

UMTRI

84649

VOLUME TWO

THE PROCEEDINGS OF THE 1992

ANNUAL MEETING

OF

IVHS AMERICA

Surface Transportation and the Information Age

May 17-20, 1992

Newport Beach, California

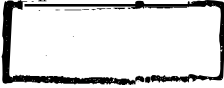
**Transportation
Research Institute**



IVHS AMERICA

1776 Massachusetts Ave., N.W.
Suite 510
Washington, DC 20036-1993
(202) 857-1202 • FAX (202) 296-5408

IVHS AMERICA



All Rights Reserved. No portion of this proceedings may be reproduced or utilized in any form or by any means, electronic or mechanical, including electrostatic or photocopying, recording, information storage or retrieval systems or computers, without prior permission in writing from IVHS AMERICA.

Some of the material in these proceedings may be available elsewhere, in one form or another; however, it is available nowhere else as it is arranged herein. Although the collection and compilation of information has been carefully prepared and represents a significant employment of staff time and resources, the accuracy and validity of text and data are the responsibility of the various authors and not IVHS AMERICA.

© 1992 IVHS AMERICA, 1776 Massachusetts Avenue, N.W., Suite 510, Washington, D.C. 20036-1993

This publication was designed and printed by

CASET
ASSOCIATES, LTD.
10201 LEE HIGHWAY #180
FAIRFAX, VA 22030

Table of Contents - Volume One

Opening General Session

Lester P. Lamm, presiding

- Welcome 3
James W. van Loben Sels, Lester P. Lamm, Kan Chen
- Keynote 9
F. Alan Smith

General Session

United States Department of Transportation: A Look To The Future

- Lester P. Lamm, presiding 15
- USDOT: A Look to the Future, Norman Van Ness 18
- IVHS - A Paradigm Shift, Ronald J. Fisher 20
- NHTSA: A Look To The Future, William Leasure 22

International Session

Japan

Taka-aki Katoh, presiding

- Current Status and the Future Plan of Traffic Control Systems in Japan 27
Hiroshi Kurauchi
- Latest Movement of VICS (Vehicle Information and Communication Systems) in Japan 36
Yataka Miyata, Yasuhiko Kumagai, Michial Hayami, Megumu Tanefusa
- Advanced Road Traffic System (ARTS) in Japan 42
Hironao Kawashima, Masao Shibata, Tetsuo Matsumura, Hiroshi Tsunomachi
- Research and Development Project for "INFO-MOBILITY" Technology 50
Sadayuki Tsugawa, Nobuo Watanabe, Haruki Fujii, Masahiro Hirayama

International Session

Europe

Fotis Karamitsos, presiding

- DRIVE II: Plans and Progress 61
Fotis Karamitsos
- PROMETHEUS - Safe and Effective Mobility in Europe Achievements and Development 69
Hans-Peter Glathe
- ERTICO: Mission and Organization 81
Jean Pierre Camus
- Implementation Issues for RTI Systems 91
Panelists:
 - Towards Global Standardization in Geographic Data Used in Traffic Information Systems 91
A.A. De Taeye
 - The Transrout/I.S.I.S. System 93
Francois Guerout
 - The Cambridge Congestion Pricing System 93
Anthony R. Pratt



Advanced Vehicle Control Systems (AVCS)

William A. Leasure, presiding

95

DIVERSE OPERATING CONCEPTS

- **Autonomous Intelligent Cruise Control** 97
Petros A. Ioannou, John Hauser, C. C. Chien
- **Cooperative Vehicle/Highway System for Automated Vehicle** 113
Norio Komoda, Hidetoshi Ichikawa, Takashi Shigematsu, Toshihiko Suzuki, Keiji Aoki
- **The Current Status of Personal Vehicle Systems (PVS)** 124
Katsunori Oshiage, Masaaki Taniguchi, Akio Hosaka
- **Automated Highway System Experiments in the PATH Program** 131
Kwang Soo Chang, J. Karl Hedrick, Pravin O. Varaiya,
Masayoshi Tomizuka, Wei-Bin Zhang, Steven E. Shaladover

Legal Issues Session

147

David H. Hugel, presiding

MEETING IVHS LEGAL CHALLENGES

- **Reviewing the Role and Mission of the Legal Issues Committee - Update on Committee Activities** 149
David H. Hugel
- **Government Procurement: Successful Decision Making When Uncle Sam is Your Customer** 151
Gena E. Cadieux
- **Tort Liability and IVHS Today** 157
Edward L. Ramsdell

Commercial Vehicle Operations (CVO) Session

165

Douglas J. McKelvey, presiding

LEADING INITIATIVES IN CVO

- **An Update of the Major CVO Corridor Deployments:
HELP/CRESCENT/Advantage I-75/CVO Technical Affairs** 167
C. Michael Walton
- **Institutional Barriers and Opportunities For Intelligent Vehicle-Highway Systems
In Commercial Vehicle Operations: An Iowa Case Study** 172
Thomas H. Maze, Mark E. Maggio, William McCall
- **IVHS at the Borders: The Ontario/Michigan Crossover Strategy** 190
Milton D. Harmelink
- **PROMETHEUS and DRIVE - Managing Problems or Providing Solutions** 194
Klaus W. Nielsen

Standards & Protocols Session	199
Richard J. Weiland, presiding	
IVHS STANDARDS: WHERE WE'RE HEADED, HOW WE'RE GETTING THERE	
• A Methodology for Incorporating IVHS AMERICA Committee Operations into the Development of User-Driven Standards	201
Thomas I. Dayharsh, Terrence J. Yung	
• Moving Toward a Software Quality Process for IVHS: A Case Study of Three Industries	210
Paula Okunieff, Anthony Hitchcock	
• Standards for Electronic Toll and Traffic Management: A Progress Report	219
Kelly P. Gravelle	
• Control Systems and System Interfaces	222
Sydney F. Bowcott	
Electronic Toll & Traffic Management (ETTM) Session	225
George P. Zilocchi, presiding	
• ETTM - Current Developments	227
Carney J. Campion	
• Advanced Traffic Management in New York/New Jersey Metropolitan Area Using ETC Technology	231
Lawrence Yermack, Thomas Batz	
• Automatic Debiting Systems in France and Future European Developments	234
Francois Guerout	
• Implementation of Dedicated ETTM Toll Lanes Dallas North Tollway	239
James W. Griffin, Kris N. Wuestefeld	
• Oklahoma Turnpike Authority's PIKEPASS Story	243
Richard L. Ridings	
• ETTM and Transportation Corridor Agencies	245
Greg Henk	
Special Topics	247
Kan Chen, presiding	
• Strategic Plan for Intelligent Vehicle Highway Systems	249
Thomas B. Deen	
• IVHS AMERICA: Multi-Year Program Plan	252
James Costantino	
• A Second Generation Interstate - Examining 21st Century Feasibility	254
James L. Covil, Jim Haugen	
• IVHS AMERICA: Japan Trip Report	267
Randolph Doi	

