSC-996

August 1978 216p.

Automobiles — Design and construction

A study has been carried out to evaluate the potential for weight reduction of automobiles. It is concluded that automobiles of lighter weight than those current (1976 models) in the domestic market may be built in each of three size classes, 4, 5, and 6 passenger, and that this can be done within the limits of presently prevailing designs and materials. Detailed weight breakdowns are presented for a 4-passenger vehicle of 1987 lbs. curb



## NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

ance data for determining fuel consumption and emissions (carbon monoxide, hydrocarbons, and oxides of nitrogen) at steady-state engine operation modes. Each engine was tested over its entire speed/load operating range. The test results proved to have sufficient repeatability to establish steady-state maps for fuel consumption and emissions over the entire operating range of the engine. These data are useful for estimation of full economy and emissions for engineering calculations involving ground transportation.

### **DOT-TSC-NHTSA-78-41 CATEGORIZATION AND CHARACTERIZATION OF AMERICAN DRIVING CONDITIONS (Phase I)**

The Center for the Environment and Man, Inc.  
H. C. Joksch, J. C. Reidy, Jr.  
HS-803 537  
DOT-TSC-1419  
Final Report November 1978 202p.

Automobiles — Fuel Consumption  
Traffic surveys  
Automobile driving — Mathematical models

The objectives of this study were: (1) develop a multi-dimensional matrix as an analysis framework to classify travel of personal motor vehicles according to fuel consumption, (2) to identify and assess available information on travel and fuel consumption, and (3) to describe how to use specific information for quantifying the matrix. A review of the fuel economy literature

revealed a large number of factors which influence fuel consumption. Only some of these factors were related to driving conditions. The factors categorizing driving conditions were selected according to their independence, their relationship to fuel consumption, and their interest for studying fuel economy policies. They are: trip purpose, trip length, time, geographic area, highway class and vehicle class and model year. Fuel consumption rates can be estimated from vehicle and trip characteristics including trip length, ambient temperature and average trip speed. These last two factors are not dimensions of the matrix but are, on the average, determined by certain dimensions: time, geographic area, highway class, and trip length. Currently available sources of vehicle travel information are sufficiently detailed to disaggregate VMT according to the selected factors. However sufficient basic data are available to estimate VMT under the selected driving conditions. The most detailed information was collected by the 1977 NPTS. Other information is regularly collected by traffic counting programs, and by motor vehicle inspection programs in certain states. An approach was outlined to estimate VMT from these sources, disaggregated according to the factors characterizing driving conditions. Potential errors of the estimates were estimated. Promising statistical methods for quantifying the matrix were identified; however, some aspects of estimating error can not be addressed without an analysis of the actual data. A plan for implementing this methodology is presented. Illustrative examples of a scaled down matrix and its use are presented in appendices.

OFFICE OF THE SECRETARY OF TRANSPORTATION

**DOT-TSC-OST-77-23.I**

**HYBRID VEHICLE TECHNOLOGY CONSTRAINTS  
AND APPLICATION ASSESSMENT STUDY**

**Volume I: Summary**

The Aerospace Corporation, Environment and Energy  
Conservation Division.

D. E. Lapedes, M. G. Hinton, L. Forrest,  
J. Kohlenberger, T. Ryan, H. Sampson,  
W. Smalley, C. Speisman, H. White

PB-278 118

FO4701-76-C-0077

Final Report November 1977 120p.

Automobiles – Fuel consumption – Testing  
Automobiles – Motors – Technological innovations

This four-volume report presents analyses and assessments of both heat engine/battery and heat engine/flywheel-powered hybrid vehicles to determine if they could contribute to near-term (1980-1990) reductions in transportation energy consumption under several sets of operational conditions: urban driving, highway driving, and stop-start, low-speed delivery service conditions. In addition, the impact of such hybrid vehicle use on vehicle-related exhaust emissions is determined, and the ability to accommodate a different energy resource base in the longer term is evaluated, i.e., by permitting a portion of the recharge energy for the on-board energy storage device (battery or flywheel) to be provided by wall-plug electric power from the utility industry instead of from the on-board heat engine. Alternative paths for power transmission from the heat engine to the vehicle drive wheels are considered along with the potential of regenerative braking to reduce vehicle energy consumption.

This first of four volumes constitutes a summary of the more significant results of the study.

**DOT-TSC-OST-77-23.II**

**HYBRID VEHICLE TECHNOLOGY CONSTRAINTS  
AND APPLICATION ASSESSMENT STUDY**

**Volume II: Sections 1-4**

The Aerospace Corporation, Environment and  
Energy Conservation Division.

D. E. Lapedes, et al.

PB-278 119

FO4701-76-C-0077

Final Report November 1977 226p.

Automobiles – Fuel consumption – Testing  
Automobiles – Motors – Technological innovations

This second of four volumes contains the first four sections of the full report. It introduces the methods used in the study and the data base employed in simulation modeling of each vehicle powertrain. It also includes a technology review of powertrain components and various hybrid systems developed in recent years.

**DOT-TSC-OST-77-23.III**

**HYBRID VEHICLE TECHNOLOGY CONSTRAINTS  
AND APPLICATION ASSESSMENT STUDY**

**Volume III: Sections 5-9**

The Aerospace Corporation, Environment and  
Energy Conservation Division.

D. E. Lapedes, et al.

PB-278 120

FO4701-76-C-0077

Final Report November 1977 190p.

Automobiles – Fuel consumption – Testing  
Automobiles – Motors – Technological innovations

## OFFICE OF THE SECRETARY OF TRANSPORTATION

construction tolerances to both cost and ride quality. It is illustrated in detail for group-rapid-transit precast concrete elevated guideway systems. These detailed cost-ride quality studies include an assessment of span properties, construction-related tolerances such as joint discontinuities, pier height variations, camber, and local surface roughness, and the effect of vehicle properties on cost and vehicle ride quality.

### **DOT-TSC-OST-77-69 WORKSHOPS ON TRANSPORTATION-AIR QUALITY RESEARCH NEEDS FOR STATE, REGIONAL, AND LOCAL GOVERNMENT OFFICIALS**

Transportation Systems Center

PB-277 802

Final Report      December 1977      114p.

Air quality — Research — Congresses  
Air pollution — Research — Congresses  
Transportation — Planning — Congresses

Four workshops on transportation-air quality research needs were sponsored in the Spring of 1977 by the U.S. Department of Transportation (USDOT) to identify the requirements for a research and development program. One hundred and sixty six persons attended the workshops, representing leaders in the transportation and air quality fields from local, regional, and State and Federal governments. Based on the workshops, and the collected analysis of distinguished transportation-air quality practitioners subsequent to the workshops, a report was prepared that first documents the ten most urgent transportation-air quality issues and then recommends sixteen research programs to address these issues.

### **DOT-TSC-OST-77-72.1 COMPUTER-BASED RESOURCE ACCOUNTING MODEL FOR GENERATING AGGREGATE RESOURCE IMPACTS OF ALTERNATIVE AUTOMOBILE TECHNOLOGIES**

Volume I: Fleet Attributes Model

Transportation Systems Center

Bruce Rubinger, Simon Prensky

PB-279 671

Final Report      January 1978      54p.

Automobile industry and trade — Mathematical models  
Automobiles — Technological innovations —  
Mathematical models

Auto production and operation consume energy, material, capital and labor resources. Numerous substitution possibilities exist within and between resource sectors, corresponding to the broad spectrum of potential design technologies. Alternative auto design concepts are examined in terms of their aggregate resource impacts.

A computer-based model has been developed for generating the resource requirements of alternative automobile technologies. The model goes beyond previous tools in its scope, level of impact disaggregation, and flexibility. It projects the annual energy, material, capital, and labor requirements of the passenger-automobile fleet through the year 2000. The methodology integrates a family-tree technique for material and energy accounting, with an input-output approach which generates the capital and labor information. Twenty-four major materials are tracked, with supply disaggregated among primary and recycled materials, imports, and domestic sources. Net energy consumption is derived, along with capital and labor impacts disaggregated by 90 industries.

The Resource Accounting methodology is described, with emphasis on the Fleet Attributes Model. Representative results are presented and discussed.

### **DOT-TSC-OST-78-1 EXPERIMENTAL INVESTIGATION OF AERODYNAMIC CHARACTERISTICS OF A TRACKED RAM AIR CUSHION VEHICLE**

See DOT-TSC-OST-77-35 for complete documentation.

### **DOT-TSC-OST-78-2 HIGHWAY NOISE MEASUREMENTS FOR VERIFICATION OF PREDICTION MODELS**

See DOT-TSC-FHWA-78-1 for complete documentation.

## OFFICE OF THE SECRETARY OF TRANSPORTATION

### DOT-TSC-OST-78-14 TRANSPORTATION SYSTEMS CENTER BIBLIOGRAPHY OF TECHNICAL REPORTS, January – December 1977

Transportation Systems Center  
Edith W. Allen  
Bibliography March 1978 94p.

