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TRANSPORTATION RESEARCH

Number 336, September 1988

CIRCULAR

Research Problem Statements on User Information Systems

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TRANSPORTATION RESEARCH *CIRCULAR*

Number 336, September 1988
ISSN 0097-8515

RESEARCH PROBLEM STATEMENTS ON USER INFORMATION SYSTEMS

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as of December, 1987

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54 operations and traffic control

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National Research Council
2101 Constitution Avenue, N.W.
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The Transportation Research Board is a unit of the National Research Council, which serves as an independent advisor to the federal government on scientific and technical questions of national importance. The Research Council, jointly administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, brings the resources of the entire scientific and technical community to bear on national problems through its volunteer advisory committees.

INTRODUCTION

This report summarizes research needs prepared by the Committee on User Information Systems, A3B08. Preparation of the research problem statements began in 1984 when then Committee Chairman H. Douglas Robertson appointed a Subcommittee headed by David B. Knies. Fourteen problem statements were developed by the Subcommittee. These problem statements were revised and fourteen additional statements were developed in 1986-87 by an Ad-Hoc Subcommittee appointed by the current Committee Chairman, Conrad L. Dudek. Members of the Ad-Hoc Subcommittee were Kenneth A. Brewer, Truman Mast, Roger W. McNees, Thomas A. Raney and Arthur W. Roberts.

After review and approval of the content by the entire Committee in the summer of 1987, members then ranked the problem statements according to priority. The table on the following page shows the priority ranking assigned to each problem statement. It was the initial intent to classify the research needs according to high, medium and low priority based on the average rank score. A review of the average rank score revealed that there was no distinct demarcation to easily separate the high, medium and low priorities. Therefore, it was the consensus of the Committee to list the first 10 problem statements as high priority, the next 9 statements as medium priority and the last 9 as low priority.

RANKING OF RESEARCH PROBLEM STATEMENTS
TRB Committee on User Information Systems (A3B08)
July 1987

Rank		Average Rank Score
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Rank		Average Rank Score
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PROBLEM STATEMENT #1 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Determine the Effectiveness of Symbol Signing

2. PROBLEM: Particular emphasis is needed to evaluate the contribution of symbol signing in construction areas. At present, the motorist's existing level of comprehension in unknown. This knowledge would be a particular benefit to the transportation/traffic engineering profession in providing effective traffic control. An efficient evaluation technique would be useful to determine the effectiveness of a sign or series of signs which are placed in the environment.

3. OBJECTIVE: The objectives of this study are as follows: (1) to develop an easy, efficient, and unbiased study to determine the effectiveness of symbol signing, (2) to segment results of test applications by age, driver exposure, experience, educational level, and sex to more specifically understand the findings, (3) to make recommendations concerning methodology for sign evaluation, and (4) to provide recommendations concerning the effectiveness of symbol signs evaluated.

4. KEY WORDS: Symbol Sign Evaluation, Symbol Signs, Traffic Control Evaluation, Construction Areas.

5. RELATED WORK:

6. URGENCY/PRIORITY: This project has a high priority.

7. COST: $100,000 to $150,000

8. IMPLEMENTATION: The transportation profession needs to know how symbol signing contributes to overall travel behavior, particularly in construction areas.

9. EFFECTIVENESS: Major benefits in understanding motorist comprehension of this area of traffic control may result in improved safety and reduced costs.

PROBLEM STATEMENT #2 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Motorist Comprehension of Complex Overhead Signing Arrays

2. PROBLEM: Complex overhead guide signs in congested urban areas create a comprehension and processing time problem for many motorists. The driver is typically overloaded at the decision points where these complex arrays are located. This is a serious safety problem and should be given high priority.

3. OBJECTIVE: The objective of this study is to investigate the problems motorists have in comprehending and processing the information on complex overhead freeway-signing arrays. Guidelines will be developed to permit improved signing array designs to reduce motorist information processing problems.

4. KEY WORDS: Overhead Signing, Guide Signs.

5. RELATED WORK: This work is a continuance of the study entitled "Motorist Comprehension of Regulatory, Warning and Symbol Signs" which was completed in October 1985.

6. URGENCY/PRIORITY: This research is high priority.

7. COST: $250,000

8. IMPLEMENTATION: Guidelines for improving motorist comprehension and information processing of complex overhead signing arrays at freeway interchanges.

9. EFFECTIVENESS: Accident reduction.

PROBLEM STATEMENT #3 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Design Principles for Effective Symbol Signing

2. PROBLEM: Symbol signs continue to be proliferated by traffic engineers in order to warn, regulate, and inform the motoring public. Some symbol signs have been designed without enough consideration for meeting driver legibility and comprehension requirements. Research is needed to develop a set of general design principles to guide sign designers in making effective symbol signs and to understand the conditions under which they should and should not be used. For example, particular emphasis is needed to evaluate the contribution of symbol signing in construction areas. An efficient evaluation technique would also be useful to determine the effectiveness of a single sign or series which are placed in the environment.

3. OBJECTIVE: The objectives of this study are as follows: (1) to conduct an easy, efficient and unbiased study to determine the effectiveness of symbol signing, (2) to segment the results of test applications by age, driver exposure, experience, educational level, and sex to more specifically understand the findings, (3) to develop a set of general design principles for comprehensible and legible symbol signs, (4) to make recommendations concerning methodology for sign evaluation, and (5) to provide recommendations concerning the effectiveness of symbol signs evaluated.

4. KEY WORDS: Symbol signs, symbol sign legibility, symbol sign comprehension, symbol sign evaluation, construction area signing, traffic control evaluation.

5. RELATED WORK: This work relates to the ongoing effort to improve the design of highway information displays being undertaken under FHWA Project 2N, Motorist Information Systems. Recent research was completed on the evaluation of motorist comprehension of a sample of regulatory, warning, and symbol signs (1986).

6. URGENCY/PRIORITY: This research is high priority.

7. COST: $250,000

8. IMPLEMENTATION: Set of recommended principles for designing effective symbol signs.

9. EFFECTIVENESS: The transportation profession needs to know how symbol signing contributes to overall travel behavior, particularly in construction areas. Such understanding may result in improved safety and reduced traffic engineering costs.

PROBLEM STATEMENT #4 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Longitudinal Barrier Delineation

2. PROBLEM: There is a growing concern over the need to delineate longitudinal barriers, both guardrails and concrete barriers. Collisions with barriers, while generally less serious than collisions with the hazards the barriers protect motorists from, can still cause considerable damage to vehicles and to the barriers themselves. Unfortunately, barriers are often difficult to see at night, especially in wet weather conditions. Proper barrier delineation may be useful in letting drivers know the barrier is there, and help trigger proper avoidance responses. In addition, delineation may also provide vehicle positioning and guidance information to drivers.

   Currently, few (if any) standards or specifications exist nationwide as to the correct delineation of barriers. There is a definite need to determine (1) the conditions that warrant barrier delineation, (2) the best methods of delineation, and (3) the impacts of barrier delineation on traffic operation and safety. Also, the effects that roadway and barrier delineation have on each other must be evaluated so that the visual information presented to drivers is consistent and understandable.