Special Topics	271
Patricia F. Waller, presiding	
DIVERSE VIEWS	
• Radical Approaches to IVHS Goals	273
Professor Kan Chen	
• Perspective from Rural Status	282
Kathleen Braaten	
• IVHS: How Will It Change Society?	285
Patricia F. Waller	
• IVHS & The Mobility of Older Americans	290
Gwendolyn M. Bedford	
Institutional Issues	293
G. Sadler Bridges, presiding	
• Institutional Issues Committee Report	295
G. Sadler Bridges	
• Public-Private Partnerships	298
Stephen C. Lockwood, moderating	
Panelists:	
- Public - Private Issues In IVHS Deployment: Report On the April 1992 FHWA Conference	300
Gray Ritter	
- IVHS Strategies	304
Mark A. Roberts	
- Financing Public - Private Partnerships	309
Donald A. Savitt	
Institutional Issues	311
Thomas E. Marchessault, presiding	
• Resolving Institutional Barriers To Effective Traffic Management	313
Daryl S. Fleming, Steven T. Hogan, Todd Chavers	
• The Design of an Organizational Framework for Cooperation in IVHS	319
Hans K. Klein	
• IVHS Policy - A Call to Action: Report of A Workshop on Institutional and Environmental Issues	329
Jonathan L. Gifford, Daniel Sperling, Thomas A. Horan	
• Public-Private Partnerships for Evolutionary Development of AVCS in the PATH Program	341
Steven E. Shladover, Michael Dearing, Paul Bouchard, Roy Bushey	

Benefits, Evaluations and Costs (BEC)	347
Donald E. Orne, presiding	
CONDUCTING IVHS FIELD EVALUATIONS	
• An Overview of Evaluation Plans For IVHS Operational Tests	349
Burton W. Stephens	
• Avoiding Delay, Death and Dirty Air: Framework for Evaluation of Intelligent Vehicle Highway Systems	358
Steven E. Underwood, Fredrick M. Streff	
• TravTek Evaluation: Plans and Initial Status	382
Joseph I. Peters, Frank J. Mammano, Rebecca N. Fleischman	
The Evaluation Challenge	385
Panelists:	
- Daniel Brand	385
- Robert Johns	386
- E. Ryerson Case	387
Benefits, Evaluations and Costs (BEC)	391
James L. Covil, presiding	
PREDICTING IVHS PROGRAM AND PROJECT PAYOFFS	
• Comparing IVHS Benefits With Alternative National Transportation and Telecommunications Strategies	393
Ashok B. Boghani	
• Estimates for the Years 2000 and 2010	404
Melvyn D. Cheslow	
• Cost Benefit Analysis of Electronic Toll and Traffic Management	413
Michael C. Pietrzyk, William L. Ball, Patrick Griffith	
• Evaluation Plan for AVL Implementation in Four U.S. Cities	426
Robert F. Casey, Lawrence N. Labell	

Table of Contents - Volume Two

System Architecture	437
Robert E. Parsons, presiding	
• The Relationship Between System Architecture and Radio Frequency for IVHS	439
D. James Chadwick, Vijay Patel, George Beronio	
• Vehicle/Roadside Communications (VRC): The Next Infrastructure?	445
Daryl S. Fleming, Thomas L. McDaniel	
• Review of Federal Highway Administration's System Architecture Program	449
Gary W. Euler	
• An IVHS Systems Architecture Workshop	449
Bernard A. Galler, Kan Chen	
• Alternative Achitecture for ATIS ATMS	456
Michael F. McGurrin, Melvyn D. Cheslow, S. Gregory Hatcher	
System Architecture	469
Gary W. Euler, presiding	
• The TEMPO Alternative: A Case for Immediate Achievement of IVHS Goals Using a Compound (Mechanical/Electronic) Solution	471
Philippe C. Nobileau	
• The Development of a New Navigation System with Beacon Receiver	485
Kenji Ohishi, Hidetaka Suzuki	
• A Vehicle to Roadside Communications System for IVHS	490
Peter D. Shloss, Dale Feikema	
• A Distributed, Hierarchical System Architecture for ATMS and ATIS	499
Anthony F. Holz, C. H. Much, T.J. Goblick, E.G. Corbett, A.M. Waxman, K. Ashok, M.E. Ben-Akiva, H.N. Koutsopoulos	
Advanced Public Transportation Systems (APTS)	509
Michael P. Bolton, presiding	
SMART BUS IN THE SMARTER WORLD	
• Smart Bus In The Smarter World German "Smart Bus" Technologies: Lessons For the U.S.	511
Robert W. Behnke, Park Woodward	
• Houston Smart Commuter IVHS Demonstration Project	513
Katherine F. Turnbull, Dennis L. Christiansen	
• Future Shock - Data Fusion and System Integration System for Advanced Public Transit Systems	519
Michael P. Kushner, Joseph Romancheck	
• Advanced Fare Payment Media	530
Thomas L. McDaniel	

Advanced Public Transportation Systems (APTS)	535
Ronald J. Fisher, presiding	
TRANSIT AS A MOBILITY MANAGER: MORE THAN JUST A BUS	
• IVHS Technology for Improving Ridesharing	537
John S. Niles, Paul A. Toliver	
• Responsive Multi-Modal Transportation Management Strategies	548
Aladdin Barkawi, Salvatore J. Bellomo, Ronald J. Fisher	
• Flexible, Intelligent, Multi-Modal Transportation	553
Monica M. Suter	
• A Multi-Mode Approach to ATIS Featuring the Destination Travel Card	563
Alan Danns	
Advanced Traveler Information Systems (ATIS)	567
Frank J. Mammano, presiding	
• TravTek	569
James H. Rillings	
• A Conceptual Overview of ADVANCE	579
B. Clark Smith, Philip Pollock, Frank Koppleman, Chandra Bhat, Peter Nelson, Douglas Rorem	
• Travelguide: Ontario's Route Guidance Concept	589
Gabriel Heti	
• The California Smart Traveler	597
Robert Ratcliff	
Advanced Traveler Information Systems (ATIS)	601
James H. Rillings, presiding	
• Information Requirements for Advanced Traveler Systems	603
John Jasper, Nancy Marsh	
• Development and Implementation of Systems to Collect, Analyze, and Disseminate Real-Time Traffic Information: A Private/Public Enterprise	608
Kevin N. Balke, William R. McCasland	
• Experimental Studies For Toyota Voice Route Guidance Using Beacon	614
Michima Ogawa, Hiroshi Morita	
• Dynamic Route Guidance and Traffic Management Operations in Germany	623
Heinz Sodeikat	
• ATIS Committee Report	627
James H. Rillings, Frank J. Mammano	

Advanced Traffic Management Systems (ATMS) Gene Ofstead, presiding	633
• Guidelines for Implementing Advanced Traffic Management Systems (ATMS) Robert E. Maki, David M. DeVaughn	635
• Marketing ATMS and Measuring the Benefits Leslie N. Jacobson	645
• ATMS: Seven Steps to Deployment Richard F. Beaubien	650
• ATMS Technology: What We Know and Don't Know Alberto J. Santiago	654
Advanced Traffic Management Systems (ATMS) Bo Strickland, presiding	661
• Communications Infrastructures for Advanced Traffic Management Systems Mark R. Komanecky, Thomas Minior	663
• The Traffic Operations Center of the Future Craig H. Seidel, Thomas I. Dayharsh	672
• Technology Considerations for a Fault-Tolerant, Windowed Video Computer Control System for Fast-Response Incident Management Paul A. McOwen, Jr., John Collura	681
Advanced Traffic Management Systems (ATMS) Jeffrey A. Lindley, presiding	689
• Color Graphics - Anaheim Intertie Project Gregory B. Damico, Shahram Shariari, Donald W. Dey	691
• Intelligent Data for Incident Detection Henry B. Wall, III, Blair G. Marsden, John Hunt	695
• Real Time Diversion Strategies for Congested Urban Networks Antoine G. Hobeika, K. Ozbay, R. Subramaniam, R. Sivanandan	706
• Communication System Design for Los Angeles Smart Corridors Project S. Edwin Rowe, Verej Janoyan	717