#### Transportation – Bibliography

This bibliography lists unlimited distribution reports released by the Transportation Systems Center from January through December 1977. It supplements Transportation Systems Center Bibliography of Technical Reports July 1970-December 1976 (DOT-TSC-OST-77-17). Reports are listed by sponsoring agency, and are indexed by subject, personal author, title, contract number, and report number.

### DOT-TSC-OST-78-19 JOINT COST, PRODUCTION TECHNOLOGY AND OUTPUT DISAGGREGATION IN REGULATED MOTOR CARRIERS

Transportation Systems Center  
Russell C. Cherry  
PB-289 884  
Interim Report November 1978 138p.

Transportation, Automotive – Freight –  
Economic aspects  
Trucks – Cost of operation

This study uses a sample of 252 Class I Instruction 27 Motor Carriers (Instruction 27 carriers earned at least 75 percent of their revenues from intercity transportation of general commodities over a three year period, the ICC requires that these carriers report a set of supplemental data – such as TL and LTL revenues) of General Flight that existed continuously during the period 1965-1974 to estimate a long run cost function for the regular route, general freight section of the motor carrier industry. The functional form of the estimated equation belongs to the class of flexible, second order approximations to any cost function that are referred to as transcendental logarithmic or "translog" functions. This class of functions does not make any

prejudgments about the proper functional form, or the nature of the economic technology that motor carriers use to produce output; the functions may be derived from a Taylor's series expansion. The output of the industry was disaggregated into 1) truck load ton-miles; 2) less-than-truck load ton miles; 3) pick up and delivery tons per hour and 4) terminal-platform tons. The inputs for which prices were included in the cost function are: 1) labor-salaried, clerical and other; 2) labor-linehaul; 3) labor-pickup and delivery and terminal platform; 4) other inputs not elsewhere classified; 5) purchased transportation; 6) owner-operators; 7) materials; 8) fuel, and 9) capital. The estimated cost function shows that there are no economies of scale in the domains for which the function was estimated, and that the usual representation of cost, using a Cobb-Douglas or CES function, is a serious misspecification because the true underlying function is non-separable and therefore the composition of output is a function of the level of factor prices.

### DOT-TSC-OST-78-20 RAIL TRANSPORTATION REQUIREMENTS FOR COAL MOVEMENT IN 1985

Input Output Computer Services, Inc.  
John M. Witten, Samir A. Desai  
PB-290 150  
DOT-TSC-1282  
Final Report December 1978 166p.

Coal – Transportation  
Railroads – Freight

This study of transportation requirements for coal movements through 1985 is one of the series conducted for the U.S. Department of Transportation to identify and quantify future transportation requirements for energy materials. This report presents the results of the study.

The primary objectives of the study were to develop a scenario for 1985 coal production and consumption and to project rail coal traffic volumes and equipment and facilities requirements consistent with the scenario. A second objective was to identify the planning processes used by the railroads to identify and prepare for future traffic. The third objective of the study was to

## RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION

### DOT-TSC-RSPD-77-1.I DEVELOPMENT OF TECHNIQUES AND DATA FOR EVALUATING RIDE QUALITY

#### Volume I: Summary

Dunlap and Associates, Inc.

R. D. Pepler, L. L. Vallerie, I. D. Jacobson,

R. W. Barber, L. G. Richards

PB-282 326

DOT-TSC-1090-1

Final Report February 1978 16p.

Buses — Design and construction

Railroads — Passenger-cars — Design and construction

Ride-quality models for city buses and intercity trains are presented and discussed in terms of their ability to predict passenger comfort and ride acceptability. These models were developed using passenger response data gathered under actual field conditions.

This, the first of three volumes, summarizes the results of the project.

### DOT-TSC-RSPD-77-1.II DEVELOPMENT OF TECHNIQUES AND DATA FOR EVALUATING RIDE QUALITY

#### Volume II: Ride-Quality Research

Dunlap and Associates, Inc.

R. D. Pepler, L. L. Vallerie, I. D. Jacobson,

R. W. Barber, L. G. Richards

PB-283 019

ED77-1(II)

DOT-TSC-1090-2

Final Report February 1978 164p.

Buses — Designs and construction

Railroads — Passenger-cars — Design and construction

This, the second of three volumes, contains a technical discussion, of the ride-quality models developed during the research effort using the data gathered on city buses and intercity trains. The methods and procedures employed to derive the models are also presented, together with examples of how models are used to evaluate the ride quality of existing and future transportation systems. The raw data used as a basis for the models are presented in the appendixes to this volume.

### DOT-TSC-RSPD-77-1.III DEVELOPMENT OF TECHNIQUES AND DATA FOR EVALUATING RIDE QUALITY

#### Volume III: Guidelines for Development of Ride Quality Models and Their Applications

Dunlap and Associates, Inc.

R. D. Pepler, L. L. Vallerie, I. D. Jacobson, R. W. Barber,

and L. G. Richards

PB-282 327

ED77-1(III)

DOT-TSC-1090-3

Final Report February 1978 46p.

Buses — Design and construction

Railroads — Passenger-cars — Design and construction

This, the last of three volumes, contains procedural guidelines to be employed by transportation specialists in developing ride-quality models and in using them to evaluate passenger comfort in existing or future systems. Specific guidelines are provided for: 1) collecting vehicle-motion and passenger comfort data in the field; 2) generating ride-quality models based on these data; 3) validating models against data from passengers on scheduled services; 4) using models to evaluate or predict vehicle ride quality; and 5) specifying ride characteristics for new vehicles.

### DOT-TSC-RSPD-77-2 BIBLIOGRAPHY AND COMMENTS ON LORAN-C GROUND WAVE PROPAGATION

Transportation Systems Center

Carol Veronda

PB-279 463

Final Report December 1977 52p.

Loran — Bibliography

This report contains a selected bibliography of work dealing with ground wave propagation of Loran-C signals. The selected works include reports on both theoretical and measurement activities over both water and land. A summary of and comments on Loran-C time difference errors to be expected as a result of only ground wave propagation effects are given with references to the original work. Estimates of probable propa-

## RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION

**OT-TSC-RSPD-78-7**

### **AGGREGATION IN NETWORK MODELS FOR TRANSPORTATION PLANNING**

Mathematica, Inc.

Daniel Cullen, Harold Kuhn, and Marguerite Frank

OT-TSC-883

Final Report February 1978 138p.

Transportation — Planning — Mathematical models  
Network analysis (Planning)

This report documents research performed on techniques of aggregation applied to network models used in transportation planning. The central objective of this research has been to identify, extend, and evaluate methods of aggregation so as to improve the capabilities of the transportation planner by better computational methods, by more flexible models, and by increased confidence in the results obtained from aggregated models.

The results of the research are presented in a series of papers. Papers 1 and 2 address the question of error rounding in the lifted (disaggregated) solution using the application of duality theory. Paper 3 reviews the potential performance of a new algorithm for the equilibrium model using path extraction aggregation. Paper 4 addresses potential savings of aggregation. Paper 5 presents results on aggregation test networks and attempts to formulate rules for equilibrium models. Papers 6 and 7 present specific mathematical results on two aggregation-related problems.

**DOT-TSC-RSPD-78-8.I**

### **NETWORK AGGREGATION IN TRANSPORTATION PLANNING**

#### **Volume I: Summary and Survey**

Mathtech, Inc.

Donald W. Hearn

PB-281 384

DOT-TSC-1232-1

Final Report April 1978 100p.

Network analysis (Planning)

Transportation — Planning — Mathematical models

This, the first of two volumes, summarizes research on network aggregation in transportation models. It includes a survey of network aggregation practices, definition of an extraction aggregation model, computational results on a heuristic implementation of the model, and related mathematical results.

**DOT-TSC-RSPD-78-8.II**

### **NETWORK AGGREGATION IN TRANSPORTATION PLANNING**

#### **Volume II: A Fixed Point Method for Treating Traffic Equilibria**

Mathtech, Inc.

Harold W. Kuhn

PB-281 385

DOT-TSC-1232-2

Final Report April 1978 76p.

Network analysis (Planning)

Transportation — Planning — Mathematical models

This, the second of two volumes, defines a new algorithm for the network equilibrium model that works in the space of path flows and is based on the theory of fixed point method.

**DOT-TSC-RSPA-78-9**

### **ESTIMATION OF TRAFFIC VARIABLES USING POINT PROCESSING TECHNIQUES**

Massachusetts Institute of Technology. Electronics  
Systems Laboratory

R. L. Lopez, P. K. Houpt

PB-283 014

DOT-TSC-849

Final Report May 1978 80p.

Traffic flow

Traffic estimation

An alternative approach to estimating aggregate traffic variables on freeways — spatial mean velocity and density — is presented.

Vehicle arrival times at a given location on a roadway, typically a presence detector, are regarded as a point or

## RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION

Choice of transportation

The first volume of this Final Report is principally directed at the generation of materials to facilitate the development of a theory of traveler attitude-behavior interrelationships. Such a theory will be useful in the design of transport systems and operating policies which satisfy passenger requirements. Literature review efforts were undertaken to survey attitudinal and marketing concepts which could contribute to theory development. Attitudes are divided into three components in order to better understand how they relate to traveler behavior. Hierarchical and multiattribute models are explicitly considered. It is recognized that not all travelers are identical, and market segmentation is an aspect of our modeling orientation designed to account for differences between groups of travelers. A tentative model framework is presented along with an overview of how to quantitatively evaluate variations within the framework. This volume concludes with a review of data collection considerations that support quantitative analyses of traveler attitude-behavior interrelationships.