3. OBJECTIVE: Barrier delineation research must address the following: (a) Warrants for deciding where and when barrier delineation is needed must first be determined. (b) At locations where delineation is needed, the best methods of delineation must be identified and studied. The studies must consider factors such as visual background, existing roadway delineation, and barrier position over a wide range of traffic, geometric, and environmental conditions. An analysis of delineation methods must include consideration of delineation devices, spacings, mounting position on the barrier, and mounting method. Studies must be geared towards both concrete barriers and guardrail barriers since these differ in height, construction materials, and visibility at a given illumination level. (c) The impacts of delineation upon traffic safety and operations must be documented. Since actual accident records may not be sensitive enough to examine the effect of different delineation methods, surrogate measures of effectiveness will need to be examined. Measures such as lane changing, lane distribution, lateral placement, and speed changing should be considered. Additional non-operative measures, such as

installation and maintenance costs, vandalism, and weathering effects, will also need to be documented. (d) The results of the research should lead to delineation installation guidelines for adoption into standards and specifications. Such guidelines may vary with conditions and specifications.

4. KEY WORDS: Delineation, Roadside, Longitudinal Barrier, Nighttime, Reflectors, Fixed Object Accidents, Adverse Weather, Guardrail, Concrete Barrier.

5. RELATED WORK: Studies by McGee, Seguin, and Hostetter (1972) indicate that delineation of guardrail was useful in helping to lead drivers along the highway. An HPR study is currently underway in New Jersey examining guardrail delineation methods. Both Texas and New Jersey have HPR research underway that is examining methods of concrete barrier delineation. Other states, such as Ohio and North Carolina, are also experimenting with concrete barrier delineation.

6. URGENCY/PRIORITY: This project has a high priority.

7. COST: $400,000 to $500,000

8. IMPLEMENTATION: The determination of the needs, devices, mounting methods, and placement criteria for maximum effectiveness will allow proper and efficient application of barrier delineation by highway agencies.

9. EFFECTIVENESS: The potential for savings in the form of reduced accident costs and barrier maintenance costs is substantial. For example, it is estimated that accident costs from collisions with barriers in New Jersey alone were nearly 12 million dollars in 1980. Also, this figure does not include an additional 500,000 dollars in barrier maintenance costs that were incurred because of these accidents.

PROBLEM STATEMENT #5 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Vehicle/Highway Information Load and Driver Performance

2. PROBLEM: With no other competing sign sources around or with competing signs when the driver has selected a sign of importance, it is not known how much time a critically slow driver takes to read various configurations, symbols and messages. Critically slow drivers include inexperienced and older drivers, presumably. If there was a crudely quantifiable relationship between sign information processing performance, speed of travel and information load on a sign, with modifying factors for critical segments of the driver population and for high task loads such as for negotiating, heavy traffic loads, constrained lanes, critical searching, merging, turning, a more professional approach to signing could be applied.

3. OBJECTIVE: Under various constraining tasks found in the field, determine how long it takes representative drivers to process various sign information loads at various speeds. Determine the relationship between processing, message load and travel speed.

4. KEY WORDS: Sign messages, Symbols, Diagrammatic signs, Information load, Sign shape, Lab studies, Travel speed.

5. RELATED WORK: R. Dewar and T. Forbes have performed some work in the past -- Dewar with symbols and Forbes with letters and numbers.

6. URGENCY: High. The driving population has changed significantly since Forbes work.

7. COST: $400,000

8. IMPLEMENTATION: Adequate funding can lead immediately to a revamping of the country's sign system and modifications to present standards and applications.

PROBLEM STATEMENT #6 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Highway Information Displays and the Performance of Impaired Drivers

2. PROBLEM: Impaired drivers who are within legal limits but yet suffer from some disabling condition constitute a significant although unknown proportion of the driving population. Impaired drivers include the aged, fatigued, and those within the legal bounds of alcohol and other drug consumption. Within practical limits, highway information displays must be designed to accommodate the impaired driver.

3. OBJECTIVE: The objective of this study is to develop and evaluate improvements to highway information systems to accommodate the impaired driver operating within the legal limits of the law. This requires first determining the specific performance decrements associated with the various impairments, identifying strategies for counteracting these decrements, identifying critical driving situations associated with each impairment for which information must be presented to the driver, and developing information systems for conveying critical information to drivers.

4. KEY WORDS: Highway information displays, impaired driver performance.

5. RELATED WORK: A study by Diedman, Moskowitz and Niemann (1980) found alcohol impairment effects on visual tasks related to the information processing demand. The authors identified strategies for compensating for alcohol impairment effects, including redundance in the design of signs and improvement of the "attention-getting" value of information systems to help overcome the inappropriate focus of attention. Ranney and Gawron (1984) identified single vehicle run-off-road accidents as

a problem of alcohol-impaired driving and tested the effectiveness of rumble strips and wide edgelines in counteracting the tendency of impaired drivers to drift off the road. They also tested several spot treatments (including flashing displays, patterned delineation and chevron alignment signs) as means of improving performance on curves. O'Hanlon and Kelly (1974) evaluated rumble strips and raised pavement lines as potential means of alerting fatigued drivers. Work of this type must be extended to address specific impairment effects associated with prescription drugs and age impairments.

6. URGENCY/PRIORITY: High.

7. COST: $500,000

8. IMPLEMENTATION: This study will provide recommendations for design changes to highway informations systems to accommodate impaired motorists.

9. EFFECTIVENESS: Accident reduction.

10. REFERENCES: O'Hanlon, J. F. and Kelly, G. R. A Psychophysiological Evaluation of Devices for Preventing Lane Drift and Run-Off-Road Accidents (1736-F). Sacramento, CA: California Department of Transportation, September, 1974.

Ranney, T. A. and Gawron, V. J. Identification and Testing of Countermeasures for Specific Alcohol Accident Types and Problems-Volume II: General Driver Alcohol Problem (DOT-HS 806-650) U. S. Department of Transportation, December, 1984.

Ziedman, Moskowitz, H. and Niemann, R. A. The Effects of Alcohol on the Driver's Visual Information Processing. U. S. Department of Transportation, National Highway Traffic Safety Administration, September, 1980.

PROBLEM STATEMENT #7 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Driver Compliance with Regulatory Traffic Control Devices

2. PROBLEM: Nearly 40 percent of all traffic accidents on surfaced roadways occur at intersections which are signed or signalized. Compliance with stop signs and traffic signals at intersections is questionable. Stop signs and red ball traffic signals have clear-cut violation rates of approximately 19 and 8 percent, respectively. The increased conspicuity of traffic signals and greater traffic impedences at signalized locations may in part explain the differences in compliance between these two types of regulatory devices. Increasing the specificity of information conveyed by traffic signals (e.g., use of left-turn arrows) can provided marginal improvements in driver compliance.

High violation rates are sometimes thought to indicate improper use of specific traffic control devices such as poor signal timing or limited times when the devices should apply. At some locations, a different device such as a yield sign would be more appropriate.

Some violations may be attributed to drivers being unable to detect or recognize the message being conveyed due to either inadequate sight distances or distractions associated with visual clutter. Several attempts have been made to isolate the effects of geometrics, location of the traffic control devices, traffic and other environmental factors which could contribute to high violation rates. However, factors associated with vehicle defects and driver comprehension and attention have been shown to contribute to relatively few intersection accidents. Therefore, it can be presumed that the major contributors to intersection accidents are roadway and weather-related factors and to willful violations by drivers.

