Motorist Services ~~TRAFFIC~~

NCHRPR-064

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
REPORT 64

MOTORISTS' NEEDS AND SERVICES ON ~~INTERSTATE~~ IS HIGHWAYS NWYS

HIGHWAY RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

REPORT CRITIQUE

Project NCHRP 64

Motorists' Needs and Services
on Interstate Highways

The report fulfills the purpose of the study very well. The text is presented in a straight-forward mannor accompanied by the necessary data, tables, charts and graphs. A separate section is used to present and explain in detail the mathematics and data used in the report.

The report states that it is on the rural portions of the Interstate Highway System that the motorist needs and services are least fulfilled. The findings of the report are, therefore, widely applicable since the greatest number of miles of Interstate Highway are rural.

Some of the recommendations made may seem excessive, such as use of STOL and VTOL aircraft as patrol and emergency vehicles; but as pointed out in the report, a detailed cost analysis would have to be made to determine the feasibility of implementing any of the recommended improvements by each specific state.

The report answers a number of questions on needed motorist services and somewhat fills the gap on the benefit of signing. Data of this nature is required before changes in standards are initiated. This report documents the stand that service information panels should be provided only in safety rest areas.

It is apparent from a study of the information contained in the report that each state needs to develop a complete, comprehensive, service signing policy outlining what will be signed and how it will be signed.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT 64

MOTORISTS' NEEDS AND SERVICES ON INTERSTATE HIGHWAYS

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RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS IN COOPERATION WITH THE BUREAU OF PUBLIC ROADS

SUBJECT CLASSIFICATION:
TRANSPORTATION ADMINISTRATION
ROADSIDE DEVELOPMENT
MAINTENANCE, GENERAL
HIGHWAY SAFETY
ROAD USER CHARACTERISTICS
TRAFFIC CONTROL AND OPERATIONS
TRAFFIC MEASUREMENTS
LEGAL STUDIES

HIGHWAY RESEARCH BOARD
DIVISION OF ENGINEERING NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING 1969

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Bureau of Public Roads, United States Department of Transportation.

The Highway Research Board of the National Academy of Sciences-National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway departments and by committees of AASHO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Highway Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

This report is one of a series of reports issued from a continuing research program conducted under a three-way agreement entered into in June 1962 by and among the National Academy of Sciences-National Research Council, the American Association of State Highway Officials, and the U. S. Bureau of Public Roads. Individual fiscal agreements are executed annually by the Academy-Research Council, the Bureau of Public Roads, and participating state highway departments, members of the American Association of State Highway Officials.

This report was prepared by the contracting research agency. It has been reviewed by the appropriate Advisory Panel for clarity, documentation, and fulfillment of the contract. It has been accepted by the Highway Research Board and published in the interest of an effectual dissemination of findings and their application in the formulation of policies, procedures, and practices in the subject problem area.

NCHRP Project 7-7 FY '66
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FOREWORD

By Staff

Highway Research Board

This report will be of primary interest to highway administrators and traffic planners who are concerned about the present and future service demands on the Interstate Highway System. This study compares the availability and the demand for (a) emergency services, which are those normally supplied by police, tow vehicles, and ambulances; (b) normal services, which are routine services such as gasoline, food, and lodging; and (c) supplemental services, which include rest areas, signing for directions and services, and a choice of service types, brands, prices, etc. Recommendations are presented which should remove some of the deficiencies found by the researchers.

The Federal Aid Highway Act of 1956, which established the Interstate Highway System, prohibited the location of automotive service stations and other commercial establishments for serving motor vehicle users on the rights-of-way of the Interstate System. In June 1961 the American Association of State Highway Officials published a booklet entitled *An Informational Guide on Services to Motorists on Interstate Highways.* This document states:

> The statutory prohibition against commerical activities on the Interstate right-of-way was enacted on the basis of the best available judgment in consideration of the anticipated physical and operating characteristics of Interstate freeways, governmental responsibilities, and the economic and business factors involved. When a representative number of long toll-free sections have been in operation for several years in both rural and urban areas, it will be possible to see how well motorists' service needs are being met and to evaluate more objectively the soundness of the basic policy which prohibits commercial activities on the rights-of-way. It will also be possible to obtain more definitive data regarding characteristics of Interstate travel, including trip-length trends.

