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RESEARCH PROBLEM STATEMENTS: FREEWAY OPERATIONS

mode

1 highway transportation

subject area

54 operations and traffic control



FREEWAY OPERATIONS COMMITTEE (A3A09) as of October 1, 1982

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Illinois DOT, Oak Park, Illinois

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FOREWORD

The Freeway Operations Committee (A3A09) developed 14 new research problem statements during 1979. In 1980, these statements were combined with 35 problem statements that were previously developed by the Committee and had been published in TRB Special Report #158.

All 49 research problem statements were then ranked by the following process. Each member ranked the statements from highest (1) to lowest (49), and the results were averaged. After discussion of the scores at the June, 1980 meeting, the statements were reviewed by a task group of the Publications Subcommittee and with minor modifications the top 10 were selected. At the mid-year meeting in June, 1981, the Committee approved these 10 statements and recommended that they be published.

Members of the Freeway Operations Committee during the ranking of the statements are listed below:

Joseph M. McDermott, Chairman
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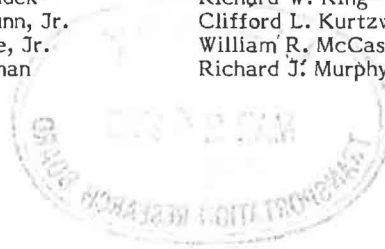
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RESEARCH PROBLEM STATEMENTS

PROBLEM NO. 1

- 1.1 **TITLE:** EFFECTIVE FREEWAY CORRIDOR MANAGEMENT
- 1.2 **PROBLEM:** There are many tools available which permit improved freeway corridor operations. These include, for example, preferential high occupancy vehicle (HOV) treatment, traffic signal systems, ramp metering, changeable message signs, incident management, etc. There are various lengths and widths of freeway corridors and various volume conditions. There is a need to provide a set of guidelines to governmental agencies on how to effectively manage the traffic along corridors within various sized cities.
- 1.3 **OBJECTIVE:** To develop a set of guidelines on the management of freeway corridor systems. These guidelines will assist states and cities in determining the type and amount of manpower and resources needed to manage their corridors and provide information on how to do the job right.
- 1.4 **KEY WORDS:** Manpower requirements, effective application
- 1.5 **RELATED WORK:** Most of the freeway corridor management appears to exist in larger cities, such as Los Angeles, Chicago, Dallas, and Minneapolis. Cities reaching the size of these cities could benefit from past and existing management procedures applied by these cities. Freeway corridor management could (and should) be developed by smaller cities -possibly 100,000 population and above. There is no known information available to these cities on effective management. Corridor Management Teams or Urban Management Teams could be of assistance in this regard. The makeup of these teams varies, but includes the state and city traffic personnel, the city police and transit representatives. At present, these teams are being developed and tasks carried out on a learn as you go basis.
- 1.6 **URGENCY/PRIORITY:** There is an urgency for the research. The tools are being developed, but the guidelines on how to effectively use these tools on a systems basis have not been developed.
- 1.7 **COSTS:** It is estimated that the cost for the project will be \$150,000.
- 1.8 **USER COMMUNITY:** The city and state personnel involved (or who should be involved) in the management of freeway corridor systems and/or urban systems within cities.
- 1.9 **IMPLEMENTATION:** The research could be implemented by the states in their daily work with city and transit personnel.
- 1.10 **EFFECTIVENESS:** The results will provide society with an efficient operating management system which will in turn provide efficient and cost effective services within the multimodal urban transportation system.

PROBLEM NO. 2

- 2.1 **TITLE:** INTEGRATED FREEWAY AND AREA TRAFFIC CONTROL
- 2.2 **PROBLEM:** Many large urban centers have installed both area traffic control systems and freeway ramp

metering control systems to alleviate congestion on their street networks and urban freeways. The problem is that most of these systems operate essentially independently of one another. In fact, they often operate at cross purposes, particularly under severe congestion, since there is no integrated overall control strategy which attempts to optimize simultaneously the performance of traffic flow both on the street and on the freeway. Control of on-ramp queue spillover on the local street network and prevention of off-ramp queue spillback on the freeway are obvious examples where integrated control is highly desirable.