This effort is intended to focus on all factors which promote compliance with stop signs and traffic signals and to examine specific traffic control techniques which could improve compliance and reduce intersection accidents. Based upon an understanding of the factors which induce poor compliance, strategies and specific measures for improving compliance will be proposed. The more promising strategies and techniques are to be evaluated during this research effort.

3. OBJECTIVE: The first objective of this research is to determine the relationships for driver compliance with specific intersection regulatory traffic control devices (i.e, stop signs and the red phase of traffic signals), with intersection conflicts and intersection accidents. The second objective is to develop strategies and techniques for increasing driver compliance and reducing intersection accidents and to evaluate the more promising solutions to intersection safety problems.

4. KEY WORDS: Regulatory Traffic Control Devices, Driver Compliance, Driver Violation, Intersection Accidents, Stop Signs, Traffic Signals.

5. RELATED WORK:

   a. An FHWA contract with Center for Applied Research on "Motorist Compliance with Standard Traffic Control Devices" was initiated on September 1, 1986. This 30 month, $294,999 contract is to: quantify the driver non-compliance problem for traffic control devices and identify safety and operational effects, determine relationships of traffic violations with control device types, traffic operational characteristics and roadway features, identify and/or develop potential countermeasures to increase compliance for problem areas, and implement and evaluate proposed countermeasures.

   b. A 3-month graduate research fellowship study, "Motorist Compliance with Traffic Signals" studied driver compliance at 12 traffic signals in Maryland, Virginia, and D.C. The analyses

looked at violation rates versus time of day, geometrics, traffic volumes, etc.

6. URGENCY: This research is high priority.

7. COST: $300,000

8. IMPLEMENTATION: Strategic and techniques for improving driver compliance with regulatory traffic control devices.

9. EFFECTIVENESS: Accident reduction.

PROBLEM STATEMENT #8 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Additional Guidelines for Curve Signing

2. PROBLEM: As part of a recent FHWA research study on Driver Information Needs a field investigation of more than 5,000 miles of two-lane rural roads in Virginia, Maryland, Pennsylvania, New York, Vermont, West Virginia, North Carolina, Tennessee, Ohio, Oklahoma, Texas, Colorado, Washington, Idaho, and Utah was conducted. The investigation identified numerous horizontal curves as being information deficient. On higher classes of roads, curve advance warning signs were "overused". On lower classes of road, there was a frequent misuse, nonuse, and inconsistent use of advance warning signs, chevron alignment signs, post-mounted delineators and large arrow signs. The Pennsylvania Department of Transportation has indicated that the most frequent information deficient situations are curves. Driver performance problems were frequently experienced on reverse curves where the second curve was much sharper than the first curve, winding road sections with sharper internal curves, isolated curves, turns with tangentially intersecting side roads, and curves preceeded by sight-restrictive crest vertical curves. These information deficiencies may contribute to accidents on curves. In general, accidents tend to be more severe on curves than on tangents, and the accident rate is normally higher on isolated curves than on tangents.

3. OBJECTIVE: The objectives of this study are to (1) estimate the magnitude of the problems associated with inadequate curve signing, (2) evaluate alternative informational treatments for various types of curves, and (3) develop recommendations for optimum information treatments for various types of curves. The study should result in specific application, placement and design criteria for the accommodation of influencing factors including sight distance, approach geometry, night visibility, traffic volume, etc., that should be considered in applying curve signing treatments.

4. KEY WORDS: Curves, Warning Signs, Markings, Delineation, Guidance Task, Speed and Path Selection, Information Processing, Decision Making.

5. RELATED WORK: Zwahlen (1983) recently evaluated Curve Warning Signs and Advisory Speed Plates. However, he only evaluated two curve sites. The Virginia Highway Research Council (1984) evaluated signing at five curve sites. Lyles also evaluated warning and regulatory signs for curves, but his sample only included observations of 100 vehicles for each treatment evaluated. Extensive field studies of driver's choice of speeds through curves were conducted by M. L. Ritchie and his colleagues in the 1970's.

6. URGENCY/PRIORITY: This research is high priority.

7. COST: $300,000

8. IMPLEMENTATION: The responsibility of implementing these guidelines would primarily rest with state and local highway departments.

9. EFFECTIVENESS: Additional guidelines would reduce inconsistent signing practices and may result in an overall reduction in accidents on curves.

PROBLEM STATEMENT #9 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Roadside Delineation at Exits and Splits

2. PROBLEM: The appearance of roadside post delineators at exits and splits is often a visual mess providing inadequate cues for the location and outline of physical gores. The reflectors are at eye height providing no depth cues, they visually "float" due to a lack of ground reference and are installed and maintained mostly out of alignment with each other.

3. OBJECTIVE: To design and evaluate roadside delineation systems on posts, guiderails and attenuators at exits and splits that are reflective all the way to the ground and are easily installed and maintained for high quality alignment while providing maximum physical gore cues at night and resistance to dirt accumulation. An investigation of problems behind keeping good alignment should be included.

4. KEY WORDS: Roadside delineation, Reflective devices, Reflector mounting methods, Visual effects, Visual cues, Depth perception, Driver visual perception, Visual patterns, Delineator installation, Delineator maintenance, Guiderail delineation, Post delineators, Attenuator delineation, Reflective materials, Reflectors, Reflective sheeting.

5. RELATED WORK: Recent FHWA administrative contracts have been issued regarding delineating attenuators. Potters Industries is working on full post reflectorization concepts. Guiderail delineation is being researched at NJDOT Research.

6. URGENCY: High. This will have direct impacts on safety.

7. COST: $100,000

8. IMPLEMENTATION: Workable designs can be demonstrated immediately for adoption into practice.

PROBLEM STATEMENT #10 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Capabilities of Unfamiliar Drivers

2. PROBLEM: The unfamiliar driver needs to get to a particular place by means of an infrequently or newly traveled route without having great difficulty correcting mistakes and by maximizing travel comfort, convenience and expectancy. Navigational aids - such as destinations, cardinal directions, arrows, maps, travel advisory services, route numbers, confirmation signs, diagrammatic signs or roadside service or traffic generator signs - are designed for the unfamiliar driver. Familiar drivers do not need such information. New drivers, vacationers and long distance travelers, especially off the interstates, are often unfamiliar drivers and they are found in largest percentages in mid-morning or mid-afternoon on most roads. A sizeable amount of research has been aimed at helping unfamiliar drivers and a lot more research would be useful. There is insufficient knowledge about how drivers make navigational decisions best. How effectively are cardinal directions, destinations, route numbers, route shields and various types of arrows used by what kind of drivers and why? Would purely numerical information be helpful as an addition or substitution for other forms of enroute navigational sign information? Why? For what kind of drivers? What kind of people use maps well? Who doesn't? Why not? Is more highway based information needed? Who can be helped? Who can't? Why not? We need a more solid base of experimentally derived knowledge of why drivers make navigational decisions from sign information and how well each component of highway control, guidance and navigational information is used in the process.

3. OBJECTIVE: To determine the types of navigation information use impairment in the driving population.

   To perform laboratory-based simulator research with young, old and newly licensed drivers with a wide variety of navigation information use impairments to determine driving performance implications for TCDs.

   To recommend priorities for navigation information improvements based on critical case unfamiliar drivers.