With nearly one-half of the Interstate Highway System constructed and open to traffic, this research project was initiated by the American Association of State Highway Officials to investigate the needs and desires to motorists for services along the Interstate routes. The researchers were to determine to what extent these needs and desires are now being met and the adequacy of such services.

To conduct this project, the Airborne Instrument Laboratory researchers utilized five data sources. (1) They reviewed the available literature on the subject. (2) They obtained a variety of information for toll-road facilities. (3) They interviewed officials from various state police agencies; highway departments; automobile clubs; and gasoline, restaurant, and motel chains. (4) They observed the number and type of service locations by driving over 4,000 miles of open Interstate Highways. (5) They collected and compiled data from 14,000 mail questionnaires representing a nationwide survey.

The motorist services are classified into three categories: (1) emergency, such as out-of-fuel, mechanical failures, accidents, emergency medical needs, and results of criminal acts; (2) normal necessities, such as need for fuel, food, lodging, toilet facilities, and information as to geographical and historical features; and (3) supplemental services, such as information pertaining to choice of lodging and food facilities (quality, location, commercial brand, etc.), and other information. The analyses of data considered both the rural and urban availability of these services, the extent of the demands for these services, and comparison of the availability with the demand.

In the conclusions and recommendations portion of this report certain service deficiencies are cited, together with suggested methods to help develop practical solutions for these service problems. Some mathematical guidelines are presented in the appendices to assist highway planners in evaluating the need for availability of service facilities along various types of freeways.

CONTENTS

ACKNOWLEDGMENTS

The research reported herein was performed under NCHRP Project 7-7 by Airborne Instruments Laboratory, a Division of Cutler-Hammer, with Martin A. Warskow, Manager of Transportation Research, as Principal Investigator. He was assisted in the research and the preparation of the report by A. Kuprijanow and S. Rosenzweig, Research Engineers.

Space limitations preclude acknowledging by name the many individuals in various parts of the United States who made this work possible through their cooperation and assistance. It is hoped, however, that the following listing of their organizations will serve to adequately express the appreciation due them:

American Automobile Association
AAA affiliated clubs in:

California	Automobile Club of Southern California
Connecticut	Connecticut Motor Club
Florida	Peninsula Motor Club
Georgia	Georgia Motor Club
Kansas	Automobile Club of Kansas
North Carolina	Carolina Motor Club
North Dakota	North Dakota Automobile Club
Oklahoma	Oklahoma City, Oklahoma Division, AAA
Oregon	Oregon State Motor Association
Texas	Dallas Automobile Club
Virginia	Automobile Club of Virginia
Washington	Automobile Club of Washington

American Motor Hotel Association
American Petroleum Institute
American Society of Appraisers
Bureau of Public Roads
BPR Division Offices in:
California
Florida
Georgia
Kansas
Michigan
Oklahoma
Oregon
Texas
Virginia
Washington
California Highway Patrol
Commonwealth of Virginia, Department of Highways
Florida State Department of Public Safety
Holiday Inns of America
Howard Johnson's
International Association of Chiefs of Police
Kansas Highway Patrol
Michigan State Highway Department
Motel Association of America
Motel Association of New York
New York State Thruway Authority
North Carolina State Highway Commission
North Carolina State Highway Patrol
Ohio Turnpike Commission
Oklahoma Department of Highways
Oklahoma Highway Patrol
Oregon State Highway Department
Oregon State Police
Police Department, County of Suffolk, New York
Shell Oil Company
Socony Mobil Oil Company
State Highway Commission of Kansas
State Highway Department of Georgia
State of California, Department of Public Works
State of New York, Department of Public Works
State Road Department of Florida
Texaco
Texas Department of Public Safety
Texas Highway Department
Tourist Court Journal
Virginia State Police
Washington State Patrol

Appreciation is also given to the 14,000 automobile owners who responded to the questionnaire, and to the many individual authors and agencies responsible for the reference material that was found applicable to this study.

Finally, acknowledgment is made of the invaluable assistance of John C. Woo and Ivor S. Wisepart of the Airborne Instruments Laboratory staff.

MOTORISTS' NEEDS AND SERVICES ON INTERSTATE HIGHWAYS

SUMMARY

The title of this study program, *Motorists' Needs and Services on Interstate Highways,* NCHRP Project 7-7, accurately describes the purpose of this program: to determine the services available to the Interstate Highway driver and the services he needs or wants. Three service types are studied:

1. Emergency—services that the motorist needs because of accidents, breakdowns, or any other unexpected circumstances,
2. Normal—services such as gasoline, food, and lodging,
3. Supplemental—desirable services that may be nonessential and whose absence would not deter the motorist from continuing; these include: rest areas, adequate information, and a choice among service types, prices, brand names, etc.