- 2.3 **OBJECTIVE:** To develop design guidelines and integrated optimal control strategies for the simultaneous control of traffic flow on urban freeways and the local street network, and to demonstrate the effectiveness of same by a field test in a suitable location.
- 2.4 **KEY WORDS:** Traffic Control, Integrated Traffic Control, Freeway Surveillance and Control, Area Traffic Control, System Optimization
- 2.5 **RELATED WORK:** Virtually all area traffic control systems in use today employ so called First Generation Control in which pre-stored plans are called up on either a time-of-day or traffic responsive basis. The timing plans for the splits and offsets are usually determined from an off-line traffic signal optimization program such as TRANSYT or SIGOP.

Many freeway control systems also use time-of-day control using pre-stored plans (metering rates, in this case) but some use traffic responsive control. The plans are usually determined manually from consideration of freeway capacity and demand although there are some off-line programs which determine optimum metering rates (e.g. FREQ3C). It is not at all clear how, if at all, these two approaches could be combined for integrated control. Most likely, a new approach is needed.

This research would go beyond the freeway corridor control problem which has been mainly concerned with optimal distribution of the corridor demand between the freeway and the parallel alternate routes. Both parallel and perpendicular arterial traffic must be considered for integrated control of the freeway and the local network.

- 2.6 **URGENCY/PRIORITY:** There is some urgency to establish at least preliminary guidelines for integrated control if only to allow the designers of area traffic control or freeway control systems to allow for possible system interface and additional computer capacity to meet future integrated control requirements (shared data base, etc.)
- 2.7 **COSTS:** \$500,000 to 1,000,000, including a field test program.
- 2.8 **USER COMMUNITY:** FHWA mainly.
- 2.9 **IMPLEMENTATION:** Findings should be implemented first in a demonstration project.
- 2.10 **EFFECTIVENESS:** Integrated control would produce greater total benefits (less waste of time and energy resources, etc.) than both freeway and area control systems operating independently.

PROBLEM NO. 3**3.1 TITLE:** FREEWAY CORRIDOR IMPROVEMENT ANALYSIS

3.2 PROBLEM: Urban freeways are frequently congested during peak hours or are reaching the limit of their capacities. In some cases it is not possible to increase the capacity of the system unless the freeway corridor is treated as an integral part of freeway traffic control. This approach can produce the greatest people carrying capacity of the freeway-corridor system but it needs the improvement of streets, parking lots and bus routes along the corridor.

There is a need to provide a step by step procedure to logically and systematically improve a freeway corridor with funds available to the governmental agencies. Guidelines in determining the low cost short range and the high cost long range improvements are needed to cover the wide range of possibilities, such as: geometric changes at intersections, use of electronic wireless traffic signal coordination equipment, high occupancy vehicle (HOV) ramp bypass lanes, reversible lanes along arterials, revising interchange design, providing traffic responsive freeway management systems, and adding freeway main lanes. Non-construction improvements must also be considered such as the increased use of car pools and buses, and staggered working hours.

To arrive at the most efficient plan and in order to coordinate all improvements a step by step procedure must be developed for analyzing the various improvements. Guidelines to evaluate freeway corridor improvements on a system basis using a similar procedure as in NCHRP Project No. 3-18 (3), "An Approach for Selecting Traffic Control Systems," should be developed.

It is anticipated that NCHRP Project 3-22A, "Guidelines for Design and Operation of Ramp Control Systems" along with the results of other recent research projects will provide resources for much of the analysis guideline development covering possible improvements, anticipated costs, benefits and utility per dollar invested.

Corridor streets, frontage roads and major arterials can be analyzed using the PASSER II and III computer programs to determine the most cost effective distribution of traffic between the freeway and the corridor system. Further research and the development of a compatible traffic assignment model for corridor systems will help to plan improvements which will lead to a balanced freeway-corridor system (uniform level of service).

3.3 OBJECTIVE: This research project is intended to develop the tools (computer programs, short/long term improvements, cost analysis) to evaluate the available options for balanced corridor systems at the least costs.

3.4 KEY WORDS: Traffic Management, Optimum Operation, Cost Analysis, Transportation Planning

3.5 RELATED WORK: NCHRP Report 232, "Guidelines for Selection of Ramp Control Systems" (describes a cost-effectiveness evaluation); FHWA Report "Human Factors Requirements for Real-Time Motorist Information Displays"; Computer

Analysis Programs **FREQ**, **FREFLO**, **PASSER II** and **III**.

3.6 URGENCY/PRIORITY: Restrictions in the construction of new urban freeways dictate the need to make the best possible use of existing resources. This is an urgent project.