4. KEY WORDS: Driver Characteristics, Unfamiliar Drivers, Navigation Information, Driver Error, Critical Performance.

5. RELATED WORK: G. King has completed some work on navigation problems experienced by some drivers.

6. URGENCY: High. Better knowledge of a wide range of driver navigation capabilities is absolutely necessary to efficiently develop improvements to driver navigation information.

7. COST: $150k over 3 years, plus $200,000 for simulation equipment for use at the contractor's site.

8. IMPLEMENTATION: Significant innovations in navigation information improvements can only come as a result of significantly better understanding of driver impairments, problems and needs. The improvements will likely come in the form of both static signing and mapping through simulation studies and real time through in-car system studies for some who will be able to buy and maintain them.

PROBLEM STATEMENT #11 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Unique Signing Requirements of Large Trucks

2. PROBLEM: Trucks exceeding the standard dimensions and trucks at or near the legal load limit often have special information signing needs which are unique to them and greatly different from the signing requirements for the smaller vehicles in the traffic stream. Furthermore, all signing for large trucks has unique placement and sign design needs due to the elevated location of the driver with respect to the automobile design driver for signing.

   In the first part of the problem, there is a need to determine truck limiting conditions, such as weight and width restriction on structures, for maximum effectiveness of signing for truck restrictions. Less than optimum design of such signing and less than optimum application of such signing leads to large trucks attempting to negotiate a roadway restriction with resultant damage to roadway elements or truck accidents, or at least requires a truck operator to turn around and retrace the route yielding commercial traffic inefficiency and hazardous traffic maneuvers.

   In the second part of the problem, when a sign is placed at the optimum location within the roadway environment for an automobile design driver, the large truck driver with an eye height that may be 9 feet above the roadway may have a line of sight contributing significantly to missing the message. Night visibility of signs may be adversely affected for operators of large trucks.

3. OBJECTIVE: The objective of this research will be to identify the unique signing requirements of large trucks with respect to the smaller vehicle traffic stream, to analyze those requirements and generate alternate sign system measures to mitigate any adverse operational effects, and to develop strategies for implementation of each alternate sign system measure.

4. KEY WORDS: Truck operators, large trucks, highway signing, highway safety.

5. RELATED WORK: Walker, Alicandri and Roberts (1985) have studied symbolic signing for trucks carrying hazardous cargoes and identified principles designed to ensure that truck operators find the route markers. Walker, Alicandri and Roberts (1984) have studied the design of symbolic signs for oversized-truck routes and have identified critical points of possible confusion for special signs within the overall scheme of all highway signing. The California experience in signing for truck terminals and special truck service areas is a resource from which to begin this research.

6. URGENCY/PRIORITY: This has a medium for all states and a high priority for states with vehicular tunnels, long bridge systems over extensive bodies of water, or frequent load embargoed bridges due to the increasing danger of transporting hazardous materials in trucks.

7. COST: $200,000 for 24 to 28 month project.

8. IMPLEMENTATION: Changes in signing to better accommodate the needs of large trucks will result from this research. Successful completion of the project will yield strategies to guide highway agencies in making these changes in a priority to maximize the safety return.

9. EFFECTIVENESS: It is anticipated that successful completion of this research could increase the safety and the efficiency of traffic flow in congested urban truck corridors which have long bridges or vehicular tunnels to generate road user cost savings annually of 10 to 20 times the cost of conducting the research and implementing the results.

10. REFERENCES: Walker, Jonathan, Elizabeth Alicandri, and King Roberts, 1984. Symbolic Sign for Oversized-Truck Route Signs. Report FHWA/RD-85/064, Federal Highway Administration, Washington, D.C. 1984.

An Evaluation of Candidate Symbolic Routing Signs for Trucks Carrying Hazardous Cargo. Report FHWA/RD-85/081, Federal Highway Administration, Washington, D.C. 1985.

PROBLEM STATEMENT #12 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Driver Navigation

2. PROBLEM: The subject of driver navigation and the human factors and decision-making processes involved seem complex and varied and have eluded researchers for many years.

   We have an extensive sign system in place on the Interstate and well standardized letters and numbers are used to direct motorists to destinations on state and local roads. Yet motorists unfamiliar with many routes are getting lost, unnecessarily increasing their exposure to hazard and wasting an unusually large percentage of their time and resources.

It seems that signs with navigational information address the needs of hypothetically typical motorists, but do not necessarily provide aid to the vast majority of motorists whose needs are unusual and more specific.

However, improvements in providing the best navigational information very much depend on understanding the many types of specific problems motorists are having navigating in unfamiliar territory on the various routes provided. Some of these problems are associated with map information and the specific inabilities and skills many motorists lack in using spatially oriented path information. Some of these problems are associated with sign information and the observational or directional skills or abilities many motorists lack. Some problems are a result of a combination of the two or a simple lack of information in map or sign form.

New in-vehicle navigation computers are being offered but there is no indication that drivers will be able to navigate more effectively with these devices or any innovations until the problems are well investigated and defined in the detail that their quantity and variation deserves.

3. OBJECTIVE: Investigate and document motorist navigation problems in unfamiliar territory using a wide variety and a large number of selected subjects. Perform laboratory and in-vehicle tests to uncover and define navigation problems, especially among older, younger and newer drivers.

   Determine driver behavior observation measures that are closely associated with these problems and MOE's that traffic engineers and researchers can use to evaluate the seriousness of these problems at particular signs or decision points.

   Recommend innovative techniques that could be tried in laboratory and field tests to address the more specific widespread problems uncovered.

4. KEY WORDS: Navigation, Motorists, Drivers, Signs, Maps, MOE's, Subject Response, Laboratory, Field, Decision Errors.

5. RELATED WORK: G. King has completed some recent work on the inefficiency of highway navigation.

6. URGENCY: High. The motorist population is becoming vastly different from that for which signs and maps were originally designed.

7. COST: $300,000

8. IMPLEMENTATION: Navigation information improvements based on actual road scenes presented to subjects representing problem drivers will lead directly to new designs and innovations for field experiments and demonstrations.

PROBLEM STATEMENT #13 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Traffic Engineering Methods for Defining Drivers Requests and Needs for Traffic Control Devices

2. PROBLEM: Highway professionals do not fully understand the scope of problems that the driving public experiences while most drivers accept most problems with sign messages and other traffic control needs as having unavailable solutions. The public will more often complain by phone then by letter. Phone complaints are easily ignored because they lack documentation. Letters of complaint are regarded more seriously but there are, of course fewer of them and many represent either a result of people having nothing better to do, the biased few who compulsively complain, or the honest complaints from those many of whom cannot express themselves well enough to adequately define the problem at hand. Complaints through the political process probably receive the greatest amount of attention, but unfortunately also usually lack adequate definition and specificity.

   The use of market research techniques such as community or route oriented questionnaires or other more systematic and structural techniques to assess and define traffic control device problems such as sign message content should provide a more valid basis for satisfying driver needs.

3. OBJECTIVE: Synthesize the various methods and techniques now used by traffic engineers to investigate complaints, to assess traffic control device problems and the need for devices such as signs with certain messages, and to determine driver needs, paying special attention to systematic questionnaire survey methods and not traffic analysis methods nor analyzing complaints received in the office for their worth alone.

   Make recommendations on how to advance the state-of-art of using complaint investigation and...systematic survey methods to determine driver needs.