DOT-TSC-RSPA-78-14. II

### ON THE DEVELOPMENT OF A THEORY OF TRAVELER ATTITUDE-BEHAVIOR INTER-RELATIONSHIPS:

Volume II: Theoretical and Empirical Findings

Charles River Associates Incorporated

PB-286 664

CRA # 347

DOT-TSC-1326-II

Final Report August 1978 246p.

Choice of transportation

The second volume of this final report presents conceptual and empirical findings which support the development of a theory of traveler attitude-behavior interrelationships. Such a theory will be useful in the design of transport systems and operating policies which satisfy passenger requirements. A brief consideration of theoretical concepts precedes the review of our empirical methodology. Structural equations, flowgraphs and two-stage least squares are simply explained because they

provide a framework for understanding theoretical and empirical findings. General empirical results comprise a substantial portion of this report. The structure of traveler attitude-behavior interrelationships is examined for two transport modes, buses, and carpools, over three different datasets. Among the major findings are that traveler attitudes influence behavior toward transport alternatives and that traveler attitudes and behavior mutually affect each other. Various theoretical extensions of this work are described. A new quantitative procedure for assessing differences between travel market segments is developed and implemented. The relevance of the modeling orientation to transport system design and policy analysis is noted. Some implications of the modeling approach for data collection efforts are also noted.

DOT-TSC-RSPA-78-14. III

### ON THE DEVELOPMENT OF A THEORY OF TRAVELER ATTITUDE-BEHAVIOR INTER-RELATIONSHIPS:

Volume III: Executive Summary, Overview of Methods, Results, and Conclusions

Charles River Associates Incorporated

PB-286 655

CRA # 347

DOT-TSC-1326-III

Final Report August 1978 38p.

Choice of transportation

The executive summary of this Final Report offers an overview of methods, results, and conclusions which support the development of a theory of traveler attitude-behavior interrelationships. Such a theory will be useful in the design of transport systems and operating policies which satisfy passenger requirements. A summary of project methods and achievements as evidenced by project reports serves as an introduction of theoretical considerations which guided the study. Various attitudinal components are identified and defined. Brief discussions of multiattribute models, hierarchical models, market segmentation, and structural equations

## RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION

ion, a transportation-sensitive dynamic model of the evolution of the organization of urban centers was developed.

Volume I presents a model of the evolution of the organization of urban centers.

### DOT-TSC-RSPA-78-20. II DYNAMIC MODELS OF URBAN EVOLUTION Volume II: Intra-Urban Evolution

University of Brussels

M. Allen, J. L. Deneubourg, M. Sanglier, F. Boon, and A. dePalma  
DOT-TSC-1185  
3-289 958

Interim Report      October 1978      136p.

Cities and towns — Growth

In this report the concept of "order by fluctuation," that has appeared recently in physico-chemical and biological systems, is applied to the description of urban growth. It is shown that fluctuations play a vital role in the evolutionary process of urban growth. The evolution of a complex system cannot be known simply by studying the deterministic equations describing the system. It is necessary, in addition, to study the effects of fluctuations or historical accident which can drive the system to new modes of behavior. Taking account of both the deterministic elements of urban growth and the occurrence of fluctuations in population in an urban region, a transportation-sensitive, dynamic model of the evolution of the spatial distribution of urban populations was developed.

Volume II analyzes the spatial distribution of urban populations.

### DOT-TSC-RSPA-78-21 DYNAMIC URBAN GROWTH MODELS

University of Brussels

M. Allen, J. L. Deneubourg and M. Sanglier  
3-289 900

DOT-TSC-1185  
Interim Report      December 1978      64p.

Cities and towns — Growth — Mathematical models

In this report the concept of "order by fluctuation," that has appeared recently in physico-chemical and biological systems, is applied to the description of urban growth. It is shown that fluctuations play a vital role in the evolutionary process of urban growth. The evolution of a complex system cannot be known simply by studying deterministic equations describing the system. It is necessary, in addition, to study the effects of fluctuations, or historical accident, which can drive the system to new modes of behavior. Taking account of both the deterministic elements of urban growth and the appearance of innovations at chance locations in an economic region, a transportation-sensitive dynamic model of the evolution of the organization of urban centers and the evolution of the spatial distribution of urban populations was developed.

### DOT-TSC-RSPA-78-22 PROGRAM PLAN FOR FLIGHT TEST EVALUATION OF LORAN-C IN THE STATE OF VERMONT

Transportation Systems Center

Harold Stein

Interim Report      November 1978      40p.

Loran — Testing

A plan is described to evaluate Loran-C as an air navigation system suitable for enroute, terminal and nonprecision approaches to airports. The plan presents the test objectives as well as the data and testing requirements necessary to evaluate Loran-C. The primary objectives of the program are also defined as follows:

- 1) Evaluate the reception qualities of Loran-C in a typical airport environment.
- 2) Ascertain feasibility of predicting Loran-C time difference variations as a function of distance and bearing from a particular Loran-C monitor station.
- 3) To assess the repeatability and magnitude of Loran-C "grid bias or grid error" as a function of range and bearing from a given point.
- 4) Document, by monitoring and recording, the Loran-C signal quality as a function of seasonal changes during short and long-term periods at various predefined locations in the test area.



## URBAN MASS TRANSPORTATION ADMINISTRATION

**OT-TSC-UMTA-76-19**

### **EXCITATION OF SURFACE ELECTROMAGNETIC WAVES ON RAILROAD RAIL**

University of Missouri-Rolla

J. A. Goben and M. Davenport

3 279-853

MTA-MA-06-0025-77-18

OT-TSC-1150

University Research Final Report March 1978 65p.

car-couplings

railroads — Signalling

local transit — Signalling

MTA's Office of Rail Technology research programs aim to improve urban rail transportation systems safety. This rail-transit research study attempts to develop an onboard, separate and independent obstacle-detection system — Surface Electromagnetic Wave (SEW) — so that rear-end train collisions can be avoided. The use of SEW for communication, control, and obstacle-detection on guided railroad systems is already underway in the United States, United Kingdom, Japan, and Canada. SEW have been successfully used on the surface of standard railroad rail and other metallic surfaces. In this report, the preliminary investigation of the propagation properties of SEW on rail surfaces indicates that there exist applications in train-and-obstacle detection. The excitation efficiencies of two types of SEW couplers (prism and grating) are measured as functions of frequency, vertical displacement (h) of the coupler above the rail, horizontal displacement (a) of the coupler from rail center, pitch angle (Phi) of the coupler, and yaw angle (Psi) of the coupler. The coupling efficiencies for both prism and grating couplers show a dependence on vertical displacement above the rail; horizontal displacement from rail center, pitch, roll, and yaw angles of the couplers. Measurements of radiation patterns are also made on the two types of SEW couplers in the vicinity of the rail and in isolation at several microwave frequencies. The results of radiation pattern data show that to meet the FCC specification of 500 uV/m at 100 ft from the coupler for 100 mW input, the couplers must be redesigned. The data indicate that both the prism coupler and grating coupler will operate successfully on a moving track-guided vehicle.

**DOT-TSC-UMTA-77-13**

### **SERVICE AND METHODS DEMONSTRATION PROGRAM ANNUAL REPORT — EXECUTIVE SUMMARY**

Transportation Systems Center

H. Slavin, D. Kendall, C. Heaton

UMTA-MA-06-0049-77-1

Final Report April 1977 28p.

Local transit

This report contains a summary description of the Service and Methods Demonstration Program. Recently completed and current and future demonstration projects are described and project results from similar demonstrations are compared. The comparisons are made by grouping projects according to the program objectives addressed: (1) decrease transit travel time, (2) increase transit reliability, (3) increase transit coverage, (4) increase transit vehicle productivity, and (5) improve the mobility of transit dependents.

Independent activities carried out in support of the demonstrations are described, such as the development of evaluation guidelines and improved methodologies for demonstration evaluation, analytical studies in support of the development of experimental demonstrations, studies of independent local innovations, and case studies of transit operations in small communities. Information dissemination mechanisms and activities intended to facilitate more widespread knowledge of effective approaches to improving transit are discussed.

**DOT-TSC-UMTA-77-19**

### **USER-SIDE SUBSIDIES FOR SHARED RIDE TAXI SERVICE IN DANVILLE, ILLINOIS: Phase I**

Crain & Associates Urban Consultants

Peter G. Fitzgerald

PB-292 805

UMTA-IL-06-0034-77-1

DOT-TSC-1081

Final Report June 1977 234p.

Taxicabs

Local transit — Illinois — Danville

## URBAN MASS TRANSPORTATION ADMINISTRATION

ape. Evaluation of the system's performance is provided by off-line simulation, which reflects the conditions and processing procedures proposed for the Phase II AVM tests in Los Angeles.