For this study, five fundamental data sources were used:

1. Available literature, reports, articles, survey results,
2. Data accumulated by various toll facilities,
3. Personal interviews with cognizant personnel in several states,
4. Personal observations and records of pertinent service data,
5. A questionnaire, submitted to a random sampling of automobile owners concerning their habits, preferences, etc.

Each service type is studied to determine: (1) what is actually available for each service type, (2) the magnitude of the need for each service type, and (3) whether the services available satisfy the need.

Emergency services are reasonably adequate on the Interstate Highways in densely populated/high-ADT (average daily traffic) areas, but post somewhat of a problem in the rural areas where the ADT is low. In such areas, the waiting time for emergency services may be extremely long. Since nearly 80 percent of the proposed Interstate System will be rural, this is considered a problem area.

The interstate motorist appears also to be reasonably well supplied with normal services based on the fact that supply meets the demand—that is, commercial enterprises compete for the motorist's patronage. Based on his travel habits and preferences, he will generally find plentiful services near urban centers, but considerably less in rural areas. The only potential problem area is in rural areas where the demand for gasoline during the night is not high enough to warrant gasoline stations being open, and distances between successive stations are great.

Although the present quantity and quality of rest areas along the Interstate Highways are inadequate in some areas, steps are being implemented by most states to upgrade their existing rest facilities, and build new, well-equipped ones along the lines of the AASHO policy. The only deficiency appears to be that there are too few accommodations for travel-trailers, both in the existing and planned rest areas. Informational needs of the motorist present a problem; it is found that the motorist considers official signing his chief annoyance when traveling. Also, signs for services,

according to the motorists' indicated preferences, are not nearly sufficient. The motorist uses outdoor advertising for roadside services as an information medium. In view of the provisions of the Highway Beautification Act of 1965, it is not believed that the proposed services signing will satisfy the motorists' needs. Therefore, presentation of service information to the motorist is considered a problem area.

Having thus indicated the existing or potential problem areas, possible solutions to the deficiencies are suggested and discussed.

Specifically, it is recommended that in conjunction with a national police agency, a detailed operational study be conducted of: (1) the possibility of using STOL-type aircraft for patrol of rural Interstate Highways, (2) better use of existing ground vehicles and personnel, (3) the use of VTOL-type aircraft for emergency ambulance service, and (4) using the passing motorist as a communications channel.

It is also recommended that steps be taken to make gasoline available 24 hours a day wherever GAS is signed by requiring that the station remain open and attended, or by providing self-service, unattended, or semiattended gasoline pumps.

To aid in solving the service information problem, it is recommended that service information be displayed in the safety of rest areas and, if the distance between successive rest areas is too long, at selected exits. It is also recommended that the distance limitations imposed for signing services be extended considerably. Two specfic methods of presenting the service information to the motorist in this manner are suggested and discussed.

Finally, more uniform and higher standards of driver training, requirements, testing, and levels of proficiency would greatly contribute to the safety and efficiency of traffic flow as well as have a beneficial effect on the service problem.

Appendixes A through F at the end of the report contain selected material to substantiate the findings in this report.

CHAPTER ONE

INTRODUCTION

With about one half of the originally projected 41,000 miles of Interstate Highway System complete and in operation, there is some doubt concerning whether the ever-increasing number of motorists using the system will find adequate services along the new routes. The motorist's safety is directly, or indirectly, affected by the availability of services that range from the presence of highway patrols for the prevention of crime, through his ability to purchase the necessities of motor travel such as gasoline and food, and to find rest establishments. Further, the utility of the Interstate System is affected by the availability of these services.

Toll facilities, some of which form a part of the Interstate network, endeavor to meet these needs by establishing service/rest areas at reasonably regular intervals, patrolling the facility, and in general providing the required services in a way such as to ensure that the motorist/customer remains satisfied.

On the free sections of the Interstate, however, the situation is different. First, Federal Law prohibits the location of service stations anywhere on the Interstate Right-of-Way (Public Law 85-767, paragraph 111). This immediately removes some of the services from the motorist's easy access: gasoline, auto service, and rest rooms.