4. KEY WORDS: Traffic Engineering, Driver Needs, Market Research, Questionnaire Surveys, Traffic Control Devices.

5. RELATED WORK: The fist step of the Positive Guidance procedure is related but does not get into sufficient detail concerning problem definition, complaint investigation, and market research techniques concerning getting feedback from the community and the drivers regarding alternative solutions.

6. URGENCY: High. Assessment of complaints and driver needs though drivers and the community can help to avoid working on poorly justified problems.

7. COST: $50,000

8. IMPLEMENTATION: Better traffic control problem definition approaches can be used immediately by more professional traffic engineers. New approaches can be immediately programmed for development and implementation.

9. EFFECTIVENESS: Better use of traffic engineering resources by more valid assessments of complaints and driver needs.

PROBLEM STATEMENT #14 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: A Feasibility Study for Using Reflective and Non Reflective Raised Pavement Markings and Traffic Buttons as the Primary Marking System

2. PROBLEM: The current primary pavement marking system is not totally effective under all types of weather conditions. Paint and thermoplastic striping are effective under dry pavement conditions. However, they lose their effectiveness (reflectively) under wet and icy pavement conditions.

   In recent years, the use of raised pavement markers (RPMs) has increased because of their effectiveness on wet and icy pavements and acceptance by the motoring public. The cost (initial and maintenance) for RPMs in some cases over the service life of the pavement may also provide better economies than paint and thermoplastic. There is a need to evaluate the feasibility of using RPMs as the primary marking system on certain classifications of highways and/or where environmental conditions dictate.

3. OBJECTIVE: The object of this study is to determine the feasibility of using RPMs as the primary marking system. The economic and operational implications will be studied. Laboratory and proving ground studies would be conducted to determine motorist's understanding of the marking system. Field studies will be conducted to evaluate operational performance.

4. KEY WORDS: Roadway Marking, Primary Roadway Marking System, Reflective Raised Pavement Markings.

5. RELATED WORK: There has been little research in this area.

6. URGENCY/PRIORITY: This project has high priority.

7. ESTIMATED COST: $750,000

8. IMPLEMENTATION: The findings will be useful in the development of a primary all weather marking system.

9. EFFECTIVENESS: An increase in safety and a decrease in cost for the marking system may be achieved.

PROBLEM STATEMENT #15 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Minimum Luminance Properties of Raised Pavement Markers

2. PROBLEM: There are no guidelines as to the required minimum level of luminance (reflectivity) for reflective raised pavement markers (RRPMs). Most states replace RRPMs only after the markers are missing or become totally non-reflective. To maintain uniform and acceptable standards, minimum levels of reflectivity should be established.

3. OBJECTIVE: Perform field studies to determine minimum luminance levels of RPMs.

4. KEY WORDS: Luminance, Raised Pavement Markers, Reflectivity.

5. RELATED WORK: There has been little research in this area.

6. URGENCY/PRIORITY: This research has high priority.

7. ESTIMATED COST: $300,000

8. IMPLEMENTATION: The results would be used to establish maintenance guidelines for RRPMs.

9. EFFECTIVENESS: Increased safety and improved driving environment.

PROBLEM STATEMENT #16 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Low-Cost Solutions for the Motorist Direction-Finding Problem

2. PROBLEM: Improvements in motorist direction-finding performance can reduce unnecessary travel and provide an important savings of fuel. It has been estimated if highway direction-finding efficiency was improved by only one percent, through better pre-trip planning and/or route finding, an annual savings of over 15 billion unnecessary miles of travel would be achieved. Moreover, there is evidence substantial safety benefits will be achievd by giving motorists improved ways to solve their route-following problems. Lost and confused motorists cause accidents by slowing, stopping or backing up at decision points, reading maps under dangerous conditions, and driving erratically.

3. OBJECTIVE: The objective of the study is to develop the potential solutions found to be cost-effective under the contract, "Economic Assessment of Potential Solutions for Improving Motorist Route-Following".

4. KEY WORDS: Motorist Direction-Finding Performance.

5. RELATED WORK: This work is a continuance of the study entitled "Economic Assessment of Potential Solutions for Improving Motorist Route-Following", which was completed in October 1985.

6. URGENCY/PRIORITY:

7. COST: $250,000

8. IMPLEMENTATION: Cost-effective solutions for the motorist direction-finding problems can be achieved.

9. EFFECTIVENESS: Economic savings of fuel.

PROBLEM STATEMENT #17 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Wet Night Striping Systems

2. PROBLEM: Ordinary paint and tape used to delineate lanes and roadways are almost invisible at night. Raised pavement markers (RPMs) have been developed to provide wet night visibility, but several unsolved problems remain:

    1. The appearance between paint and RPMs is different, thus some of the intended coding is lost, since discrete markers do not have the same coding capability.

    2. The maintenance operation is different and requires more equipment.

    3. Day visible RPMs are not snowplowable, at this time, which prevents the use of a total RPM system in snow country.

3. OBJECTIVE: To develop both temporary and permanent wet night striping. Temporary wet night striping should withstand heavy traffic for six months, whereas permanent wet night striping should be as durable as regular striping paint, realizing that this will not likely be accomplished right away.

4. KEY WORDS: Wet night visibility, Traffic paint, Temporary tape, Traffic tape.

5. URGENCY: Medium, but such systems would be quickly implemented because they make sense to traffic engineers and maintenance managers.

6. COST: $600,000 over 3-5 years.

7. IMPLEMENTATION: Traffic engineers and maintenance managers would prefer a single all weather system. Once the systems are developed to an acceptable level, implementation would come quickly. Development would need to continue for 10-15 years to address more difficult conditions.

PROBLEM STATEMENT #18 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Raised Pavement Markers on Multilane Lighted Highways

2. PROBLEM: On highways or freeways where more than two lanes are provided for one direction, drivers find lane tracking unusually difficult on wet nights, especially where there is slight curvature. Many sources of lights from luminaires and commercial lighting exacerbate lane finding and tracking difficulties due to many irrelevant "line like" reflections on the dark wet pavement. The normal spacing of RPMs at 80 feet at these locations is too great to provide the normal pavement visibility. There is some indication that a similar problem exists at entrances to many lanes from ramps and intersecting roads on wet nights.

3. OBJECTIVES: To investigate in the field the need for exceptional placements and spacing of RPMs at multilane highways at ramp entrances, slight curves, slight curves with vertical components, and at multilane locations with multiple light sources.

   To recommend placement and spacing of RPMS at locations identified in the previous paragraph.

   To demonstrate improvements at field locations, providing photographic "before" and "after" wet/night documentation by means of using standard headlights, fast film, no extra lights in a way that approximates the driver's progressive view.

4. KEY WORDS: RPMs, Wet night visibility, Entrance ramps, Multilane highways, Curves, Vertical curves.

5. RELATED WORK: A. Roberts and W. Mullowney have done related SRPM studies at NJDOT, including realistic photographic methods, SRPM placement, spacing, wet night observations, and traffic performance measures.

6. URGENCY: High. RPM spacing is inadequate and special applications continue to be "armchaired." No need for RPMs at lighted roads is assumed while actual wet night observations uncover an apparent greater need at higher density.

7. COST: $400,000

8. IMPLEMENTATION: If properly documented, the existing standards and guidelines can be modified.

PROBLEM STATEMENT #19 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: The Effects of Vehicle Characteristics on Visibility of Reflectors and Signs

2. PROBLEM: The visibility of reflective devices is lower with large trucks than with smaller vehicles due to a larger angle of divergence or distance between the driver's eye and the vehicle headlights.