Safety & Human Factors Peter Hancock, presiding	725
SAFETY AND HUMAN FACTORS OF CRASH AVOIDANCE	
• The Importance of Crash Problem Analysis in Defining NHTSA's IVHS Program William A. Leasure, Jr.	727
• A Front End-Analysis of Rear-End Crashes Ronald R. Knipling, Donald L. Hendricks, Joseph S. Koziol, Jr., John C. Allen, Louis Tijerina, Colin Wilson	733
• How to Evaluate Safety of AVCS Devices Anthony Hitchcock	746
• Rationalizing the Study of Active Safety Technologies Robert D. Ervin, Paul S. Fancher	751
• Managing Alertness and Fatigue in Advanced IVHS Donald I. Tepas, Michael J. Paley	785
Safety & Human Factors B. Clark Smith, presiding	791
SAFETY AND HUMAN FACTORS OF DRIVER INFORMATION AND QUALIFICATION	
• Development of a Traffic Information System Driver Interface Gretchen Paelke, Paul Green	793
• Potential Implications of IVHS for Driver Preparedness and Qualification Patricia F. Waller	803
• In-Vehicle Navigation Systems: Research on Driver Behavior and Traffic System Performance R. Wade Allen, Anthony C. Stein, Jaime F. Torres, and Abolhassan Halati, Theodore Rosenthal	807
Safety & Human Factors Thomas B. Sheridan, presiding	827
• SAFETY IN IVHS: WHAT IS REAL? Panelists:	829
- Rodger J. Koppa	829
- R. Wade Allen	831
- Paul Green	832
- August Burgett	835
- Michael Finkelstein	837
- Eugene I. Farber	838
- Truman Mast	840
- Mark Freedman	841
Closing General Session Lester P. Lamm, presiding	847
• Transportation Research & Technology Coordinating Committee Report Louis Tornatzky	851
- Transportation Research Board's Research & Technology Coordinating Committee Thomas Deen Patricia Waller	856 858
Glossary	861

TRAVTEK

James H. Rillings
Principal Research Engineer
Vehicle Systems Research Department
General Motors Corporation
Warren, Michigan

Introduction

TravTek is a joint public sector - private sector project to develop, test and evaluate an integrated river information system and supporting infrastructure in metropolitan Orlando, Florida. TravTek provides motorists with navigation, real-time traffic information, route selection and guidance, and motorist information services. TravTek systems are installed in one hundred 1992 Oldsmobile Toronados operating in a 1200 square mile area surrounding the city of Orlando. Seventy-five of the cars are in an AVIS car rental fleet for use by visitors to Orlando and 25 of the cars are being used by local residents and for special controlled tests.

TravTek is a partnership between the private sector, represented by General Motors and the American Automobile Association, and the public sector, represented by the Federal Highway Administration, the Florida Department of Transportation and the City of Orlando. Additional private sector participants include Magnavox, Motorola and Avis. Major contractors to the project include Farradyne Systems, ETAK, Navigation Technologies, and SEI Information Technologies. General Motors serves as the project manager and systems engineer for the entire TravTek project.

Features

TravTek provides a wide variety of features for assisting drivers: 1) navigation with color electronic maps showing location of the car and the location of any destination, 2) real-time traffic information, including information on congestion and incidents, 3) route selection and guidance using real-time traffic information to provide the fastest time route to any destination in the Orlando area, 4) on-board local information listings for more than 7,000 establishments, including restaurants, hotels, dry cleaners, ATM machines, and all the places drivers might want to go to in their TravTek car.

The local information listings are integrated with the traffic information and navigation systems, so

once a driver finds a place to go, she can ask for a fastest-time route to that destination. TravTek provides this information for the entire metropolitan Orlando, Florida, area of about 1,200 square miles. TravTek also provides location assistance for emergency services. There are two additional features which support the TravTek project but are transparent to the driver. The first is that the cars serve as traffic probes, providing real-time traffic information back into the TravTek infrastructure for transmission to the other vehicles. The second is data logging on board the vehicle. TravTek is a field test to better understand how people make use of driver information systems in their cars and what the benefits are. To provide data for these analyses, the vehicles record the drivers use of the system; the screens they select, the routes they compute, and the times it takes them to travel to their destinations.

To provide TravTek drivers with these features, we developed the three-part system architecture shown in Figure 1. The first element is a traffic management center located in downtown Orlando, supported by a traffic information network (TIN). The TIN includes more than 250 instrumented intersections in the Orlando area, 11 miles of video surveillance on the major freeway, Interstate 4, information from commercial traffic sources, such as Metro Traffic Control, construction schedules, and public service agencies, and the TravTek vehicles themselves.

The Traffic Management Center, (Figure 2), fuses traffic information from the many TIN sources, adds event information from the information services center, then transmits the data to all the vehicles once per minute over an 800 MHz. SMR data link.

The transmitted messages contain four types of data: coded traffic conditions and incidents, abnormal roadway link times, current events, and current weather forecasts; all of these available on command by the drivers in the cars.

In turn, the Traffic Management Center receives link time information and status reports from

the cars as they drive through the Orlando traffic network.

Figure 3 shows the TMC operator's console, a graphic display terminal when the operator sues to enter traffic information from verbal reports. Information from electronic sources, such as the UTCS traffic signal control system, is entered automatically.

The second element of the system is the TravTek Information and Services Center (TISC). This is located at the American Automobile Association headquarters in Heathrow, Florida. Its responsibility includes supplying data bases and travel information data bases used by TravTek, providing the special events information to the Traffic Management Center, and serving as a help desk (Figure 4) for drivers who have questions about using the TravTek system. Drivers reach the TISC using the automatically dialed cellular telephone in the TravTek cars. The TISC operators are equipped with two TravTek vehicle simulators to assist them in answering questions. The TISC also provides general operations support for the conduct of the operational phase of TravTek.

The third element of the system is the TravTek cars. These are 1992 Oldsmobile Toronados specially equipped with the TravTek electronics and communications systems.

The TravTek Vehicles

The TravTek vehicle architecture (Figure 5) contains two computers: a navigation computer, which performs navigation using an ETAK map data base, and driver interface tasks, and a routing computer which provides route selection and route guidance using an AAA map database, real-time traffic information, traffic probe, and data logging. Each of these custom computers uses an Intel 80386 processor and a 20 megabyte removeable hard disk.

Additional equipment includes a data communications radio a GPS receiver and a digital voice synthesizer. The driver interface consists of a 5 inch diagonal color video display with a 5 X 5 touch screen matrix for use while the car is in PARK and four double-function toggle buttons on the steering wheel hub for use while the car is in motion.

Figure 6 shows the interior of the car. It looks like completely stock 1992 Oldsmobile Toronado. The touch screen is used normally for control, the radio, climate control and other functions. The "NAVIG" button, which normally displays an electronic compass, is used to provide an entry into the TravTek system.

Figure 7 shows main menu which the driver uses to select the functions desired, while the car is in park. The driver can enter destinations, select a service, and attractions menu, browse local maps, request emergency assistance or request instructions from a built-in tutorial.

If the driver selects the services and attractions menu and then "Where to Stay", for example, (Figure 8) she has a number of ways of finding a hotel or campground. She can select from an alphabetical list, from a location on the map, spell out the name of the hotel, or select by cost, AAA diamond rating, and amenities of interest.