Likewise, the motorist desiring food or lodgings for the night must leave the Interstate to find them. Emergency services must originate from outside the Interstate facility,

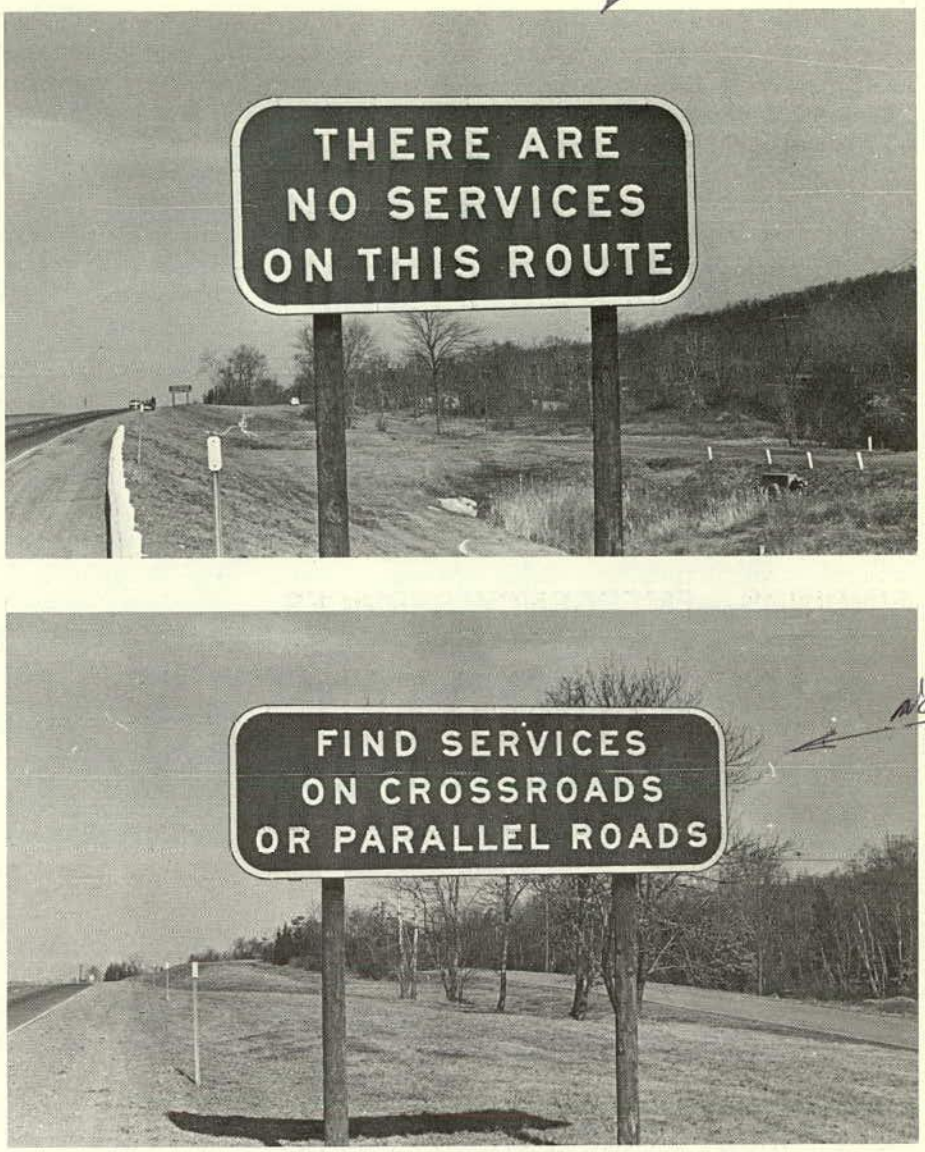


Figure 1. Examples of highway signs for services.

since they are usually supplied by commercial establishments, which cannot locate on the Interstate.

Because of restrictive legislation on advertising along the right-of-way, commercial interests just off the Interstate face another problem—that is to reach the motoring public. Provisions of the Highway Beautification Act of 1965 will further compound this problem.

The needs of motorists and the services offered on Interstate Highways have been investigated on a nationwide basis. The results are presented in the following sequence:

1. The services, as offered currently to Interstate travelers, are examined as to their frequency, availability, and type, by various areas and in relation to pertinent variables such as the prevailing traffic levels, distance from population/business center, etc.