Opposing headlights create blocked out areas of the road ahead due to the glare. Some drivers are affected to the extent that they need to slow down. This can create a hazardous situation due to greater speed variances.

Larger vehicles block out the view of many TCDs for drivers in smaller vehicles. Drivers are more or less affected depending upon their position, the degree of information redundancy and the road geometry.

3. OBJECTIVE: To determine the degree to which visibility of reflectors is affected by vehicle headlight and driver position characteristics. To describe the effects by vehicle characteristic and the population of those vehicles in the traffic stream. Field study.

   To determine the conditions which cause variations in glare sensitivity and how these variations cause different size areas of road vision to be blocked out, describing the size of the cones of vision blocked out or the range of cone angles. Laboratory study.

   To determine the vehicle mixes and geometric conditions which would sufficiently degrade the driver's view to warrant more than the standard signs. Simulator study.

4. KEY WORDS: Visibility, View blockage, Glare, Vehicle characteristics, Reflective performance.

5. RELATED WORK: Little to no work has been done on these problems.

6. URGENCY: Medium. Would be of special relevancy to laboratory simulation design and in determining when more sign redundancy is needed.

7. COST: $200,000 for a combination of laboratory, simulator and field studies.

8. IMPLEMENTATION: If visibility discrepancies due to headlight/driver position are large enough, RPMs, roadside delineators and reflective materials on signs should be redesigned.

   Better knowledge on cones of glare within driver's view can provide redirection of delineation application.

   Warrants for determining needs for sign redundancy or special signs due to vehicle mix blockage problems can be developed directly.

PROBLEM STATEMENT #20 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Guidelines for Digitized Street and Road Maps

2. PROBLEM: Technologies are emerging for sophisticated self-contained route guidance systems in automobiles. Early communications-based precursors include automatic vehicle location systems for transit

buses and police cars; tests in the U.S., Federal Republic of Germany and Japan of route guidance using in-vehicle devices which interact with roadside equipment to generate guidance messages; and various radio triangulation schemes. These are being superseded by contemporary autonomous technologies based on dead reckoning or satellite positioning techniques, usually in conjunction with map data bases, made possible by the microcomputer.

Examples include the inertial-odometer technique demonstrated by Honda, the satellite technique being developed by Ford and the magnetic compass-odometer approach being investigated by Nissan. Routeware, already tested for programmed-route applications, uses a differential odometer and an on-board map-matching algorithm for precise location.

The first function of an in-vehicle route guidance system is that of maintaining real-time knowledge of the vehicle's location. The minimal system provides real-time location information to the driver for visual correlation with a map. The Honda system uses a transparent map overlay on a CRT projection of vehicle path to facilitate correlation. The Ford system projects both path and map on a CRT screen. The Routeware approach compares location with a digitized map and issues real-time route-guidance instructions so that the driver does not have to interpret the map which in effect, remains in the computer memory.

Regardless of what type of vehicle location technology eventually prevails for in-vehicle route guidance, if a system is to be more than a simple navigation aid it must incorporate on-board digitized maps. Thus the development and widespread use of in-vehicle route guidance requires a data base of digitized maps on a local, regional, and national basis. In addition to route data, such a map data base could include a variety of information on landmarks, facilities, etc., all keyed to location.

Inasmuch as current efforts toward in-vehicle guidance systems focus on vehicle location technology, little effort has been directed toward standardizing the contents and formats for digitized maps with the goal of making them universally useful for in-vehicle application. Therefore, it is desirable to establish and recommend guidelines for digitized maps intended for such use.

3. OBJECTIVE: The objective of this research is to study approaches for digitized maps, to survey current directions and future needs for digitized maps in motor vehicle navigation systems, and to synthesize and recommend guidelines for standardizing the content and format of vector encoded digitized maps for in-vehicle use.

4. KEYWORDS: Automobile navigation, route guidance, automatic vehicle location, digitized map, map matching, closed-loop dead reckoning.

5. RELATED WORK: The most extensive body of related work is the GBF/DIME (Geographic Base File/Dual Independent Map Encoding) System developed

by the U.S. Census Bureau for virtually all Standard Metropolitan Statistical Areas (SMSA). Graph theory is used as a conceptual framework. Each street is considered a series of lines, and each street intersection is considered a node. Other physical features such as streams, railroads, or political boundaries are also defined in terms of lines and nodes. Other encoded information includes street names and street number ranges between nodes, approximate coordinates of nodes, etc. The Census Bureau is now developing the improved TIGER (Topologically Integrated Geographic Encoding and Referencing) System to meet the needs of the 1990 Decennial Census.

6. URGENCY/PRIORITY - HIGHEST PRIORITY LEVEL: The current rate of progress on developing in-vehicle route guidance systems indicates that the location technologies will be established within this decade. This pace is conducive to a near-term scramble for digitized maps which, without guidelines, would result in a multiplicity of incompatible data bases. Early guidelines are essential to gain maximum national benefits from in-vehicle route guidance and to avoid unnecessary duplication of effort and waste of resources.

7. IMPLEMENTATION: The guidelines could be created by conducting a workshop whose attendees represent interested groups such as transportation related government agencies, urban information associations, transit and taxicab associations, automobile clubs, automobile manufacturers, vehicular systems suppliers, electronic map publishers, etc. A steering group would plan and organize the workshop and would coordinate sponsorship by appropriate organizations. A panel selected from participants would consolidate and summarize information and ideas exchanged during the workshop and would prepare a report (for peer review) recommending guidelines based upon common elements and needs.

8. EFFECTIVENESS: The creation of guidelines to be followed by future digital cartographers and electronic road map publishers would be cost-effective industry-wide because guidelines would help minimize potential future data base and/or software conversion expense incurred by users who choose dead-end digital map approaches. In addition, this first step toward digital map standardization would tend to expedite the development of vehicular technologies that are dependent upon the existence of large-scale digital map bases.

PROBLEM STATEMENT #21 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Development of a Prototype Urban Freeway Corridor Information System Using the Latest Technology

2. PROBLEM: The complexity of urban travel and the degree and frequency of urban traffic congestion are producing greater demands and "work loads" on drivers. Innovative technologies (e.g., changeable message signs, highway advisory radio, etc.) are being used to alleviate some of those problems. Newer advanced technologies have the potential for improving the urban traffic communication systems even further.

Applications of these advanced technologies need to be evaluated.

3. OBJECTIVE: The objective of this research is to design, construct and evaluate a prototype urban freeway corridor information system using the latest technology (e.g., laser, infrared, millimeter wave technology, digital burst, holography, etc.)

4. KEY WORDS: Freeway Information System, Traffic Control, Freeway Corridor

5. RELATED WORK: NCHRP Project 3-38(1), "Assessment of Advanced Technologies for Relieving Urban Traffic Congestion.

6. URGENCY/PRIORITY: This research has high priority.

7. ESTIMATED COST: $1,000,000 - $1,500,000

8. IMPLEMENTATION: Several large cities suffer from severe congestion.

9. EFFECTIVENESS: Advanced system in reduced urban congestion and delays.

PROBLEM STATEMENT #22 USER INFORMATION SYSTEMS COMMITTEE

1 TITLE: Reflectorized Signing and Delineation for Truck Ramps

2. PROBLEM: Increased legal truck weights, increasing frequency of trucks operating with front axle brakes disabled, and the continuing presence of grossly overloaded trucks on the highways has caused highway agencies to install more truck escape ramps in mountainous terrain as a safety measure to cope with the danger of a heavily loaded runaway truck. Past research and experience has contributed to improve applications in better location along the downgrade, better design to dissipate the truck's kinetic energy, and general agreement on the guidelines to produce an effectively designed and constructed installation. However, there is not yet any agreed upon uniformity in signing and marking of truck escape ramps. Since these facilities are used under the stress of emergency operations, it is important to establish guidelines for uniformity of signing and marking to further increase the operational effectiveness of truck escape ramps.