If she chooses to spell out the name, she only needs to enter two or three letters of the name and then press "done," to get a listing of the hotel (Figure 9) - in this case, the Residence Inn by Marriott - with several pages of information.

Across the bottom of the screen, there are a number of keys she can press to show the hotels location on the map, telephone it, or, make it a destination. When she presses the "make destination" button, the TravTek system sorts through all the literally up-to-the-minute real-time traffic information and provides a route. The driver has a choice of whether she wants that to be the fastest route or the fastest route avoiding interstates or the fastest route avoiding toll roads.

Figure 10 shows the map with a magenta line indicating the selected route. The map auto-scales to show the car's location and the destination.

All of the above features are available to the driver only while the car is in park. As soon as the gear selector is moved to drive, the screen display switches from the map showing the route as an overlay to a series of guidance screens as in Figures 11 to 13. These guidance screens are designed to provide all the information needed by the driver to get to her destination with a minimum of extraneous information and distraction.

These screens are also backed up, if the driver chooses, by a computer synthesized voice giving turn instructions including the name of the turn street and distance to the turn.

Across the bottom of the guidance screen is the name of the driven road, in the box on the right is the next turn road, with the distance to that maneuver underneath. Across the top is the distance to the destination in miles and in minutes under current traffic conditions.

After the driver executes this maneuver, she is shown the next maneuver. If the next maneuver is more than one mile, (two miles on freeways) the system just shows a straight arrow.

At any time, the driver can toggle, using the steering wheel button "Swap Map", between the guidance screen and the information map screen. The information map screen, also shows real-time traffic conditions at four levels. No symbol along the side of a road means normal traffic conditions. Red "X"s mean that that section of the road is closed. Solid yellow circles mean heavy congestion while open circles mean moderate congestion.

A key factor determining the usability and acceptance of any ADIS system is the human factor of the driver interface. This fact was the main driver of TravTek's vehicle system design. The goals were to 1) maximize the drivers's comprehension of the information presented to him or her while 2) minimizing distraction from the driving task.

The driver interface design process began with the TravTek functional requirements, and was constrained by the display hardware available: a 12 cm diagonal color CRT, later augmented with a text-to-speech computer voice synthesis unit. The requirements were developed into a series of data-flow diagrams that described the generation of data, its movement between various processes, and between the vehicle system and the driver. Next an experienced human factors professional designed a sequence of preliminary screens

providing navigation, route selection and guidance, real-time traffic information and other information to the driver. These screens were then tested at the human factors laboratory of the University of Idaho for understandability, learnability, attention demand and other factors, using a variety of laboratory techniques. The results of these tests were fed back to the screen designers for iteration. Only after this process converged did the design of the software to implement the screens, the screen flows and the supporting algorithms begin. A similar procedure was used to determine screen nomenclature and voice message wording.

Evaluation

TravTek is more than just a demonstration, it is an experiment, and with a very substantial evaluation phase being run by Science Applications International Corporation. The project is being evaluated on many factors: performance, user satisfaction, safety, the actual improvements in trip efficiency that can be gained by having real-time traffic information and route guidance, the features that people prefer, and the indirect benefits to people who do not have these kinds of systems in their cars.

Acknowledgements

TravTek has been a true team project. Its concept, design and execution is the result of dedicated efforts on the part of the men and women of the TravTek partners, participants and contractors. The original concept for TravTek was developed under the leadership of William M. Spreitzer.