2. The demand for the same services is examined, wherever possible, in terms of the same variables. In the case of the need for emergency services, the demand is assumed to be based on the statistically expected rate at which such emergencies occur. For the other service types, largely motorist usage and/or preferences determine the demand.

3. Comparison of the services offered versus those needed follows. Substantially, this consists of a point by point weighing of the comparable items of the preceding two steps. Substantial divergence indicates need for improvement.

4. Based on the items most in need of improvement, ways are discussed in which such improvement could be accomplished with a view toward immediate and long-term solutions, economics, and predicted developments in the road/vehicle/driver of the future.

Categories

1. *Emergency Services.*—These services may be generally required by the motorist anywhere along the facility. The motorist's need for these services must be recognized and fulfilled wherever and whenever required, in the shortest time possible. The availability of these services is essential for the motorist's safety and well-being.

2. *Services Catering to Motorist's Normal Necessities.*—These are fundamentally supplied by service stations, food establishments, and the availability of lodgings. The spacing between them, accessibility, and adequacy of the quantity and quality of services available are compared with the demand for such services.

3. *Supplemental Services.*—These pertain to choice of lodging and food facilities including: (a) a choice in the types and quality of facilities ranging from adequate to luxurious, (b) a choice of the specific brand names, (c) availability of rest areas and facilities therein, and (d) aspects of supplying the motorist with service information.

CHAPTER TWO

FINDINGS—EMERGENCY SERVICES

AVAILABILITY

Emergency services are those that are generally required by the motorist anywhere along the facility. The motorist's need for these services must be recognized and fulfilled wherever and whenever required, in the shortest time possible. The availability of these services is essential for the motorist's safety and well-being.

Whereas parts of the Interstate System incorporate some toll facilities (New York State Thruway, Connecticut Turnpike, Turner, and Will Rogers Turnpikes, etc.) where cognizance for such services is borne by the agencies administering the operation of each respective facility, the chief concern of this study was the free Interstate Highway System. The data obtained from these various facilities are used selectively and with care. It is necessary to use these data because:

1. Available records of emergency stops on the toll facilities are much more complete than those of the free Interstate System because no particular agency accumulates such data for the Interstate System.

2. The type of traffic on the free Interstate Highway is similar to that on many toll facilities. Hence, data accumulated by the latter are useful in projecting to the free highways.

Emergency services are rendered principally by the highway patrol, private operators of tow services, ambulance services, and local fire departments. On the free Interstate roads, highway patrol units are sometimes assigned exclusively to patrolling the highway. Frequently, their area of responsibility also covers a network of other roads. Tow operators originate at local gasoline stations—many of which are not equipped for road calls. Local fire departments provide fire-fighting services when required.

The implications of the preceding description are clear: in many sparsely populated areas of the United States where the traffic levels are low, patrols are rather infrequent and many hours may elapse before emergency service can be rendered.

In examining the availability of emergency service in various parts of the country, a tentative conclusion is that the propensity of the highway patrol to supply emergency services is (more or less) inversely proportional to the population density of the area. Thus, in the Northeast and along a large part of the eastern seaboard, the highway patrol agencies are reluctant or unwilling to do any kind of service beyond their primary task of law enforcement and crime prevention, though they will use their communications equipment to summon help. In the much more sparsely populated Midwestern, Southwestern and Northwestern states, the highway patrol personnel often provide service for as much as half of their on-duty time.

In and around urban areas, tow and ambulance operators are called in rotation when needed by the highway patrols as a result of the patrol actually finding the motorist in distress, or as a result of a call from the motorist using one of the various accessible emergency devices—usually telephones, call boxes, and the like. On the other hand, there are no such devices on most rural sections (the majority) of the Interstate System. Thus, the highway patrol and the goodwill of other motorists are the only effective means to emergency aid available to the motorist.

SPECIFIC LOCALITIES

In Texas, there are slightly over 3,000 miles of Interstate Highway (including urban and rural sections) in operation. Over a period of four months, the State Highway Patrol has recorded the number of unit hours worked and miles driven on I 35, I 35 E, and I 35 W, which comprise about 500 miles or ⅙ of the state's Interstate Highways. It is interesting to note that the state highway patrol personnel are responsible for patrolling about 66,000 miles of highways

throughout the state—a formidable task indeed. A quick calculation for the Interstate Highways mentioned shows about 0.3 unit hours per mile per day average. Assuming that the patrol does nothing but cruise the highway at 60 mph, that the patrol posts are ideally designed, that there is no overlap, etc., a patrol density of somewhat less than one per hour is arrived at. However, patrol activity involves enforcement, investigation, and other activities. From the record of miles driven during the same time period, we find that the average (long term) speed is about 18 mph—or less than 33 percent of the speed cited. Thus, the patrol density on an arbitrarily chosen mile of the Interstate sections mentioned in the state likely averaged between 3 or 4 hours.