The report is divided into four volumes. This volume contains an Executive Summary of the Philadelphia Phase I test results.

### **DOT-TSC-UMTA-77-36.II FIELD TESTING OF A PULSE TRILATERATION AUTOMATIC VEHICLE MONITORING SYSTEM IN PHILADELPHIA Vol. II: Test Results and Data**

Hazeltine Corporation  
James F. O'Connor, Alexander H. Riccio  
UMTA-MA-06-0041-77-5  
DOT-TSC-1236  
Final Report August 1978 262p.

Automatic vehicle monitoring

The report is divided into four volumes. This volume presents the Philadelphia Phase I test results and data. It describes the Hazeltine AVM system and the test configuration in detail. This volume also explains the data analysis and reduction techniques used, and proposes changes which would be made in the system prior to Phase II.

### **DOT-TSC-UMTA-36.III FIELD TESTING OF A PULSE TRILATERATION AUTOMATIC VEHICLE MONITORING SYSTEM IN PHILADELPHIA**

**Vol. III: Test Histograms**  
Hazeltine Corporation  
James F. O'Connor, Alexander H. Riccio  
UMTA-MA-06-0041-77-6  
DOT-TSC-1236  
Final Report August 1978 98p.

Automatic vehicle monitoring

The report is divided into four volumes. This volume contains time point and location accuracy histograms for the fixed route, random route, and special case tests discussed in Volume 2 (Section 4).

### **DOT-TSC-UMTA-77-36.IV FIELD TESTING OF A PULSE TRILATERATION AUTOMATIC VEHICLE MONITORING SYSTEM IN PHILADELPHIA**

**Vol. IV: Test Log Sheets**  
Hazeltine Corporation  
James F. O'Connor, Alexander H. Riccio  
UMTA-MA-06-0041-77-7  
DOT-TSC-1236  
Final Report August 1978 178p.

Automatic vehicle monitoring

The report is divided into four volumes. This volume accounts for aborted and excluded tests, and reproduces vehicle log sheets for all tests.

### **DOT-TSC-UMTA-77-37 DEVELOPMENT OF ECONOMIC FACTORS IN TUNNEL CONSTRUCTION**

Bechtel Inc.  
L. R. Damskey and G. T. Gin  
PB 280-878  
UMTA-MA-06-0025-77-16  
DOT-TSC-1104  
Final Report December 1977 183p.

Tunneling — Economic aspects  
Subways — Design and construction — Economic aspects

The escalating cost of underground construction of urban transportation systems has made transit planning, especially construction cost estimating, difficult. This is a study of the cost of construction of underground, rapid transit tunnels in soft ground and is sponsored by UMTA's Office of Rail Technology.

Twenty-two tunnels from the San Francisco Bay Area Rapid Transit District (BART), the Chicago Metropolitan Sanitary District, and the Washington DC, Metropolitan Area Transit Authority (WMATA) have been ana-

## URBAN MASS TRANSPORTATION ADMINISTRATION

sition of valid test data using the system. The GVTS includes measurement systems for vehicle voltage, current, acceleration/vibration, pressure, temperature, displacement, strain and test reference data. Each individual measurement system is described in detail in the Appendix of this document. This document presents a system overview of the entire GVTS as well as a summary of the instrumentation systems referenced to the applicable Standard Outputs of the GVTP. It also describes signal monitor and calibration equipment and electrical shielding and grounding techniques. Descriptions of the supporting documentation file, the inventory control system, and miscellaneous system notes are also included. References are listed in this report.

A companion document, GENERAL VEHICLE TEST INSTRUMENTATION EVALUATION (PB 260-580) reports the results of evaluative tests performed on the instrumentation systems.

### **DOT-TSC-UMTA-77-43 USER'S GUIDE FOR THE INTERACTIVE SCHEDULING PROGRAM: PRELIMINARY CALENDAR VERSION**

Transportation Systems Center  
Paul J. Downey  
UMTA-MA-06-0074-78-1  
Operational Handbook      August 1978      30p.

Electric railroads — Cars — Maintenance and repair —  
Data processing  
Local transit — Data processing

This document describes the user's guide for the preliminary calendar version of an interactive scheduling program which was developed to aid transit authorities in the scheduling of their warranty maintenance inspections. By utilizing a set of program commands the user is allowed to enter and extract data relative to vehicle warranty scheduling. A scheduling algorithm was developed for this program which incorporates a variable work window whose purpose is to minimize fluctuations in the daily workload. This minimization results in less required manpower and overtime, and, therefore, a reduced maintenance cost. It is anticipated that a version of this program, based on mileage rather than calendar days, will be developed in the near future.

### **DOT-TSC-UMTA-77-46 AUTOMATED GUIDEWAY TRANSIT SERVICE AVAILABILITY WORKSHOP**

Transportation Systems Center  
C. W. Watt, Editor  
PB-282 295  
UMTA-MA-06-0048-77-4  
Final Report      February 1978      422p.

Automated guideway transit — Congresses

A workshop was conducted by the Transportation Systems Center to discuss, from a number of viewpoints, the meaning, specification, and measurement of service availability in automated guideway transit (AGT) systems. The makeup of the workshop insured that the widest spectrum of informed opinion was brought to bear on the questions involved. These included definitions of service availability; the way it is being, or should be, specified, predicted, and measured; and how, for a transit system, such a system-level parameter can be translated into meaningful and measurable hardware requirements for designers and builders. Four panels of participants experienced in this area discussed these questions; the texts of their remarks are presented in this report, with only minor editing. In addition, much discussion was generated; this is also presented in the report, with only enough editing to provide continuity and clarity.

The discussions illustrated clearly the wide spectrum of meanings currently given to the term "service availability." The positions taken by representatives of the various portions of the transit industry — properties, designers, researchers, and manufacturers — showed the variety of ways in which system performance is specified and evaluated today, and the reasons for such a variety.

### **DOT-TSC-UMTA-77-49.I PARATRANSIT VEHICLE TEST AND EVALUATION Volume I: Ride Comfort and Quality Tests**

Dynamic Science, Inc.  
L. Wesson, C. Culley, R. L. Anderson  
UMTA-MA-06-0052-78-1  
DOT-TSC-1241-1  
Final Report      June 1978      216p.

## URBAN MASS TRANSPORTATION ADMINISTRATION

### DOT-TSC-UMTA-77-49.V PARATRANSIT VEHICLE TEST AND EVALUATION

#### Volume V: Noise Tests

Dynamic Science, Inc.

L. Wesson, C. Culley, R. L. Anderson

UMTA-MA-06-0052-78-5

DOT-TSC-1241-5

Final Report June 1978 56p.

#### Taxicabs — Testing

This volume (Volume 5) presents the test procedures and results of the noise tests conducted on the two paratransit prototypes and the baseline test vehicle. The test series measured external vehicle noise during acceleration, constant speed, and stationary at idle conditions. Interior noise at each of the passenger locations and in the driver's compartment was also measured under the above conditions.

### DOT-TSC-UMTA-77-50 PROCEEDINGS — WORKSHOP ON MATERIALS HANDLING FOR TUNNEL CONSTRUCTION

Colorado School of Mines

Robert R. Faddick, James W. Martin, Editors

PB 276-602

UMTA-MA-06-0025-77-19

Workshop/Handbook August 1977 291p.

#### Tunneling — Congresses

#### Subways — Design and construction — Congresses

With the anticipated increases in tunnel construction in the next decade, greater demands will be made on transportation systems to remove tunnel muck at rates consistent with tunnel excavation rates. This workshop discussed and noted that conventional materials-handling systems such as rail, rubber-tire vehicles and conveyors will have to expand their capabilities. It was also stated that hybrid and lesser known systems such as pneumatic and slurry pipelines must be considered as potential systems for muck haulage, since they show substantial promise for transporting the muck volumes projected for the next decade.

This workshop was sponsored by the Urban Mass Transportation Administration, and it was held August 3, 4, 5, 1977, at Keystone, Colorado. The purpose of this workshop was to establish a workshop where information and work assignments were submitted in advance to attendees with the goal of producing a definitive document at the close. Experts were invited from the construction, metal and non-metal mining industries. The participants evaluated the state of the art of materials-handling systems for underground construction, exchanged information on current systems applications and research, itemized research needs, and produced a written summary of their conclusions. This document contains the 12 presentation papers, Questionnaire and Workshop Format, Workshop Summaries, Closing Remarks, and a List of Participants. The participants felt that major advancements in the field of materials-handling for rapid transit tunnel excavation would be best implemented by adapting ideas and techniques now used in general underground construction, metal mining, and coal mining.

### DOT-TSC-UMTA-77-51 DEVELOPMENT/DEPLOYMENT INVESTIGATION OF CABINTAXI/CABINLIFT SYSTEMS: FINAL REPORT

Transportation Systems Center

Vivian J. Hobbs, Neil C. Patt, J. Harry Hill

Wolfgang Heckelmann (SNV Studiengesellschaft

Nahverkehr mbH)

PB-277 184

UMTA-MA-06-0067-77-2

UM-836/R8744

Final Report December 1977 424p.