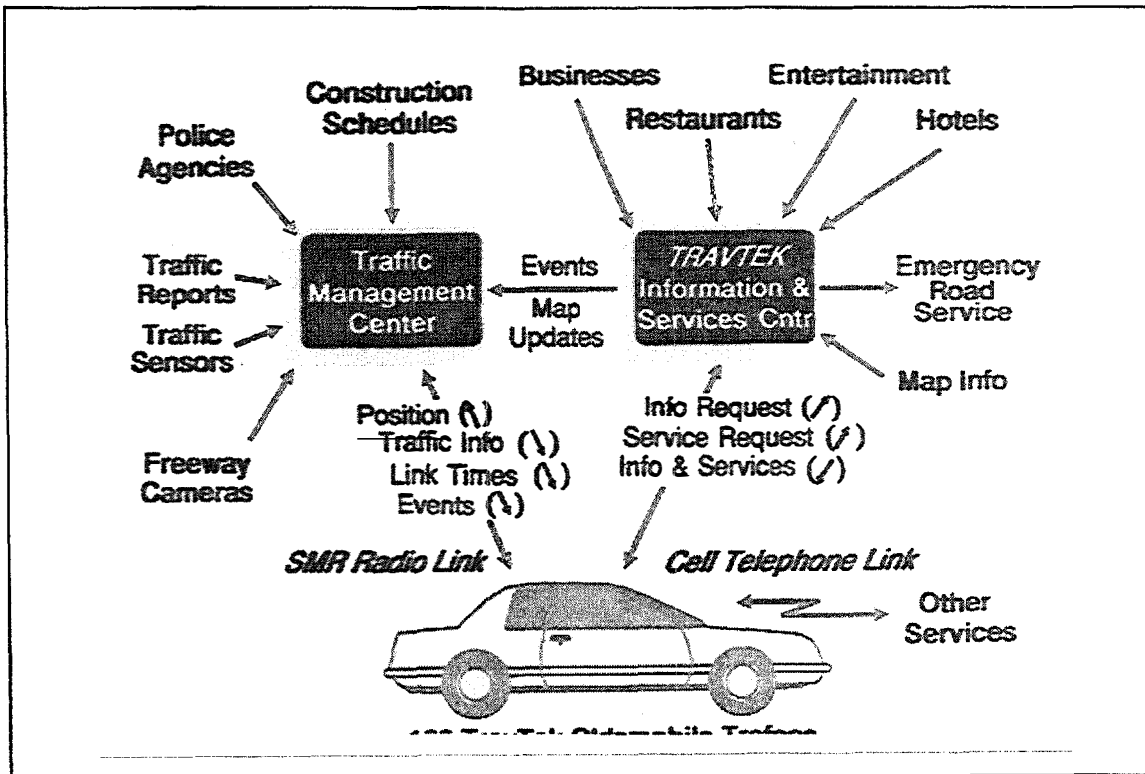


Figure 1 - TravTek System Architecture

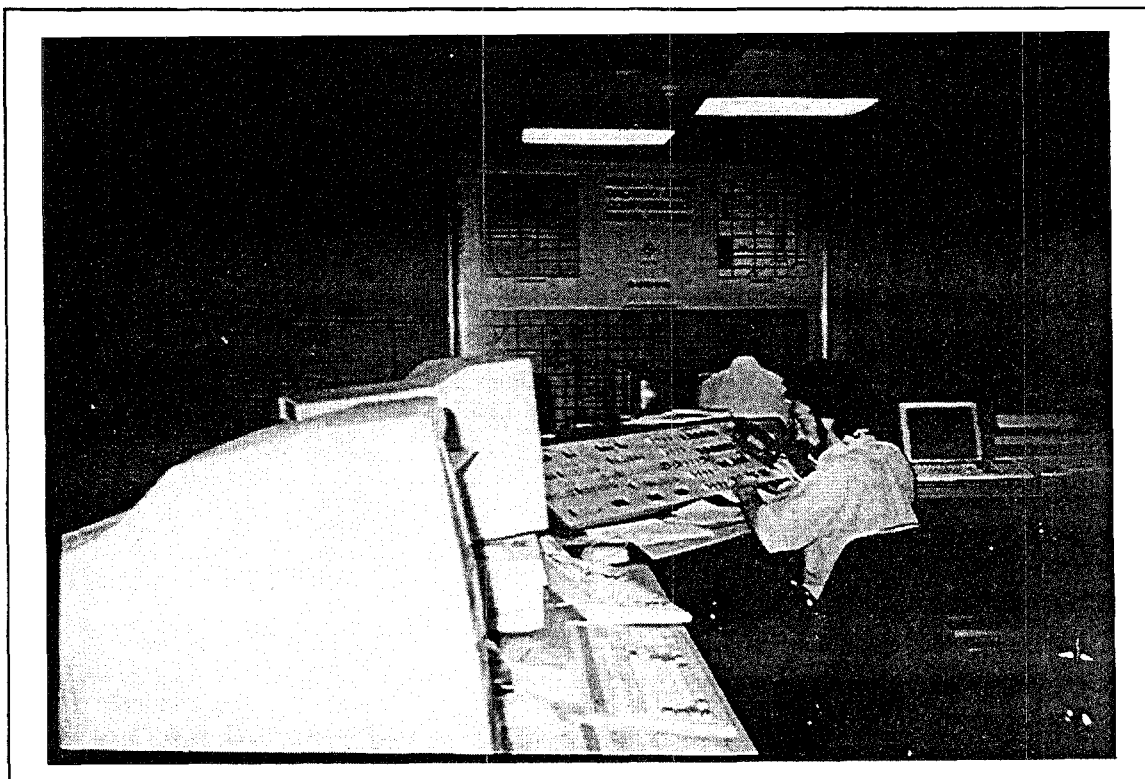


Figure 2 - Traffic Management Center in Downtown Orlando

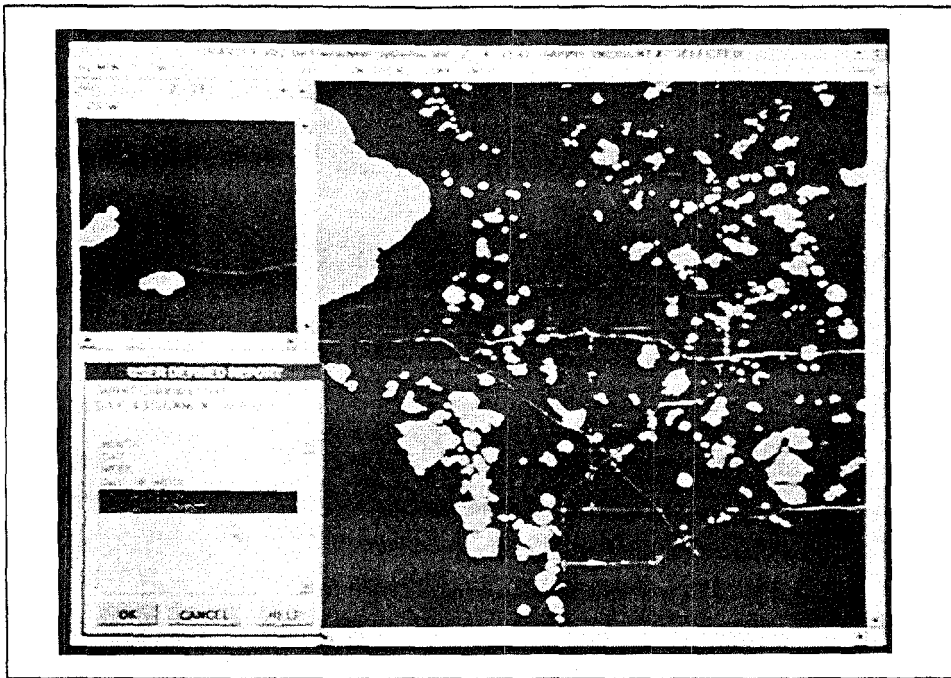


Figure 3 - Operator's Console Screen at TMC

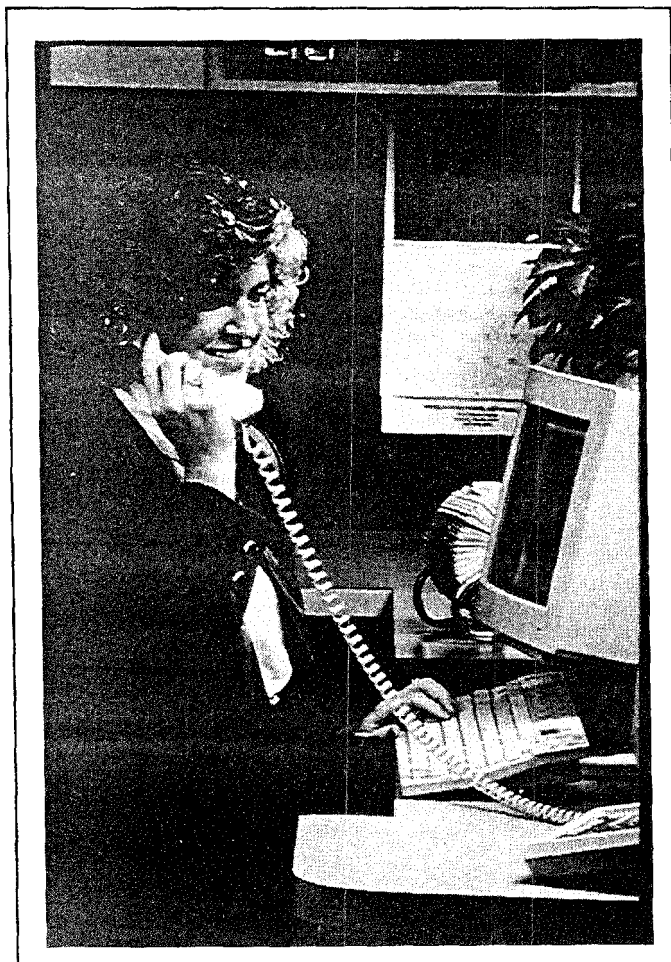