This is a rough estimate of the patrol density, and it must be modified by location, time of day, and other factors. The patrol effort at night, for example, is reduced in deference to more intense daytime activity; higher ADT areas approaching cities (for example, Austin, Dallas, Fort Worth, San Antonio, Waco) are patrolled more intensely than the more rural sections. It must be remembered that mile for mile, more of the Interstate System is rural than urban in nature.

The patrol personnel are able and willing to render assistance when necessary; during the 4-month period, 662 such assists were recorded or about 5½ per day average. Highway patrol personnel emphasize the assistance of other motorists toward each other and their ability to help themselves; they also acknowledge that they are understaffed to adequately patrol all of the highways assigned to them.

Specialized services such as tow services, mechanical aid, and ambulance are supplied by operators of gasoline stations, garages, ambulance services, and frequently funeral parlors in the area. The highway patrol will call for such help if unable to aid the motorists on the spot, or if he requests that such help be called. The waiting time for such help varies; in or around cities such as Dallas, 15 to 30 minutes wait for an ambulance is considered normal. In rural areas, this may easily run to an hour or more, depending on the distance to the nearest service needed (and, of course, its availability).

It may be of interest to compare at this point the waiting times for tow and for ambulance on one of the toll turnpikes (which is part of the Interstate network). On the New York State Thruway, tow operators and ambulance operators are assigned, under contract, sections of the facility averaging about 12 miles. From actual case records kept by the facility, it is found that the average waiting time for an ambulance is 15 minutes; the mean waiting time for a tow operator is 23 minutes, with 80 percent of the cases being less than or equal to 30 minutes as seen in Figure 2. These times do not include the time interval between the onset of the need for the service and the time the service operator is notified. The facility in question has an average ADT exceeding 10,000 and is heavily patrolled by a special unit of the state police (which averages less than 30 minutes between patrol passes) and vehicles of the facility. All of the patrols are equipped with gas, water, small tools, fire extinguishers, and radio communications equipment and are instructed to render whatever aid they can. Thus, many emergency services are rendered directly upon detection by one of these patrols, thereby limiting the service time to the detection time alone.

It is to be noted that the high level of patrol effort by the police is due to the fact that the police unit's operation is completely financed by the facility. The services supplied are undoubtedly motivated to assure the goodwill and repeat patronage of the motorist/customer who pays to use the facility. The preceding conditions do not exist on the free Interstate Highways.

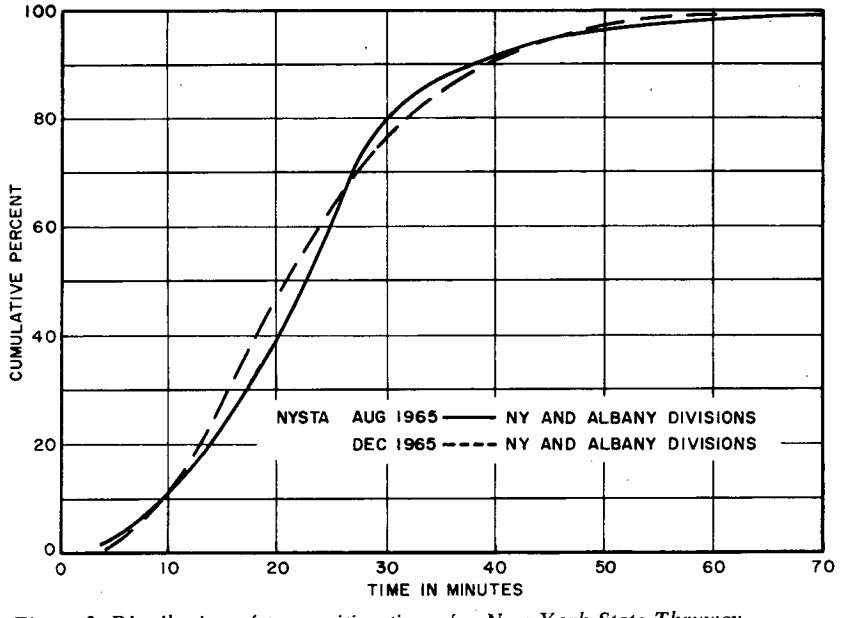


Figure 2. Distribution of tow waiting times for New York State Thruway.