#### Automated Guideway Transit

This study is an investigation of the Cabintaxi/Cabinlift Automated Guideway Transit (AGT) systems under development in the Federal Republic of Germany. It was conducted under a bilateral agreement between the U.S. Department of Transportation and the German Federal Ministry of Research and Technology, and was carried out jointly by The Transportation Systems Center (TSC) and The Studiengesellschaft Nahverkehr mbH (SNV), during the Fall of 1976 and Spring of 1977. The

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storage with those of on-board storage. Using data provided by MBTA, power levels vs. time and rail losses were calculated and used to determine the sizing and location of energy storage units. From the amounts of energy storage required, the costs of the flywheels and i/o equipment were calculated. Utilizing these modules for load leveling was also considered. However, since the energy storage required for load leveling is much greater than that required for regenerative braking, a separate study is needed to examine this in detail.

The study indicates that for systems with station densities and traffic patterns similar to the MBTA Red Line, the inclusion of wayside flywheel modules has a significantly lower first cost, and can be justified on a purely economic basis. This report also addresses recommendations for future study, contains a bibliography, and Appendices A and B: "Vehicle Energy Requirements" and "Report of Inventions", respectively.

### **DOT-TSC-UMTA-78-1 RAPID TRANSIT SUBWAYS — MAINTENANCE AND ENGINEERING REPORT**

Bechtel, Inc.

James Birkmyer

UMTA-MA-06-0025-78-1

DOT-TSC-1078

Final Report      January 1978      278p.

Subways — Maintenance and repair

The maintenance of an underground rapid transit complex requires considerable labor, equipment, and variety of material. This analysis of the maintenance and engineering data of North American and European transit properties identifies the important technical and organizational factors that affect the economics of subway maintenance.

Water seepage in structures is a prime cause of maintenance for many installed items. Methods of repairing defective structures are described and criteria for durability are developed for new structures. To minimize maintenance, escalators, elevators, and pumping and ventilating equipment of the highest quality must be selected and properly maintained. Station finish materials and systems that have demonstrated satisfactory

service in underground stations can appreciably reduce maintenance.

Careful layout and design of details in new installations to facilitate the cleaning process will effectively reduce costs. Cleaning of the trackway and appurtenant structures is important to the functioning of the train support equipment. Trackway cleaning trains are being used increasingly.

Present worth cost analyses comparing installed costs versus maintenance costs provide valuable assistance in evaluating alternative selection of most subway items.

The report presents the data collected, identifies deficiencies, and develops good-practice solutions. Two Guidelines were compiled from the data: Maintenance of Existing Properties and New Installations.

### **DOT-TSC-UMTA-78-2 RAPID TRANSIT SUBWAYS — GUIDELINES FOR ENGINEERING NEW INSTALLATIONS FOR REDUCED MAINTENANCE**

Bechtel Inc.

James Birkmyer

UMTA-MA-06-0025-78-2

DOT-TSC-1078

Guidelines      January 1978      126p.

Subways — Maintenance and repair

Economic design of new subways requires optimization of installation and maintenance costs of all the major constituent items. A prerequisite for this is an awareness of the rigorous environmental and other conditions imposed on the subway.

Durable watertight structures are obtained by using appropriate structural systems, material specifications, construction details, and waterproofing systems. Cathodic protection provides an economic protection against corrosion of metallic items in aggressive soil conditions.

Ventilation and pump structures should be planned for ease of access and maintenance. Vents flush with street or sidewalk increase the dirt load and maintenance; above-surface alternatives should be evaluated.

Escalators are high total cost items and operate under especially arduous conditions. Maintenance costs are reduced by using heavy duty components, adequate

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### DOT-TSC-UMTA-78-7

#### THE TRANSPORTATION OF TUNNEL MUCK BY PIPELINE

Colorado School of Mines

Robert R. Faddick and James W. Martin

PB 281-103

UMTA-MA-06-0025-78-4

DOT-TSC-1114

Final Report      January 1978      178p.

Tunneling

Tunnels — Design and Construction

The view reflected herein is that if the advancement of the technology of muck removal does not keep pace with advances in tunneling machine technology, muck removal can become the limiting constraint on the forward movement of the tunnel face, and hence on the growth of tunneling. The objective of this study is to advance the technology of tunnel excavation by increasing the rate of muck removal from the tunnel face. The highlights in this report are on muck haulage systems by pipeline, and the emphasis is on investigating better techniques and technology, rather than costs.

This report updates muck quantities and to some extent muck quality (in terms of its hardness and geology). Crushing equipment is examined as is extensible conveyor belt equipment. A survey of extensible equipment is made to aid in suggesting approaches for their application in tunnels to pipeline muck haulage. Recent headloss data for coarse slurries are presented for the hydraulic muck haulage system. Consideration is given to a jet pump eductor for feeding a centrifugal pump from a mixing tank. A more compact and less expensive dewatering system is also analyzed. Appendixes A through D provide background material for the systems and concepts herein and include: Pneumatic Pipeline Systems, CONOCO-CONSOL System, Dewatering Equipment, and Coal Hoisting in the U.K. A previous and related study, "Pneumatic-Hydraulic Material Transport System for the Rapid Excavation of Tunnels" (DOT-TSC-75-17), suggested a transportation system for muck haulage with a pneumatic pipeline or a slurry pipeline.

### DOT-TSC-UMTA-78-9. I

#### THE DEVELOPMENT OF MEASURES OF SERVICE AVAILABILITY

Volume I: Summary Report

Battelle Columbus Laboratories

R. D. Leis

UMTA-MA-06-0048-78-2

DOT-TSC-1283-1

Final Report      June 1978      16p.

Local transit

Automated guideway transit

Service availability is defined as the impingement of failures on passenger perceived service. The alternate technologies and applications for Automated Guideway Transit (AGT) systems require service availability measures (SAMs) to gage the impact of alternate reliability and maintainability (R/M) options and goals. The transit industry views various forms of passenger delay potential to be the appropriate parameters of service availability. The propensity of a system to induce delays is a complex function of R/M and operational characteristics. No single measure or model exists which can be uniformly applied to different technologies or applications. A methodology is presented to compute these relationships for simple loop and/or shuttle systems. More complex systems will require computer simulation procedures.

Volume I is a summary of the research effort and results.

### DOT-TSC-UMTA-78-9. II

#### THE DEVELOPMENT OF MEASURES OF SERVICE AVAILABILITY

Volume II: Task Technical Reports

Battelle Columbus Laboratories

R. D. Leis

UMTA-MA-06-0048-78-3

DOT-TSC-1283-2

Final Report      June 1978      194p.

## URBAN MASS TRANSPORTATION ADMINISTRATION

### **DOT-TSC-UMTA-78-12 EVALUATION PLAN – THE MINNEAPOLIS RIDESHARING COMMUTER SERVICES DEMONSTRATION**

Cambridge Systematics, Inc.

Len Sherman

UMTA-MA-06-0008-78-1

DOT-TSC-1405.2

Final Report      May 1978      140p.

Carpools – Minnesota – Minneapolis

Vanpools – Minnesota – Minneapolis

Commuting – Minnesota – Minneapolis

In April 1977, the Metropolitan Transit Commission initiated a two-year demonstration project designed to increase work trip-vehicle occupancy at selected employment sites in the Twin Cities region. Key elements of this demonstration which differentiate it from previous ridesharing promotion efforts are the reliance on a regional transit agency to serve as broker in marketing, coordinating, and monitoring the program; the promotion of a wide range of ridesharing services including carpools, vanpools, and subscription bus; and the choice of multi-employer sites as the focus of the program. Three demonstration sites have been chosen, ranging in size from 3,600 to 7,700 employees. All of these sites are multi-employer complexes outside the Central Business District of Minneapolis.

The evaluation of the Commuter Services demonstration will have two main objectives. First, it is intended that the evaluation provide a detailed, chronological process description of the brokerage service. While some of the institutional, legal, and administrative issues involved in the demonstration will be a site-specific nature, the evaluation report should nonetheless serve as a reference guide to other interested agencies, indicating the type and range of issues they may confront in establishing a ridesharing brokerage service. The second major objective of this evaluation is to provide a statistically sound assessment of the results of the demonstration project. Issue areas to be analyzed include level-of-service changes, demand shifts, and the costs, productivities, and economics of the ridesharing modes promoted in the demonstration.

### **DOT-TSC-UMTA-78-14/UMTA-MA-06-0052-78-6 LOW LIFE CYCLE COST DESIGN STUDY FOR PARATRANSIT VEHICLES**

ASL Engineering, Inc.

J. A. Bartol and J. G. Bishop

DOT-TSC-1351

Final Report      July 1978      210p.

Taxicabs – Economic aspects

Taxicabs – Design and construction

This report describes how the original prototype of the AMF Paratransit vehicle was redesigned to achieve low life cycle cost for projected low volume production rates. Cost estimates were prepared for the major elements of the life cycle costing including manufacturing, maintenance and repair costs. It was concluded that a paratransit vehicle, with all of the special features of this design, could be acquired, and utilized over its extended service life at a net cost to the operator that would be less than that of a conventional taxi-cab.