3.7 COSTS: \$350,000

3.8 USER COMMUNITY: State and City Authorities, Traffic Planning Agencies, Consulting Engineers.

3.9 IMPLEMENTATION: The research results will be implemented by the states, cities and transit authorities in their daily work routine.

3.10 EFFECTIVENESS: The project will provide the means to develop cost effective and balanced corridor systems.

PROBLEM NO. 4**4.1 TITLE:** FREEWAY CONTROL UNDER SATURATED CONDITIONS

4.2 PROBLEM: Most large urban centers have at least one freeway facility which suffers chronic congestion and breakdowns every day year after year. These facilities are usually old and have many deficiencies by today's standards (short ramps, numerous bottlenecks, no shoulders, little or no available capacity on parallel arterials, etc), and are poor candidates for conventional techniques such as ramp metering. Geometric improvements are generally out of the question because of lack of funds and/or right-of-way problems. Yet day after day, the motorist must suffer unpredictable stop and go conditions, with the attendant high risk of accident and personal injury, on a facility which resembles a parking lot more than it does a freeway. This is a drastic situation which calls for drastic measures and new approaches. One idea which has been suggested is to establish traffic signals right on the freeway and move the traffic along in platoons as on an arterial. At least then stops would be predictable and fewer incidents would result. The problem is that there does not appear to be any proven strategies available which would recognize the situation for what it is and try to make the best out of a bad situation.

4.3 OBJECTIVE: Develop guidelines for the implementation of freeway control strategies for chronically congested facilities where conventional techniques either cannot be used or are ineffective. Demonstrate effectiveness in a field test in a suitable facility.

4.4 KEY WORDS: Freeway Traffic Control, Saturated Condition, Chronic Congestion

4.5 RELATED WORK: There has been a considerable amount of research done on traffic control in saturated networks which would be relevant. (F. Wagner and UTCS, 3rd Gen.)

4.6 URGENCY/PRIORITY: This addresses a continuing problem which is extremely wasteful in time and energy resources.

4.7 COST: \$500,000 to \$700,000, including a demonstration project.

4.8 USER COMMUNITY: FHWA mainly

- 4.9 **IMPLEMENTATION:** Demonstration project would be first step.
- 4.10 **EFFECTIVENESS:** Minimization of starts and stops and decrease in personal injury and property damage accidents would be a worthy, and hopefully cost effective, achievement in what is otherwise a rather dismal situation.

PROBLEM NO. 5

- 5.1 **TITLE:** METHODS FOR DETECTING AND IDENTIFYING THE CHARACTER OF FREEWAY INCIDENTS.
- 5.2 **PROBLEM:** Traffic incidents on freeways can cause congestion and in some incidents a complete breakdown of traffic flow. Recovery time is strongly related to the time interval during which no steps have been taken to control and remove the incident. This is also a period when accidents caused by the incident occur. It is therefore very important to identify, localize and attend to the incident as soon as possible. Closed circuit television systems have been used successfully to identify and attend to incidents. This system, however, is costly and requires a lot of manpower for operation. To reduce the cost and manpower requirements for incident detection and identification, automatic systems should be developed. The problem is that there are no reliable automatic incident detection systems which can localize and recognize the situation for what it is and guide operations control to make the best out of a bad and potentially dangerous situation.
- 5.3 **OBJECTIVE:** Develop and test an automatic incident detection system which is reliable and effective for day and night traffic conditions on freeways. The effectiveness of the system should be demonstrated in a field test in a suitable facility.
- 5.4 **KEY WORDS:** Freeway Traffic Control, Congestion, Traffic Flow, Saturated Condition, Reduced Capacity
- 5.5 **RELATED WORK:** A number of self powered detectors have been developed which can be modified and applied in incident detection. Preferably an existing communication system should be used. The Jet Propulsion Lab has developed TV technology and pattern recognition techniques for a vehicle detection system.
- 5.6 **URGENCY/PRIORITY:** This project addresses a continuing problem which is extremely wasteful and dangerous for efficient freeway traffic.
- 5.7 **COST:** \$600,000 including a demonstration project.
- 5.8 **USER COMMUNITY:** FHWA, Freeway Control Centers and City Authorities (Police, Fire Department, Ambulance Dispatch).
- 5.9 **IMPLEMENTATION:** Through demonstration project as a first step.
- 5.10 **EFFECTIVENESS:** Reduction of traffic jam conditions, decrease in accidents and personal injuries, increased efficiency of traffic flow especially on urban freeways.
- 6.2 **PROBLEM:** Different methods have been developed to handle disabled or damaged vehicles on freeways. The problem is especially serious on urban freeways during peak hours when such vehicles cause an obstruction which will reduce traffic flow and generate potentially dangerous situations often resulting in multiple traffic accidents. It is very desirable to evaluate the methods used by different freeway traffic control centers and arrive at the most efficient, cost effective system.
- 6.3 **OBJECTIVE:** Develop guidelines for the implementation of strategies to handle disabled and/or damaged vehicles on freeways. Such guidelines should include information on the cost and the most effective and reliable equipment.
- 6.4 **KEY WORDS:** Freeway Operations, Equipment, Freeway Traffic Control
- 6.5 **RELATED WORK:** A considerable amount of information has been accumulated by the Highway Patrol, City Authorities, Freeway Traffic Control Centers and by Private Enterprises on the problems and methods of handling disabled and/or damaged vehicles.
- 6.6 **URGENCY/PRIORITY:** This project addresses a continuing problem which is of importance for the efficient control of freeway traffic. The project will also enhance the safety of freeway traffic.
- 6.7 **COST:** Survey of existing methods and development of guidelines for a most efficient system: \$100,000.
- 6.8 **USER COMMUNITY:** Freeway Traffic Control Centers, State and City Authorities, Private Business.
- 6.9 **IMPLEMENTATION:** Make guidelines and information available to Authorities and Private Business operating services for the handling of disabled/damaged vehicles on freeways.
- 6.10 **EFFECTIVENESS:** This service will reduce injuries to persons and protect property from additional damage. The guidelines will also help to train people in private business.