**Figure 4 - Information and Services Center
at AAA Headquarters**

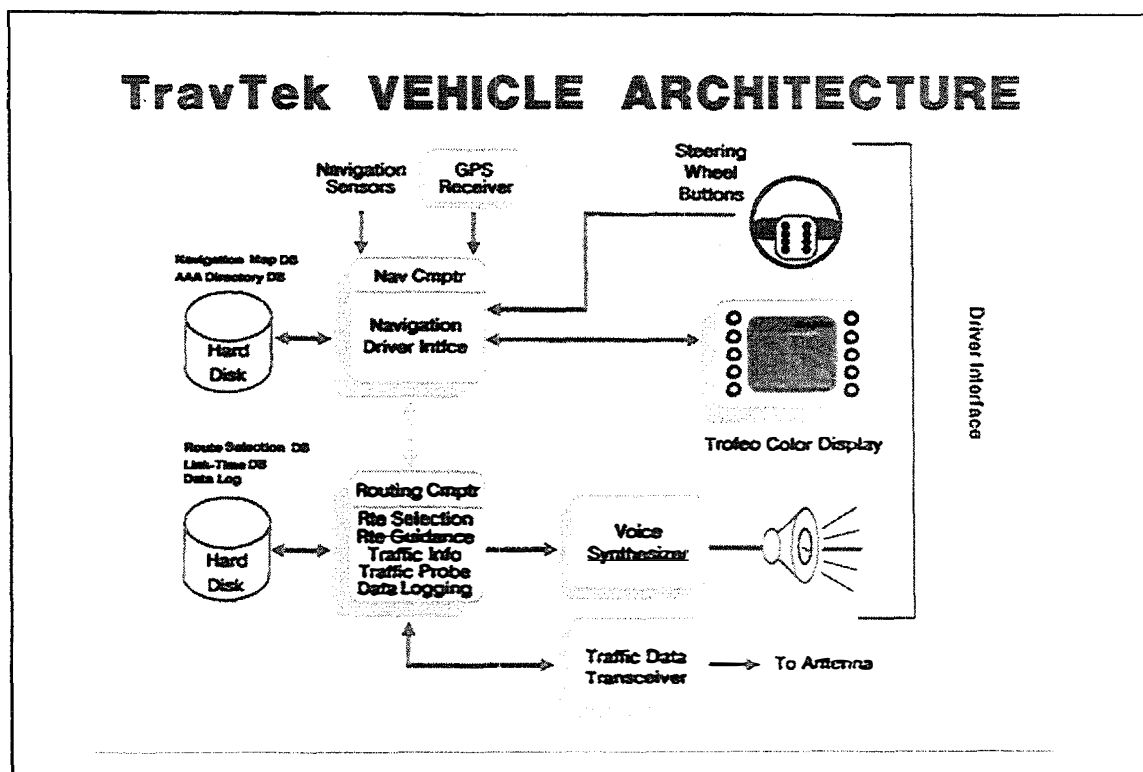


Figure 5 - TravTek Vehicle Architecture

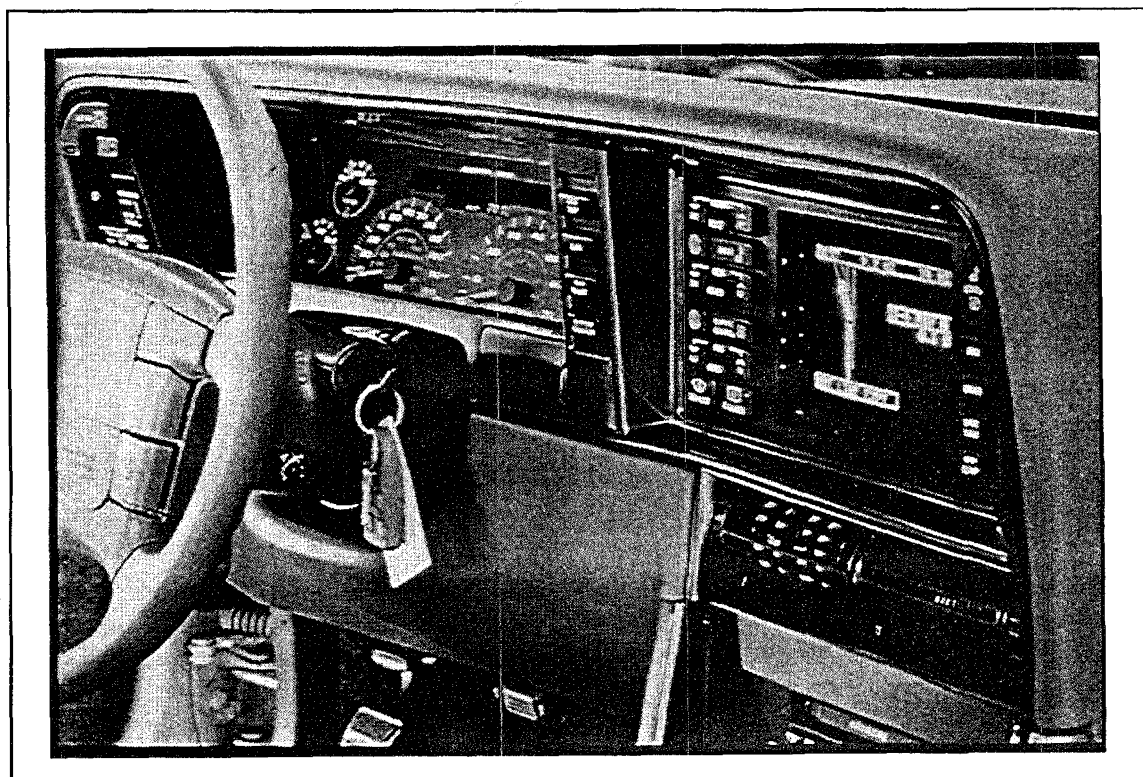


Figure 6 - TravTek Video Screen in One of the Oldsmobile Toronados

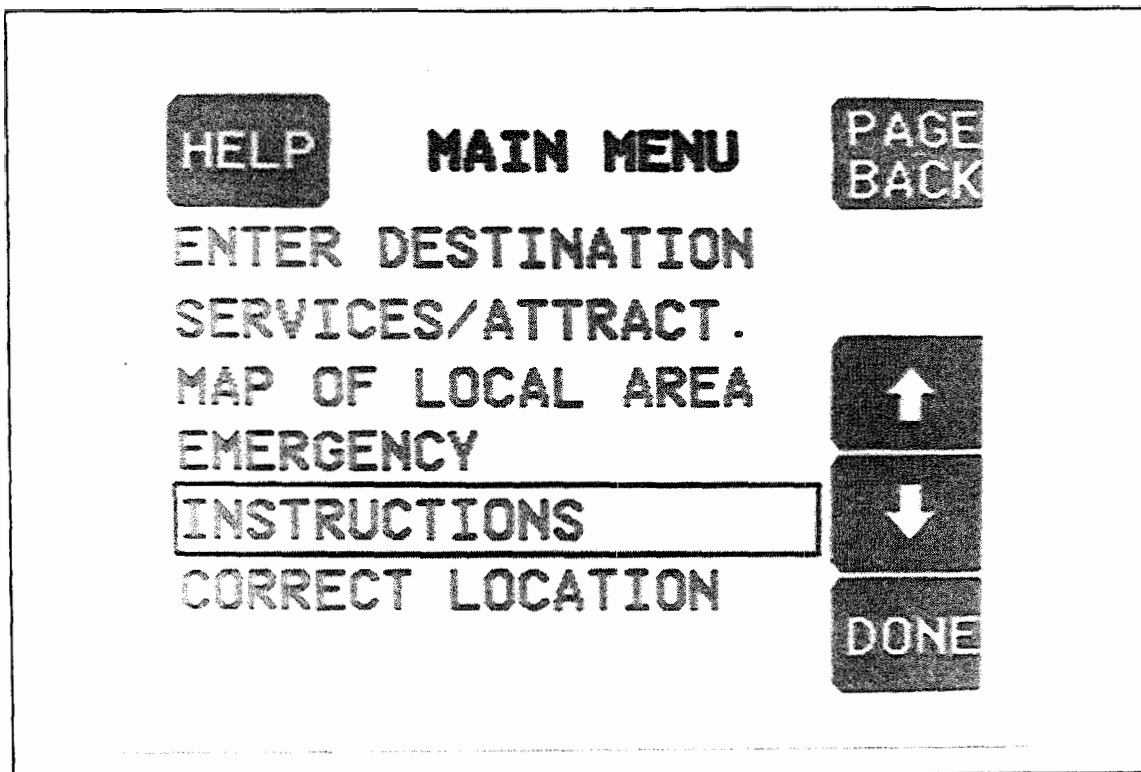