### **DOT-TSC-UMTA-78-14/UMTA-MA-06-0052-78-7 LOW LIFE CYCLE COST PARATRANSIT VEHICLE DESIGN STUDY**

Dutcher Industries, Inc.

Philip H. Schneider and David D. Norton

DOT-TSC-1352

Final Report      August 1978      84p.

Taxicabs – Design and construction

Taxicabs – Economic aspects

Demand responsive transportation – Cost of operation

A preliminary design and cost study was performed for a low life cycle cost paratransit vehicle. The manufacturing technique and cost analysis were based on limited production of 5000 units per year for a ten year period.

The vehicle configuration resembles a small van which will carry six passengers including a passenger confined to a wheelchair. A low floor is standard, and ramps can be provided to make wheelchair entry convenient.

It is estimated that these PTV's could be manufactured for \$10,659.93 each. Operational costs would be

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This report presents the technical portion of an Evaluation Plan for the Danville, Illinois User-Side Subsidy for Fixed-Route Transit demonstration project. Under the project, the City of Danville will initiate competitive bidding processes for short-term (4 month) contracts to provide new fixed-route transit services for all persons in the population. The goal will establish subsidy ratios that will reward the provider on the basis of patronage levels. More than one provider may provide services at the same time. It is hoped that actual competition or the threat of competition will produce cost-effective and user-oriented transit services. For some period of time, the handicapped and elderly sub-market of the population will be offered subsidies (at different levels) on both taxis and fixed-route services.

The demonstration project is funded by the Urban Mass Transportation Administration as part of the Service and Methods Demonstration Program. Crain & Associates, under contract to the Transportation Systems Center of the Department of Transportation will perform the evaluation of the project. This evaluation plan describes the demonstration setting, the project operation, project issues, measures for evaluation and sources of data for assessing the measures.

### **DOT-TSC-UMTA-78-20 COMMUNITY BROKERAGE OF TRANSPORTATION SERVICES FOR THE ELDERLY IN MOUNTAIN VIEW, CALIFORNIA**

Crain & Associates

Tom Cooper

UMTA-CA-06-0002-78-1

DOT-TSC-1081

Final Report February 1978 125p.

Demand responsive transportation – California –  
Mountain View

Physically handicapped – California – Mountain View

Aged – California – Mountain View – Transportation  
Transportation, Rural

This document is a final evaluation of the Mountain View Community Broker Demonstration Project, and it reports on a unique way of providing transportation and transportation-related services to elderly and handi-

capped individuals in a small geographic area. The main objective of this study is directly addressed in that the project proposes to make a new transportation service that combines informational and referral help with a very personalized transportation service to the target group. In this project, a community broker furnished his clients with individualized primary service information and scheduling assistance. He also drove these clients to their destinations in a 12-passenger van. The project was intended to demonstrate the economic and operational feasibility of combining these functions in one role. This report describes the community broker concept and project operations; assesses the economic feasibility of the idea; discusses the project's impact on the target group; and provides some commentary on ways a community-broker type of project could be integrated into the existing network of social services for the handicapped and elderly.

The author concludes that: the most popular trips were for shopping (34%), a nutrition program trip (23%), and commercial meals (11%), the total ridership never reached expected levels (only 112 users); and the estimated operating costs for the project were high (\$29,285 for 8776 passenger trips; cost per trip was \$3.34; revenues totaled only \$3,432, about 12 percent of operating cost; and subsidy cost per passenger trip was \$2.95). This demonstration has not proved the economic feasibility of the community broker concept in the Mountain View area.

### **DOT-TSC-UMTA-78-21 PARATRANSIT INTEGRATION SYMPOSIUM PROCEEDINGS: October 14, 1977**

Systems Architects, Inc., Transportation

Systems Division

D. Krechmer, J. Strawbridge, P. Wenger, S. Zavatsky

UMTA-MA-06-0054-78-2

DOT-TSC-1369

Proceedings June 1978 48p.

Demand responsive transportation – Congresses  
Taxicabs – Congresses



## URBAN MASS TRANSPORTATION ADMINISTRATION

The focus is on the use of DRT systems to provide feeder services to fixed transit routes in low density areas. A methodology for considering such services within the framework of UTPS modeling is presented herein.

A set of previously developed DRT supply models, representing many-to-many service, many-to-one cycled service, and many-to-one subscription service have been refined for the purposes of this report. These services are discussed and general guidelines for designing feeder services offered. The models themselves are described in detail (Appendix A), and the program listings provided (Appendix C). In addition, a series of nomographs (Appendix B) based on model results have been developed to enable the analyst to predict the service levels of DRT feeder systems under a range of conditions. Examples of the use of these nomographs, and the overall approach to modeling DRT feeder systems within UTPS, are also included in Appendix B. This report also provides a bibliography and a glossary of terms.

### DOT-TSC-UMTA-78-24

#### THE RESTRAINT OF THE AUTOMOBILE IN AMERICAN RESIDENTIAL NEIGHBORHOODS

Moore-Heder Architects

Howard Simkowitz, Lajos Heder, and Edward Barber  
PB 287-485

UMTA-MA-06-0049-78-3

DOT-TSC-1405

Final Report      May 1978      73p.

Traffic regulations  
Traffic engineering  
Automobile parking

This paper reviews two techniques for restraining the use of the automobile: residential parking permits and traffic restraint devices. Parking permits are issued when parking by non-residents interferes with the parking needs and other neighborhood needs of the resident. Traffic restraint devices are physical measures placed on residential streets to inhibit the flow of traffic and to divert this traffic to designated streets. The first half of this paper discusses parking policies, the causes of the parking problem, the effects it has on the neighborhood,

and the parking permit as a solution to this problem. A summary of parking policies in 40 communities and case studies for Cambridge, MA, San Francisco, CA, and Washington, DC are provided. The second half of the paper concerns the use of traffic restraint devices in neighborhoods and addresses the problem of through-traffic and its negative effects. Traffic restraint devices appear to be the most readily available solution to the problem, and their implementation and effectiveness are discussed. The devices are used in the United States and their use in 37 communities and case studies from Berkeley, CA and Seattle, WA are summarized. The report concludes that parking permit programs have become a popular means of restraining the use of the automobile in residential areas, and that existing programs have been successful in accomplishing their goals in which parking has been made available to local residents: non-resident traffic has been reduced; and the neighborhood environment has been improved. Most of the traffic restraint schemes have occurred in relatively less dense cities with a grid street pattern and sufficient reserve street capacity to accommodate the diverted traffic without causing serious congestion.

### DOT-TSC-UMTA-78-25

#### SOUTHEAST EXPRESSWAY HIGH OCCUPANCY VEHICLE LANE EVALUATION REPORT

Transportation Systems Center

Howard Simkowitz

PB 285-209

UMTA-MA-06-0049-78-4

Final Report      May 1978      77p.

Bus lanes — Massachusetts — Boston  
Traffic engineering — Massachusetts — Boston  
Carpools — Massachusetts — Boston

Unlike other reserved lane projects, implementation of the express lane on Boston's Southeast Expressway was timed to coincide with the mandatory reconstruction of portions of the roadway. The reserved lane was introduced to avoid total chaos on the Expressway. The purposes of this evaluation report were (1) to measure the impacts of the project; (2) to identify measures to improve the operation of the Expressway reserved lane;

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the Research and Special Programs Administration's Transportation Systems Center in Cambridge, Massachusetts. Twenty-eight papers were presented by experts from government and industry on system operations, passenger security, vehicle control and reliability, guideway and station structures, all-weather operation, ride comfort, deployed system assessments, automated highways, and developments in Canada, France and West Germany. The formal presentation of papers was followed by working sessions in the areas of system operations, vehicle systems and reliability, safety and security, wayside systems and all-weather operation, innovative transit, and social and economic factors. This report contains the proceedings of the conference.

### **DOT-TSC-UMTA-78-31 SAMPLE DESIGN FOR DISCRETE CHOICE ANALYSIS OF TRAVEL BEHAVIOR: THE STATE OF THE ART**

Cambridge Systematics, Inc. (subcontractor to Multi-systems, Inc.)

Steven R. Lerman and Charles F. Manski

UMTA-MA-06-0049-78-8

DOT-TSC-1083

Final Report      July 1978      70p.

#### Choice of transportation

A review of the state of the art in designing samples for discrete choice analysis of traveller behavior is presented. The basic discrete choice analysis framework is reviewed. It is assumed that any sample used is drawn by a process termed stratified sampling, in which the analyst partitions the population based on attributes and choices made, and then selects the fraction of observations taken within each stratum and the total sample size. Observations within strata are drawn at random. Two related problems, determining the distribution of the attributes in the population and estimating the choice probabilities conditional on the attributes, are explored. Various procedures for solving both these problems are detailed. The role of experimentation in extending the range of attributes in the population is explored.

### **DOT-TSC-UMTA-78-32 IN-SERVICE PERFORMANCE AND COSTS OF METHODS TO CONTROL URBAN RAIL SYSTEM NOISE: INITIAL TEST SERIES REPORT**

De Leuw, Cather & Company

Wilson, Ihrig & Associates

Robert L. Shipley and Hugh J. Saurenman

UMTA-MA-06-0025-78-7

DOT-TSC-1053

Interim Report      August 1978      414p.