PROBLEM NO. 7

- 7.1 **TITLE:** SELLING OF RAMP METERING TO LOCAL GOVERNMENTS
- 7.2 **PROBLEM:** Ramp metering, although shown to be a positive traffic control technique, has suffered from negative connotations in large urban areas. In particular, local governments must answer to the claim that ramp metering favors the suburbanite by providing him unlimited access to the freeway system while the urban freeway user must wait in line to use the same facility.
- 7.3 **OBJECTIVE:** The objective of the research would be to prepare a planned approach for selling ramp metering to local government which in turn can be sold to their constituency. The plan should include a method of presenting the need for metering, the implementation strategy, and a public relations approach.

- 7.4 **KEY WORDS:** Ramp metering
- 7.5 **RELATED WORK:** None Known
- 7.6 **URGENCY/PRIORITY:** Very High
- 7.7 **COST:** Approx. \$50,000
- 7.8 **USER COMMUNITY:** Highway Departments, FHWA, City Authorities, Freeway Control Centers.
- 7.9 **IMPLEMENTATION:** The findings, prepared as a method of implementing and selling ramp metering, should be utilized as a formalized procedure by interested agencies.
Note: The production of a movie showing the effect of ramp metering, how it works and what it does to the mainline traffic, should be considered. Showing conditions with no ramp metering and with ramp metering at selected sites should be effective and convincing.