At night and during periods when snow covers the ground, it is important that the edge of the ramp be delineated to the truck driver. It is also important that the beginning of the escape ramp be clearly evident to the driver and that the proper angle of entry into the ramp for effective slowing can be obvious to the driver. This could be achieved by placing delineators along the edge of the ramp. There are wide variations in state practices in this regard. The National Committee on Uniform Traffic Control Devices designated red delineators for use on truck escape ramps. This decision was made by traffic engineers and traffic control researchers with little, if any, input from truck drivers or other motorists.

Some agencies use vertical panel hazard markers at the entrance to truck escape ramps. There are a wide variety of signs used to mark the presence of truck escape ramps. It is important to have signing in advance of truck escape ramps to increase the truck driver's decision time. It is also important to have regulation and signing banning motorcycles, four-wheel drive vehicles and off-road vehicles from using truck escape ramps in a recreational manner that reduces the energy dissipation characteristics of the ramp for runaway trucks.

3. OBJECTIVE: The objectives of this research should include the following: (1) conduct a survey of a large sample of truck drivers to determine their perceptions and preferences with respect to the best location, message, color, etc., of reflectorized signing for truck escape ramps; (2) conduct a survey of both truck drivers and other motorists to determine what color, location, and spacing of delineators along truck escape ramps are perceived as most assisting truck drivers with minimum confusion to other drivers; (3) develop recommendations for device color, placement and message based on analysis of the perception and preference data obtained in the surveys; (4) perform limited laboratory testing to estimate the effectiveness of the recommended installation system.

4. KEY WORDS: Arrestor beds, ramp delineation, truck drivers, truck escape ramps, runaway trucks, signs, delineators, safety.

5. RELATED WORK: Williams (1978), Eck (1979, 1980) and Bullinger (1980) have reviewed practices relative to truck escape ramp location, design and operation. Their studies indicated a wide variety in practices in signing and marking for escape ramps. One step toward uniformity was taken with the establishment of an ITE committee to develop recommended practices for truck escape ramps. Signing, marking and delineation guidelines were proposed by the committee (1982) based on input from traffic engineers. The committee recommended that additional input be obtained from truck drivers. This proposed research would address this issue.

6. URGENCY/PRIORITY: This project is high priority. Longer, larger and heavier trucks are increasing as a proportion of the overall traffic stream on major highways. Confusion or misunderstanding at night about signing or delineation of a truck escape ramp may contribute to a truck driver not using such a ramp when needed or perhaps entering a truck escape ramp improperly thereby suffering unnecessary damage and/or injury.

7. COST: $150,000 for 18 to 20 month project.

8. IMPLEMENTATION: Recommendations for effective night signing and delineation of truck escape lanes are anticipated from this proposed research. These recommendations could be implemented immediately by state departments of transportation with mountainous terrain to begin observing the long-term effect of increasing uniformity in signing and marking truck escape lanes. When a general consensus exists among states having truck escape lanes on the best signing and marking, a

change to the Manual on Uniform Traffic Control Devices could be undertaken.

9. EFFECTIVENESS: It is anticipated that implementation of the results of this research will result in as high as 10 percent reduction in the damage to trucks and cargo using existing truck escape ramps. It is also probable that the results of successfully completing this research will significantly increase the rate of use of existing truck escape ramps by runaway trucks that now crash on long downgrades, and thus, it is anticipated that some small but significant increase in safety to the general traffic stream will result.

10. REFERENCES: Bullinger, Melvin, Truck Escape Ramps: Operating Experience and Design Considerations. M.S. Report, Iowa State University, Ames, IA, 1980.

PROBLEM STATEMENT #23 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Driver Visibility and Photometric Quality

2. PROBLEM: The relationship between the area of a reflective material and its specific intensity should be a simple matter of multiplying the area of the reflective material (or the projected image of it) by the brightness, which is the intensity per unit area (S.I. = B x A). However, what is not determined is the relationship of measuring area given the same material brightness as material size increases from a square inch to 100 square feet or more to driver visibility distance. Contrast may also be involved.

3. OBJECTIVE: Using subjects in the lab and field to determine the relationship between driver visibility distances including variances and the specific intensity of photometrically measured reflective materials in common use varying in size from one square inch to 100 square feet under ambient light conditions found in the field.

   To elaborate on the implications for Traffic Control Device design, such as delineator size with cube corner reflectors and sheeting size for signs with enclosed beads and microscopic cube corners. Obtain equivalent amounts of data for areas ranging from one square inch to one square foot and for areas ranging from two square feet to 100 square feet. Include high and low beam tests from cars and tractor trailers.

4. KEY WORDS: Reflectors, Reflective materials, Visibility, Headlights, Delineators, RPMs, SRPMs, TRPMs, Signs, Reflective sheeting, Field tests, Vehicle sizes.

5. RELATED WORK: W. Mullowney performed some related work on studying center barrier reflective systems, Center Barrier Visibility.

6. URGENCY: High priority to allow better application of reflectorized materials now increasing in use.

7. COST: $75,000

8. IMPLEMENTATION: Results in formula and graphic form can immediately provide guidance to traffic and other transportation engineers in the process of reflectorizing highway related facilities.

PROBLEM STATEMENT #24 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Truck Rear Visibility

2. PROBLEM: Under dark and adverse conditions, driver perception of rear truck lights, on large trucks especially, can lead to some illusions of perceptions or depth that can lead to severe driver misjudgments and rear end collisions. Flatbed tractor trailer rears with three sets of red lights can easily lead to an illusion perception of three cars ten times further down the road. The lights are often at a car driver's eye height which reduces the depth perception cue. Small lights do not tend to offer actual cues that could aid depth perception.

3. OBJECTIVE: To investigate the use of black and colored striped reflective sheeting as a supplement to rear lights to help provide more solid cues under adverse weather conditions including heavy snow and rain.

4. KEY WORDS: Trucks, Marking, Visibility, Reflective Sheeting, Rear Lighting, Depth Perception, Distance Illusions.

5. RELATED WORK: W. Burger of Vector Enterprises is doing some related work for the sides of trucks, but is not addressing flatbed trailers which have practical problems of a different nature.

6. URGENCY: High. Truck traffic is increasing. Car to truck collisions are increasing.

7. COST: $50,000

8. IMPLEMENTATION: Applications that in fact help to overcome this problem can be immediately demonstrated.

PROBLEM STATEMENT #25 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Driver's View Laboratories

A great deal of important research has preceded directly to before field studies after scant pilot studies in the laboratory or office or no preliminary laboratory studies at all. Hundreds of thousands of dollars in experimental installations have been finalized with the scantiest of laboratory facilities and experiment procedures, such as simple projector and limited photographic techniques used for subject response, while millions of drivers are subject to the result on any

given highway. Once an expensive installation is made: (1) little to no modification can be made to the benefit of the driver; (2) the installing agency is then subject to suit which may require detailed professional level data for why the experimental devices were designed as they were; and (3) very few alternative designs can be practically considered due to the high cost of field trials and this inevitably results in lower quality choices than is desired for the traveling public.