#### Railroads — Noise

The purpose of this project is to determine the acoustic and economic effectiveness of resilient wheels, damped wheels, wheel truing, and rail grinding for reducing wheel/rail noise on urban rail transit systems. The project consists of a six-phase series of field tests being performed on the Southeastern Pennsylvania Transportation Authority System's Market Frankford Line, and in-depth interviews with management and operating personnel of the North American steel wheeled rapid transit systems regarding their experience with the above mentioned noise abatement procedures.

This is the third report of this project. The first two reports, the Experimental Design and the Test and Evaluation Plan contained the procedures to be followed in conducting the project. This report includes: (a) the results of the testing performed in Phase I, II, and III including tentative recommendations; (b) changes which have occurred to the Experimental Design and to the Test Evaluation Plan; (c) economic data for the wheel types, rail grinding equipment, and wheel truing equipment under consideration; (d) a preliminary discussion of problems and enumeration of constraints which are relevant to use of these techniques on other systems; (e) a summary of remaining testing to be accomplished under the program including recommended changes to the Experimental Design or to the Test and Evaluation Plan.

It has been determined that overall noise reduction obtained by use of the various techniques is limited by the noise of the propulsion system.

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This document describes the implementation and operation of the Metropolitan Atlanta Rapid Transit Authority's fixed-route, subscription service for handicapped individuals. It is based on a site visit and discussions with several individuals in the Atlanta area. Operational characteristics including the early months of service are presented, as well as pictures/charts depicting the MARTS L-BUS vehicle, floor layout, lift design, lift operation, safety features, wheelchair securement, and problem areas. The subscription service, initiated in May 1977, began with a single bus operating three daily routes and has grown to seven buses operating 27 daily and two weekly routes. The buses are all lift equipped and most have 4 wheelchair positions and seventeen seats. As of May 1978, ridership has increased from 41 to 270 passenger trips per week.

New routes are established by grouping trip origin and destination requests into vehicle tours. At least four handicapped passengers must be able to be served in a single tour before that route is incorporated into the system. The dispersion of the desired trips and origins and destinations has resulted in low productivities and in high passenger trip costs. The net direct operating cost, excluding the extra deadheading due to special garaging requirements, was \$12.54 per passenger trip for the first seven weeks of service with only very light reductions since that time. The major difficulty that users experience with the lift equipment has been getting onto the lift platform unaided. However, with the driver/others to assist them, their usage of the system has not been restricted. Mechanically, the lift equipment has performed better than the Authority's maintenance staff expected.

This report describes recent high occupancy vehicle (HOV) preferential projects in the United States, summarizes the results of these projects and draws implications, and outlines projects which are to be implemented over the next few years. The report describes each of the following approaches to preferential treatment: non-separated concurrent-flow freeway HOV lanes, contra-flow freeway lanes, metered ramp bypass lanes and exclusive ramps, physically separated priority lanes, express bus service and park-and-ride lots, lanes on arterials and CBD streets reserved for buses, bus priority signal systems on arterials and CBD streets, transit malls, and auto restricted zones.

During the late 1960's and early 1970's a variety of priority treatments were attempted. Both capital intensive projects and non-capital intensive projects were implemented during this period. By the middle of the 1970's, thinking within the transportation planning community had moved away from the costly capital intensive priority treatments that require extensive new construction to the more operationally oriented traffic management schemes that use existing facilities in a more efficient manner. Except for the non-separated concurrent flow projects, other non-capital intensive priority treatments on freeways have fared well.

Nearly every HOV priority treatment on freeways has involved the use of new or expanded express bus service and the opening of new park-and-ride lots. Arterial and CBD street bus lanes have been implemented in many cities and transit malls have grown in popularity. Four auto restricted zones are to be built during the next few years.

### DOT-TSC-UMTA-78-37 PRIORITY TREATMENT FOR HIGH OCCUPANCY VEHICLES IN THE UNITED STATES: A REVIEW OF RECENT AND FORTHCOMING PROJECTS

Transportation Systems Center  
Ronald J. Fisher and Howard J. Simkowitz  
UMTA-MA-06-0049-78-11  
Final Report August 1978 34p.

Carpools  
Commuting  
Bus priority techniques  
Bus lanes

### DOT-TSC-UMTA-78-38 PREDICTION AND CONTROL OF NOISE AND VIBRATION IN RAIL TRANSIT SYSTEMS

Transportation Systems Center  
Leonard G. Kurzweil and Robert Lotz  
UMTA-MA-06-0025-78-8  
Final Report September 1978 124p.

Railroads — Noise  
Subways — Noise

This report presents a unified compilation of the techniques, procedures, and data currently available for the

## URBAN MASS TRANSPORTATION ADMINISTRATION

A second report that is more analytical in nature is being prepared. It seeks to quantify the potential benefits and disbenefits of transit malls and identify the circumstances which justify their construction.

### UMTA-MA-06-0049-77-12 THE SANTA MONICA FREEWAY DIAMOND LANES Volume I: Summary

SYSTAN, Inc.

J. W. Billheimer, R. J. Bullemer, C. Fratessa

PB 286-567

DOT-TSC-1084

Final Report September 1977 147p.

Bus lanes — California — Santa Monica  
Carpools — California — Santa Monica  
Commuting — California — Santa Monica

The Santa Monica Freeway connects the City of Santa Monica and downtown Los Angeles. On March 16, 1976, the median lane in each direction of a 12-mile, 8-lane segment of the Freeway was reserved for the exclusive use of buses and carpools. These lanes, known locally as the Diamond Lanes, operated during the peak hours of traffic flow, and marked the first time preferential lanes had been created by taking busy freeway lanes out of existing service and dedicating them to the exclusive use of high-occupancy vehicles. The lanes operated amid much controversy for 21 weeks until August 9th, when the U.S. District Court in Los Angeles halted the project and ordered additional environmental studies prior to its continuation. This report summarizes the findings of the official, objective, independent evaluation of the project.

Much of the controversy surrounding the Diamond Lanes consisted of conflicting claims regarding the ability of the project to accomplish its stated objectives of conserving energy, improving air quality, and expanding effective freeway capacity by increasing the occupancy of buses and automobiles using the Freeway. The project succeeded in increasing carpool ridership by 65% and the increased bus service accompanying the Diamond Lanes caused bus ridership to more than triple. Nonetheless, energy savings and air quality improvements were insignificant, freeway accidents increased significantly, non-carpoolers lost far more than carpools gained, and a

heated public outcry developed which has delayed the implementation of other preferential treatment in Southern California, and has given planners and public officials in other areas ample cause for reflection before attempting similar projects.

### UMTA-MA-06-0049-77-13 THE SANTA MONICA FREEWAY DIAMOND LANES Volume II: Technical Report

SYSTAN, Inc.

J. W. Billheimer, R. J. Bullemer, C. Fratessa

PB 286-568

DOT-TSC-1084

Final Report September 1977 525p.

Bus lanes — California — Santa Monica  
Commuting — California — Santa Monica  
Carpools — California — Santa Monica

### UMTA-MA-06-0049-78-7 THE DOUBLE DECK BUS DEMONSTRATION PROJECT

Executive Summary

CACI, Inc. — Federal

C. H. McCall, Jr., Howard Simkowitz

PB 287-838

DOT-TSC-1082

Final Report May 1978 48p.

Buses

This report is one of three documents that constitute an evaluation of the Double Deck Bus (DDB) Demonstration Project sponsored by UMTA. The project was conducted in Los Angeles and New York City (July 1974-June 1977). The primary objective at the two sites was to assess potential increases in vehicle productivity in an express, limited busway service (L.A.) and in regular service (NYC). DDB carry from 68-84 passengers; conventional buses carry from 45-47 passengers. Both buses require a single transit employee, the driver. In New York City, eight British Leyland double deckers operated on two Manhattan routes characterized by congested traffic, heavy passenger loads, frequent stops, and frequent passenger turnover. In Los Angeles, the two

## URBAN MASS TRANSPORTATION ADMINISTRATION

investigate existing experience with auto restricted zones (ARZ) and multi-user vehicle systems; 2) evaluate their feasibility as concepts applicable to urban transportation systems; 3) identify and evaluate potential sites for suitable demonstration projects; and 4) design demonstration programs for selected sites. The general goals are to preserve and enhance the attractiveness and vitality of urban centers, to improve environmental quality of urban areas, and to encourage increased utilization of non-auto modes of transport. The underlying characteristic of an ARZ as discussed in this study is that of a district or zone distinguished by a higher degree of control over vehicular traffic than the surrounding area. The report discusses techniques for ARZ which have been identified and categorized as physical, operational, economic, and regulatory control measures. The investigation of existing experience with ARZ focuses on U.S. cities and on European cities where the concept is most advanced, such as in Copenhagen, Amsterdam and Vienna, and discusses its similarities and differences. The investigation indicated that there are substantial opportunities for ARZ in American cities. A number of key factors are identified for its successful implementation, such as urban activity patterns, urban design issues, transportation infrastructure, accessibility maintenance, ARZ size, transportation policy impacts, and institutional and legal factors. This report contains Appendix A: "Bibliography" and Appendix B: "Characteristics of Pedestrian Areas in European Cities".