PROBLEM NO. 8

- 8.1 **TITLE:** UTILIZATION OF DIGITALIZED VIDEO INFORMATION FOR INCIDENT DETECTION
- 8.2 **PROBLEM:** At present most on-line incident detection models rely on vehicle detectors for their base data. Most models have relatively slow response time and marginal false alarm rates. In addition, to date, there is no reliable model for detecting incidents in low volume conditions. As an alternative to using vehicle detectors it should be possible, utilizing existing technology, to use a television camera and a video digitalizer to analyze traffic for detecting incidents.
- 8.3 **OBJECTIVE:** A research program should be undertaken that would test the feasibility of utilizing digitalized video information in the traffic environment, particularly for incident detection.
- 8.4 **KEY WORDS:** Digitalized Video, Incident Detection
- 8.5 **RELATED WORK:** Radar Moving Target Indication Techniques
- 8.6 **URGENCY/PRIORITY:** Fairly High
- 8.7 **COST:** Utilizing an existing television, and computer system approximately \$250,000.
- 8.8 **USER COMMUNITY:** FHWA, City Authorities, Freeway Traffic Control Centers Highway Control.
- 8.9 **IMPLEMENTATION:** If the results of the research are positive, traffic surveillance systems with existing television systems could implement the hardware and software at a reasonably low cost.
- 8.10 **EFFECTIVENESS:** Utilization of same criteria as other incident detection models.
Note: This project could be an extension of the "Wide Area Detection System" (WADS) presently in development by the Jet Propulsion Laboratory. A breadboard test and evaluation is expected to be completed by October 1982.
- 9.2 **PROBLEM:** Because of the complexity of freeway maintenance, a properly scheduled maintenance program can insure maintenance at the right time, can considerably decrease the cost of maintenance work and can help to make the best and most efficient use of equipment and manpower. There are certain parts which require continuous inspection and if maintenance work is carried out in time, the cost will be minimized. Other parts need attention before the deterioration has reached a point when major repair work or even replacement will be required. The maintenance schedule should be developed and categorized with the help of a comprehensive inventory. Maintenance work can then be classified and equipment can be assigned as required for the maintenance program. Methods of linear programming, cost effectiveness and useful life expectancy, developed from statistical data, should be used to develop efficient maintenance programs, which will match local resources with local conditions. Maintenance divisions have accumulated a wealth of experience and knowledge for maintenance work which has not been published in a number of cases. This knowledge and scientific optimization processes can be married to develop more efficient and cost effective maintenance programs. Though such programs must be developed for different areas, there are basic principles which should be used for the development of any maintenance program.
- 9.3 **OBJECTIVE:** To collect information and statistical data from maintenance programs in the U.S. To evaluate the statistical data for the development of a basic maintenance program for freeways, using optimization methods for the most efficient use and cost effectiveness of local resources.
- 9.4 **KEY WORDS:** Maintenance, Construction, Data Reduction and Evaluation, Optimization
- 9.5 **RELATED WORK:** There has been a considerable amount of experience and knowledge accumulated by maintenance divisions all over the U.S. Special equipment for maintenance has also been developed.
- 9.6 **URGENCY/PRIORITY:** Maintenance is a never ending problem and should be treated in the most efficient and cost effective way. There is an urgent need to collate information and data and to carry out additional research.
- 9.7 **COST:** \$300,000
- 9.8 **USER COMMUNITY:** FWHA, Cities, Local Highway Authorities, Contractors, Consulting Engineers.
- 9.9 **IMPLEMENTATION:** Make information available to the User Community.
- 9.10 **EFFECTIVENESS:** Such a program can save millions of dollars.

PROBLEM NO. 10

PROBLEM NO. 9

- 9.1 **TITLE:** SCHEDULING FREEWAY MAINTENANCE ACTIVITIES

- 10.1 **TITLE:** THE USE OF HIGHWAY ADVISORY RADIO VERSUS VARIABLE MESSAGE SIGNS.
- 10.2 **PROBLEM:** Highway advisory radio (HAR) and variable message signs (VMS) are two techniques employed to communicate messages to motorists. The cost of the VMS is very high compared to an HAR installation. In dense urban areas where many

signs may exist within a short distance, the use of HAR should be examined instead of VMS.

- 10.3 **OBJECTIVE:** The objective would be to determine the acceptance of the motorist to both the HAR and VMS in complex urban areas. A test site could include both a VMS and an HAR location.
- 10.4 **KEY WORDS:** Highway advisory radio, variable message signs, human factors engineering
- 10.5 **RELATED WORK:** Human factors work on variable message sign content has been completed by TTI. HAR reports have been recently completed by the FHWA Office of Research. The Atlantic Research Corporation is developing an engineering model and prototype Automatic Highway Advisory Radio System for test and evaluation. Similar systems are widely used in Europe and special car radios have been on the market for years.
- 10.6 **URGENCY/PRIORITY:** Since many freeway surveillance and control projects are planning to install variable message signs, the results of this research study could lead to the recommendation of a lower cost alternative for certain locations.
- 10.7 **COST:** The total cost of the research could vary. If a site was selected that included an existing variable message sign, the cost of the HAR installation would be approximately \$20,000 and the research could cost approximately \$80,000.
- 10.8 **USER COMMUNITY:** The audience that should receive the results of this research would include the FHWA and the individual states and cities who have or are planning freeway surveillance and control projects.
- 10.9 **IMPLEMENTATION:** The actual research and the findings could be implemented in an existing system or in a proposed system. A single point diversion system could be utilized for ease of evaluation.
- 10.10 **EFFECTIVENESS:** The effectiveness can be determined by testing the display of various messages by visible and audible means. Messages can be displayed individually for each technique or both at the same time. The visual "absorption rate" of the variable message signs in heavily signed areas could be examined. Measures of diversion, percent divertible, and percent diverted could be recorded.