Figure 7 - Main Menu Showing Selections and Softkeys

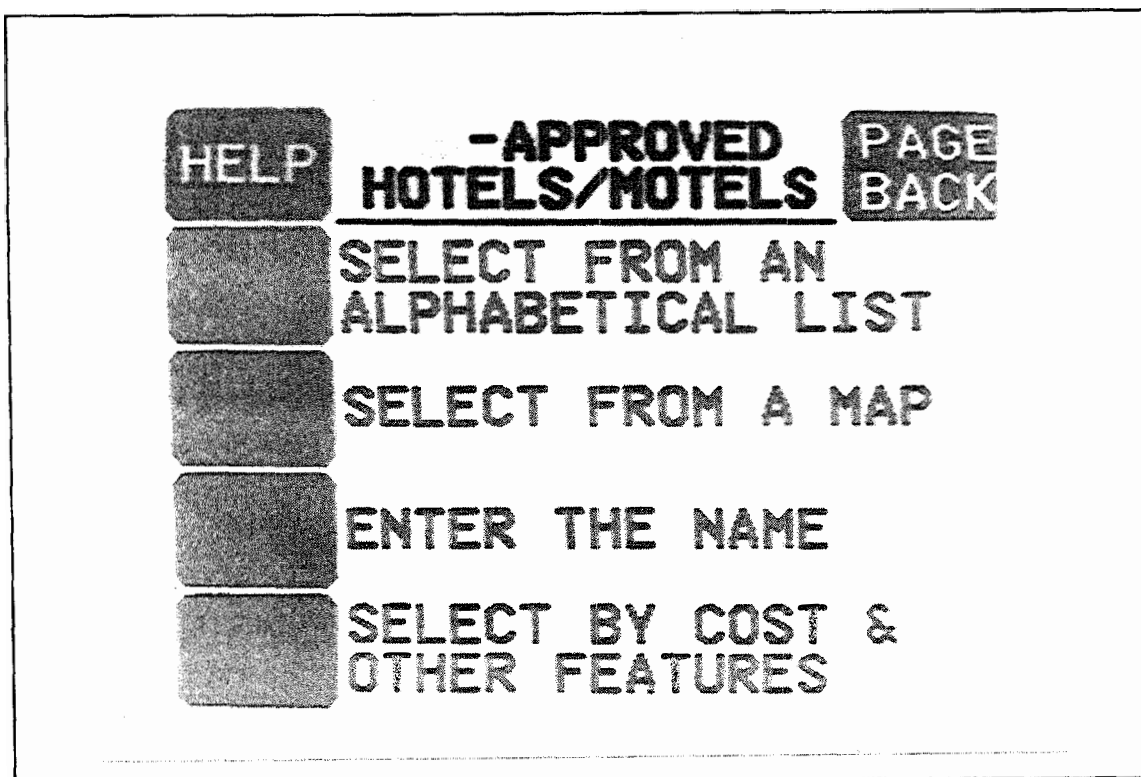


Figure 8 - Where to Stay Menu



Figure 9 - First Page of the TravTek Listing for the Hyatt Orlando

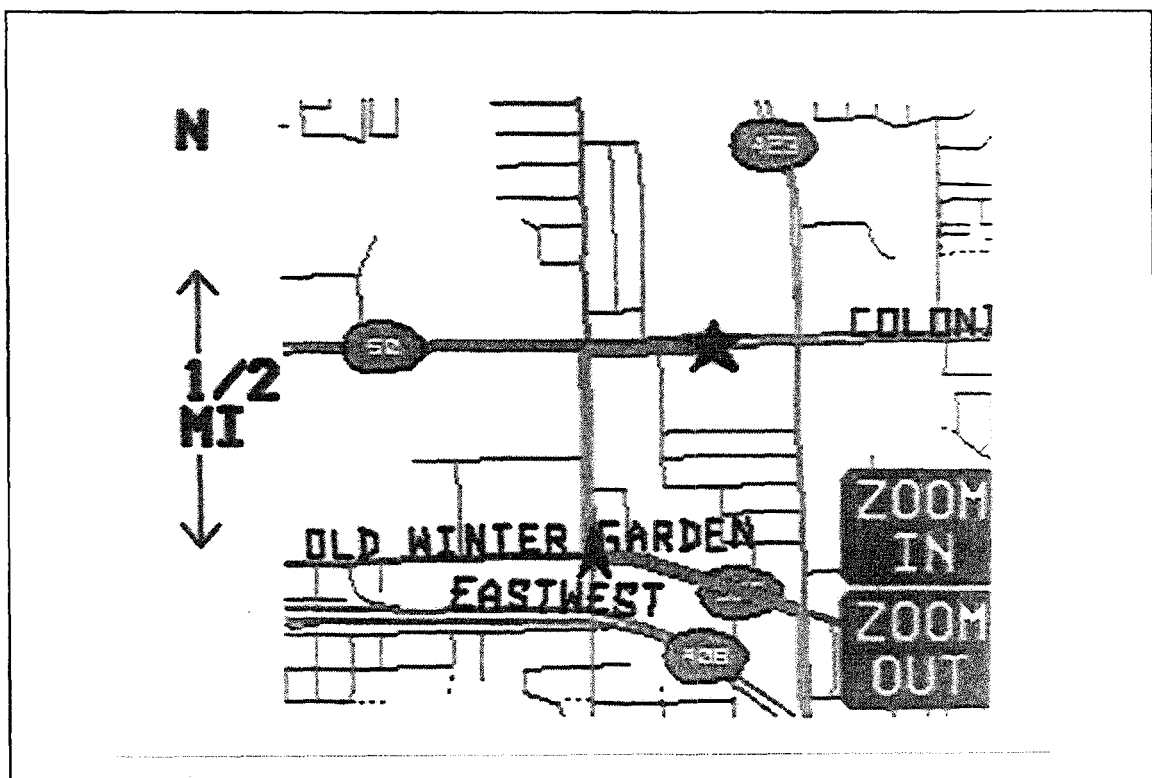


Figure 10 - Map Showing Selected Route as a Magenta (Heavy) Overlay