Volume II was produced as part of the Auto Restricted Zone/Multi-User Vehicle System Study sponsored by the Urban Mass Transportation Administration. It documents the results of an investigation into the feasibility of Multi-User Vehicle Systems (MUVS) as a mode of urban transportation and which is often suggested as one solution to the problem of transportation with congested urban areas. Under Phase I of this study, a review of existing experience, an examination of key factors, and an assessment of MUVS feasibility was conducted as the first stage in a potentially in-depth research and experimental effort. MUVS is a paratransit mode of transportation which consists of a fleet of small user-operated vehicles available for rental between terminals within a well-defined service area. Although this study considered a wide array of potential vehicles, the basic concept examined herein is similar to the various short-term rental cars. The goals and objectives of MUVS are to: 1) alleviate congestion and improve traffic flow; 2) increase mobility; 3) provide an additional choice of mode; 4) reduce air pollution from vehicle emissions; 5) reduce noise; 6) conserve energy; and 7) reduce land requirements for parking. An MUVS may be described in terms of its operating environment, fixed facility system characteristics, vehicle design characteristics, and operating policy. A detailed examination of a MUVS as a Central Business District (CBD) circulation service in Amsterdam and in Montpellier, France is presented. Various characteristics of each system are identified and compared. The basic conclusion is that while MUVS serves specific needs in particular situations, it is unlikely that it could provide a vital and viable modal alternative for intra-CBD service with or without auto restrictions. These reasons are discussed. A bibliography on MUVS is also contained herein.

### **UMTA-VA-06-0042-78-2 AUTO RESTRICTED ZONE/MULTI-USER VEHICLE SYSTEM STUDY**

#### **Volume II: Multi-User Vehicle Systems: Feasibility Assessment**

Alan M. Voorhees and Associates, Inc.,  
In association with Cambridge Systematics, Inc.;  
Moore-Heder Architects  
William S. Herald  
PB 286-314  
DOT-TSC-1057  
Final Report      December 1977      105p.

Pedestrians  
Shopping-malls  
Traffic engineering

### **UMTA-VA-06-0042-78-3 AUTO RESTRICTED ZONE/MULTI-USER VEHICLE SYSTEM STUDY**

#### **Volume III: Auto Restricted Zones: Plans for Five Cities**

Alan M. Voorhees and Associates, Inc.,  
In association with Cambridge Systematics, Inc.,  
Moore-Heder Architects  
William S. Herald  
PB 286-315  
DOT-TSC-1057  
Final Report      December 1977      257p.

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ments were presented to the client in a separate report: *Review of Potential Demonstration Sites*. The clients, TSC and UMTA made the final selection of sites, using a four-point process: city contact; initial screening; second stage screening; and recommendation. Several cities have developed the framework of a comprehensive approach to the entire Central Business District. Other cities have instituted programs that in time, will restructure the transport balance within the center city. The efforts to locate a suitable demonstration site for MUVS were unsatisfactory, as none were identified. Further effort to identify a situation for an MUVS demonstration offers promise if further evaluation is judged to be worthwhile. Appendices A and B: "City Contact Documentation, Initial Contact Letter, and Information Request" and "City Summary Fact Sheets" respectively, are contained herein.

### UMTA-VA-06-0042-78-5 AUTO RESTRICTED ZONE/MULTI-USER VEHICLE SYSTEM STUDY

Technical Appendix: Boston Auto Restricted  
Zone Study

Alan M. Voorhees and Associates, Inc.,  
In association with Cambridge Systematics, Inc.;  
Moore-Heder Architects;  
A. T. Kearney, Inc.

William S. Herald  
PB 286-317

DOT-TSC-1057

Final Report      December 1977      155p.

Pedestrians  
Shopping-malls  
Traffic engineering

This report is an Appendix to the Auto Restricted Zone/Multi-User Vehicle System Study sponsored by the Urban Mass Transportation Administration. It is a proposal for an auto restricted zone (ARZ) and for revised circulation patterns in downtown Boston. In the City of Boston, the main problems can be summarized as congestion, conflict of pedestrian and traffic, and confusion, rather than a lack of basic vitality. This study seeks to remedy the current imbalance of pedestrian versus auto use, and to

reduce the prevailing congestion in the older downtown. The objective is not to eliminate vehicles, but to promote a more appropriate balance in the use of public spaces, which would enhance the long-range economic future as well as the environment of the downtown area. The need to eliminate these problems, to create an appropriate environment for the existing or potential activities, and to improve connections among major activity areas are the basic factors for an Urban Design Plan. The goal for undertaking this proposed ARZ plan is to encourage the continued physical and economic revitalization of downtown Boston. The general objectives are to: 1) set up a more balanced circulation framework; 2) make the streets more attractive through an ongoing program; and 3) set up improved environmental management programs for the area. This report is comprised of Appendices A through D: Urban Design; Transit and Travel Demand; Traffic and Parking; and Goods Movement. These Appendices are broken down into detailed chapters that discuss the development, description, impact and evaluation of the plan concepts and address the ARZ plan proposals. It is expected that the program proposed here could aid the City in further capitalizing on the substantial investments already made in the downtown, and could assist with solving the general downtown congestion.

### UMTA-VA-06-0042-78-6 AUTO RESTRICTED ZONE/MULTI-USER VEHICLE SYSTEM STUDY

Technical Appendix: Burlington Auto Restricted  
Zone Study

Alan M. Voorhees and Associates, Inc.,  
In association with Cambridge Systematics, Inc.;  
Moore-Heder Architects;  
A. T. Kearney and Co., Inc.

William S. Herald  
PB 286-318

DOT-TSC-1057

Final Report      December 1977      128p.

Pedestrians  
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## URBAN MASS TRANSPORTATION ADMINISTRATION

taken in planning the circulation framework for the Memphis ARZ was somewhat different than that used in the other cities. Memphis had recently implemented a major change in its downtown circulation system by closing ten blocks and creating the Mid-America Mall. The Mall is active at midday during the week, but the evenings and weekends are quiet. Given the density, auto orientation, and customary use patterns of its citizens, the downtown is not likely to benefit from major street closings or changes in traffic patterns. However, selective and modest additions could extend the Mall to a larger district, provide better facilities for the now disadvantaged transit riders, and encourage development projects that could improve street environment and support conversion of now-vacant buildings. At this level, an ARZ demonstration could enhance the environment and activity potential of downtown Memphis. This report is comprised of Appendices A through D: Urban Design; Transit and Travel Demand; Circulation and Parking; and Goods Movement.

### UMTA-VA-06-0042-78-8 AUTO RESTRICTED ZONE/MULTI-USER VEHICLE SYSTEM STUDY

Technical Appendix: Providence Auto Restricted  
Zone Study

Alan M. Voorhees and Associates, Inc.;  
In association with Cambridge Systematics, Inc.;  
Moore-Heder Architects;  
A. T. Kearney and Co., Inc.  
William S. Herald  
PB 286-320  
DOT-TSC-1057  
Final Report      December 1977      207p.

Pedestrians  
Shopping-malls  
Traffic engineering

This report is an Appendix to the Auto Restricted Zone/  
Multi-User Vehicle System Study sponsored by the  
Urban Mass Transportation Administration. It presents  
technical analysis, data and supplementary information  
developed in the preparation of the Providence ARZ  
Demonstration Plan. Several existing urban design fac-

tors are critical to assess the potential for an ARZ in Providence: pedestrian environment; connections between downtown districts; quality of economic environment; and management of public spaces. These issues are discussed in the text and the urban design proposals address these as problems that the ARZ should help resolve. The City built a shopping mall, which was intended to compete with the increasing number of suburban shopping centers and to reestablish the downtown as the activity center of the City. However, while pedestrian volumes still remain high, several stores on the mall have closed. This trend suggests that the downtown may need solutions other than just pedestrianization. Several plans and developments that relate to the ARZ study have been proposed or are being prepared. The City has advanced proposals to expand the mall along with a major rehabilitation of its existing ARZ. This report addresses these proposals and the feasibility of creating a major expanded ARZ in the downtown. This program is expected to offer new energy and direction for the downtown and to reestablish this area as the center of life in the City. This report is comprised of Appendices A through D: Urban Design; Transit and Travel Demand; Circulation and Parking; and Goods Movement. These chapters discuss the development, description, impact, and evaluation of the Urban Design Plan and the ARZ proposals.

### UMTA-VA-06-0042-78-9 AUTO RESTRICTED ZONE/MULTI-USER VEHICLE SYSTEM STUDY

Technical Appendix: Tuscon Auto Restricted  
Zone Study

Alan M. Voorhees and Associates, Inc.,  
In association with Cambridge Systematics, Inc.;  
Moore-Heder Architects;  
A. T. Kearney and Co. Inc.  
William S. Herald  
PB 286-321  
DOT-TSC-1057  
Final Report      December 1977      162p.

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