Hundreds of millions of dollars in facilities have been invested in commercial aircraft simulators and marine navigation simulators yet highway laboratory simulation is at a crude level.

Although simulation for signing and delineation is needed at the state level, the development of lower cost simulators requires extensive knowledge of the state-of-art in order to emphasize the appropriate features, fast turnaround and high quality operation.

2. OBJECTIVE: As a first stage in the development and use of driver's view laboratories in sign and delineation research, summarize and detail the facilities and procedures used in sign and delineation research to date and include the types of equipment.

   Review current technology for its suitability in improved simulation of both traffic control devices and roadway designs and its possible use in subject response testing in a laboratory environment, recommending demonstration projects, where applicable.

   Evaluate previous methodology, equipment, and procedures used in signing and delineation research in subject response laboratory settings and recommend improved or additional approaches that could be used.

3. KEY WORDS: Sign, signing, delineation, laboratory, sign tested, subject response, subject presentation, simulator.

4. RELATED WORK: Some previous work was done by Dewar, Hulbert, and Blackwell, while current work is being done by Freedman with the HYSIM. Computerized driver views of unbuilt highways were developed in Colorado and Texas and demonstrated by the FHWA in other states. The Bosch simulators are common equipment.

5. URGENCY: High priority. Video and computer technology should enable an advance in the state-of-art, right now.

PROBLEM STATEMENT #26 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Interactive Computer Link for Tourist Route Information

2. PROBLEM: All states and regions are promoting tourism and the highway system is the primary means of travel to participate in tourism events. The increased emphasis on highway rehabilitation creates

travel interference for tourists that places the highway agency program at odds with the tourism and development agency program. Continued difficulty in adequately informing motorists entering a state about highway system conditions is a criticism of the highway agency. There is a need to examine the potential costs and benefits associated with the application of advanced video and computer telemetry links established between the highway agency construction and maintenance data base and tourist information centers and rest areas to enhance tourist communication on road and route conditions.

3. OBJECTIVE: The objective of this research will be to determine the feasibility and probable effectiveness of providing tourist information on road closures, bridges closed or restricted, construction and maintenance zones carrying through traffic, detours around construction zones, regional weather condition warnings, temporary load embargoed roads or bridges, etc., in interactive video display at tourist and rest areas. A further objective is to conduct a system analysis study to examine the cost effectiveness of incorporating digitized voice message, telecommunication link with maintenance management systems, and color graphics rather than text format displays. A third objective is to conduct a pilot test in a cooperating state.

4. KEY WORDS: Computers, telecommunication, tourism, maintenance, construction, traveler services.

5. RELATED WORK: There is a large body of literature on telecommunications and data transmission, all of which has some merit to this proposed project. The work of the various state lotteries in operating "computer lotto" gambling has application in cost estimates of distributed network of data communication and display systems.

6. URGENCY/PRIORITY: This has a medium for all states and a high priority for states with major tourism efforts and large highway networks to be rehabilitated, such as Texas, California, Iowa and Illinois.

7. COST: $300,000 for 24 to 28 month project.

8. IMPLEMENTATION: Implementation will require a highway agency and a development agency to share the cost of installation and operation necessitating intergovernmental agency agreements. The research output system design and analysis should provide the factual basis for agency heads to determine how to proceed with implementing a state system.

9. EFFECTIVENESS: It is anticipated that successful completion of this research will reduce the accidents at construction and maintenance work zones, will enhance the development of tourism in spite of the need to make major repairs and do reconstruction work on the highway network in the vicinity of major tourism locations. Such a system should also stimulate spur-of-the-moment tourism and thereby contribute to economic multiplier development.

10. REFERENCES: None cited at this time.

PROBLEM STATEMENT #27 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Designing Pavement Markers For A Low Facing Sun

2. PROBLEM: A low facing sun causes some of the most serious problems in driver visibility during the day, including interfering with the view of stop lights, speed signs, guide signs, warning signs, leading vehicles, pedestrians and hazardous objects that have fallen onto the road.

   Temporary and permanent day visible raised pavement markers are also vulnerable to this effect, especially on concrete road surfaces.

3. OBJECTIVE: To study the effect of various raised pavement marker designs in a low facing sun and determine what features of design enhance RPM visibility during this condition.

   To incorporate successful features in prototype markers that are already successful for other needs, demonstrate them in the field, and recommend new marker features for trial in the states.

4. KEY WORDS: Sun glare, Design, Temporary raised pavement markers, Raised pavement markers, Daytime, Visibility, Field study.

5. RELATED WORK: T. Davis in NJDOT has recently published some related work in temporary raised pavement markers.

6. URGENCY: High, especially for application in construction zones. The best features need to be incorporated while construction zone solutions are in demand and before complacency and settling for what we have now hampers implementation of new improvements.

7. COST: $50,000

8. IMPLEMENTATION: Low facing sun countermeasure features adopted by manufacturers can be used immediately in construction zones and for permanent RPM applications.

PROBLEM STATEMENT #28 USER INFORMATION SYSTEMS COMMITTEE

1. TITLE: Lighter-Than-Air Work Zone Warning Devices

2. PROBLEM: As signing and traffic control requirements to communicate with drivers have become more complex, the signing and signal requirements to conduct construction and maintenance has increased dramatically. There are pressures in the allocation of manpower and materials, especially in maintenance, which suggests that in order to increase productivity, lesser quantities of traffic control devices must be used to provide advanced warning of maintenance and

construction operations. This is an acute problem in moving maintenance or short-term maintenance operations. At one time it was hoped that the flashing arrow board would suffice as a single traffic control device for short-term and moving operations such that the motorists would be given sufficient advance warning to prepare for changes in travel speed and placement to operate safely through the work zone. As these devices are being hit more frequently, there is a concern that a more dominate device for far advance notice might be helpful.

3. OBJECTIVE: The objective of this research will be to determine the communication effectiveness of marking a maintenance or construction work zone with a lighter-than-air balloon system as compared to the Manual of Uniform Traffic Control Devices advance signing systems. It is anticipated that the balloon system will be designed to be tethered on a power remote control winch at the rear of a truck or vehicle at the rear of the work zone or moving maintenance operation. Study of effectiveness must consider raising and lowering the balloon and possibly illuminating it for night operations.

4. KEY WORDS: Traffic control, work zones, balloons, driver communication, safety.

5. RELATED WORK: None has been identified at this time with direct application.

6. URGENCY/PRIORITY: This has a low priority at this time and can be the subject of basic communication research in a laboratory setting before conducting field tests.

7. COST: $50,000 for an 18-month laboratory basic research project phase. If it is successfully completed a $150,000, 24-month field test in a cooperating state should be conducted.

8. IMPLEMENTATION: Implementation will require a change in the MUTCD to permit such a warning system to be an accepted alternate to the signing systems.

9. EFFECTIVENESS: It is anticipated that successful completion of this research will reduce the accidents at construction and maintenance work zones by 5 percent.

10. REFERENCES: None cited at this time.