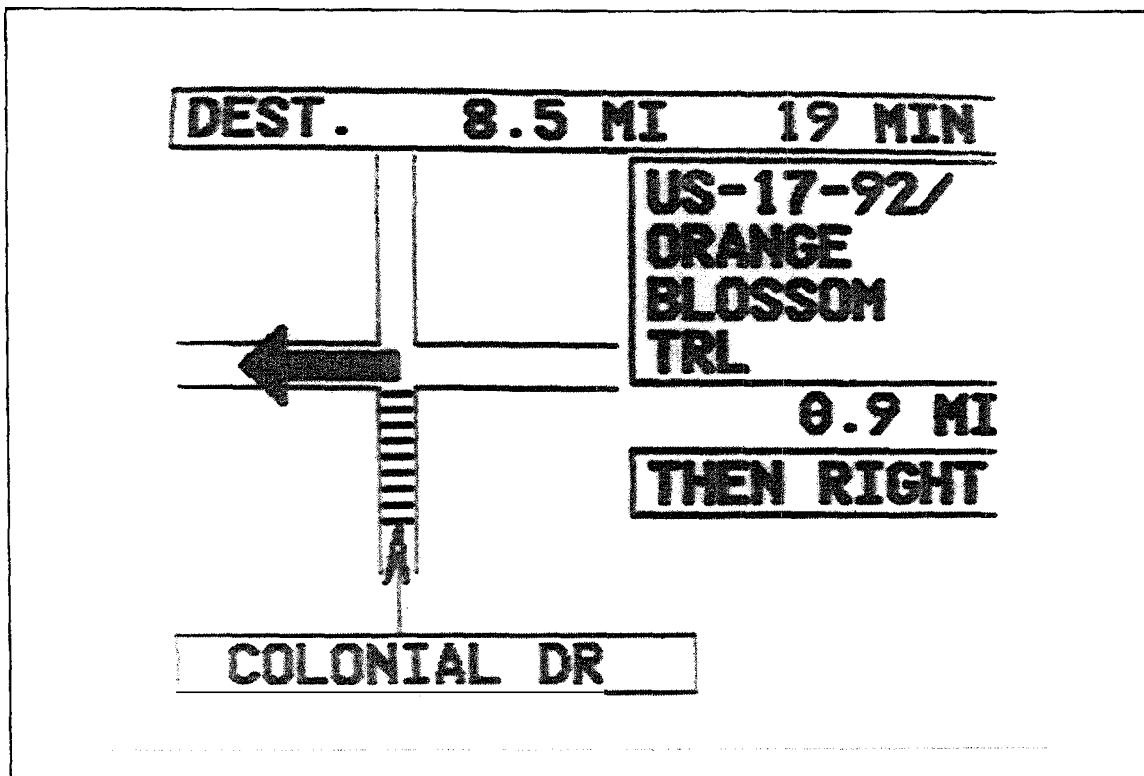


Figure 11 - Guidance Screen Showing a Left Turn

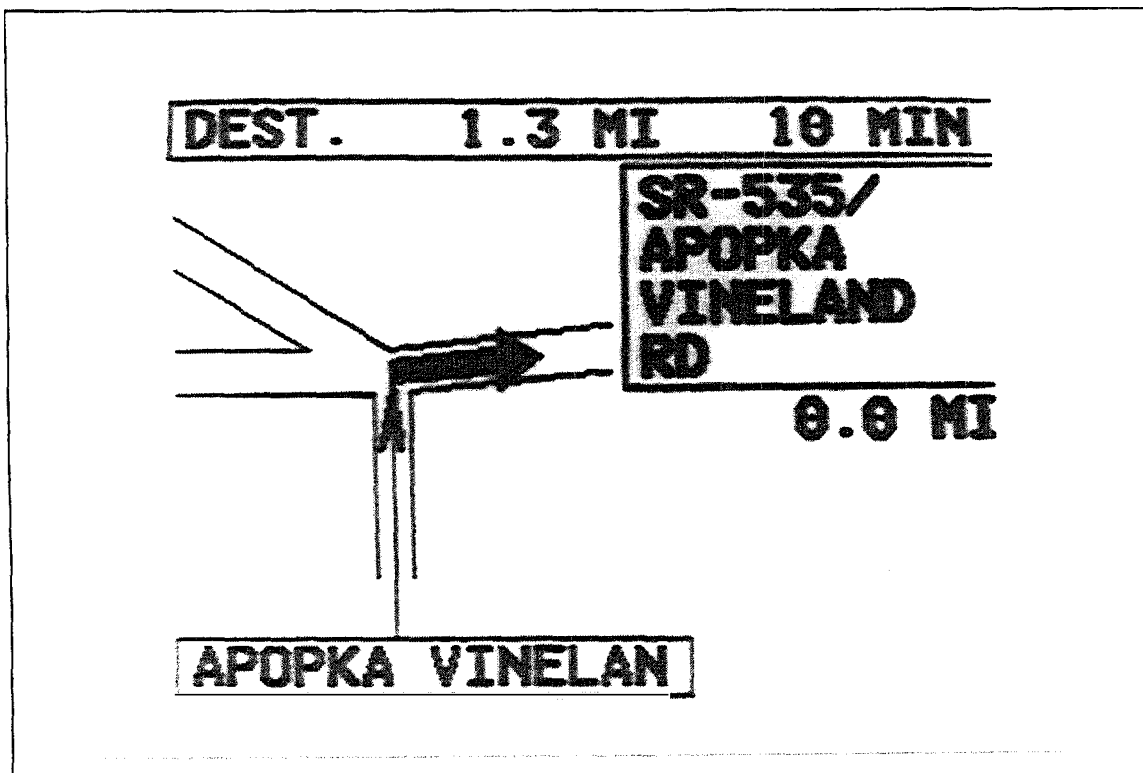


Figure 12 - Guidance Screen Showing a Right Turn

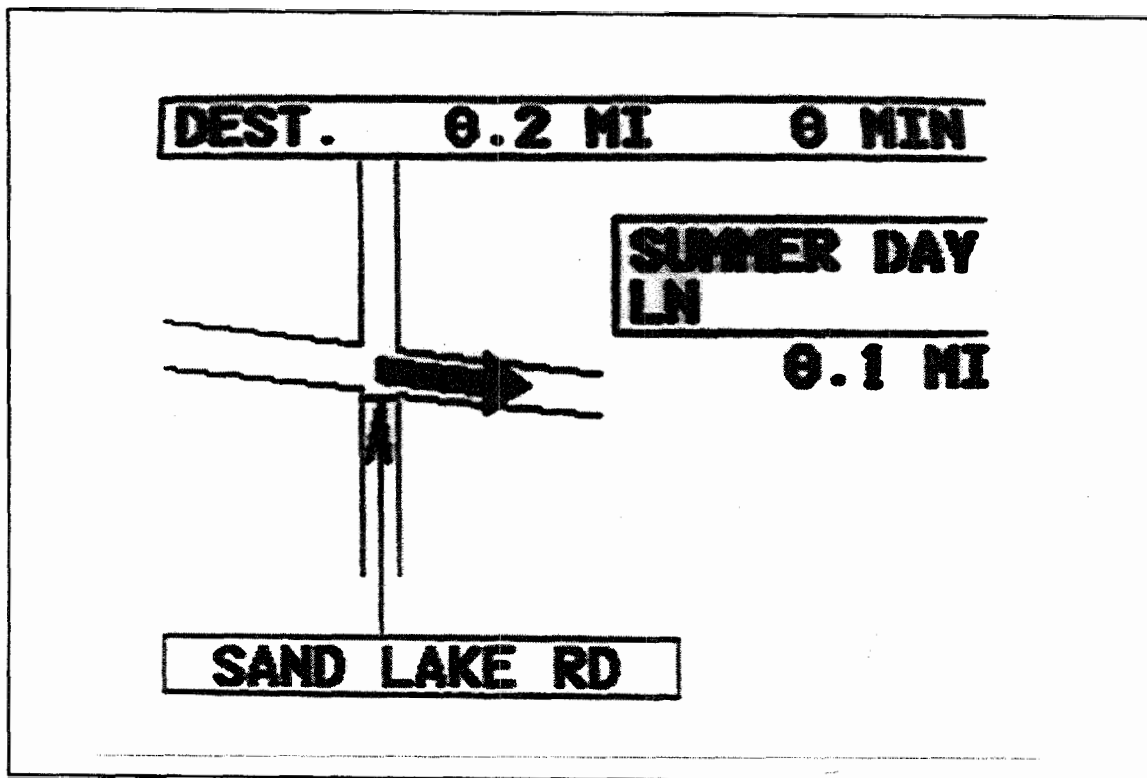


Figure 13 - Guidance Showing a Right Turn