On a midwestern toll facility (*1*) service is rendered in less than 30 minutes 90 percent of the time, following detection.

In a number of states, responsible officers of the state highway patrol agency when interviewed did not know the patrol frequency of the free Interstate; they did feel, however, that it was too low because the patrol force was understaffed. In no case does the patrol effort on the free Interstate approach that of the toll facilities. The New York State Thruway, located in the Northeast, has about 1 man per about 2.7 miles of facility (including patrol personnel, commissioned and noncommissioned officers, but not civilians employed in communications, vehicle maintenance, etc.). Another toll facility in the Southeast has comparable staffing. Generally, the number of uniformed personnel assigned to the facility and the length of the facility is indicative of the relative magnitude of the patrol effort to be expected on that facility. The ratios of miles per man for several toll facilities are listed in Table 1 (*2*). In the state of Florida the assignment of manpower on the free Interstate ranges from about 10 miles per man in congested areas to 15 to 17 miles per man elsewhere. On the toll facility, free gas is given to motorists who run out; on the free Interstate in Florida, the patrol vehicle is equipped with empty gas cans and will take the motorist to the nearest station and return him to his car. In case a wrecker or ambulance is needed, the patrol will call one of the motorist's choice, or from a rotation list.

In the state of Georgia, again, no records are available as to the patrol effort on the Interstate (principally 175) and special personnel are not assigned exclusively to it. The frequency of the patrols can be somewhat surmised by the statement of the local automobile club official stating that ". . . the driver of the disabled vehicle must use his own ingenuity to get himself out of the jam . . ." and that great reliance is placed on the passing motorist to either help or continue on and send help.

A similar situation appears to exist in the Carolinas, as was learned from interviews with cognizant personnel.

In Virginia, the state highway patrol estimates that generally the motorist may have to wait less than an hour before a patrol car passes. Interstate roads are patrolled 24 hours a day and other roads are patrolled 16 hours a day. Patrol personnel are assigned on a county basis, but additional personnel are assigned to counties with Interstate Highways.

TABLE 1

RATIO OF MILES PER MAN FOR TOLL FACILITIES

LOCATION	RATIO
Kansas Tpk.	10.3
West Virginia Tpk.	5.4
Indiana Tpk.	3.4
Ohio Tpk.	2.7
New York Thruway	2.7
Dallas-Fort Worth Tpk.	1.8
Garden State Parkway	1.8
Richmond-Petersburg	1.8
New Jersey Tpk.	1.3

The state of Oklahoma has two major free Interstate Highways, I 35 and I 40, plus the turnpikes (I 44) which are not of primary interest here. The state highway patrol is responsible for nearly 94,000 miles of rural roads, of which the interstate forms but a few hundred miles. However, patrol assignment follows the selective enforcement principle—based on accident experience. Patrol posts vary in length from 4 miles in urbanized areas to about 30 miles in the rural portions of the free interstate. Patrol vehicles are equipped with siphon pumps, jumper cables, push bars on bumpers, supplies of water, etc., and patrol personnel are willing and able to provide basic emergency aid to motorists in distress. The patrol is obligated to stop and investigate any stopped vehicle. If aid beyond the patrol's capability is required, the patrolman will first inquire if the motorist wishes any particular service and attempt to contact them. Otherwise, he will call the nearest service available from a list of such services. No waiting times for tow services were available, but it is probable that they are substantial, particularly in rural areas. Waiting times for an ambulance (after call and contact has been made) were variously estimated at 30 minutes or more in the rural areas, and 15 to 30 minutes in or near urban centers.

An interesting statistic was obtained from the Oklahoma State Highway Patrol: about 52 percent of the officer's duty time is actually spent on routine patrol—the remainder is taken up by enforcement, servicing, investigation, etc. Thus, the actual patrol frequency that one might be tempted to deduce from the size of the patrol post is more nearly half that value. This would necessarily lead to considerably higher waiting times to be found by the patrol.

As in states previously mentioned, the local people are exceedingly helpful and will go out of their way willingly to help a fellow motorist in trouble.

Limited aircraft patrol is used, but the latter can only serve as a detection and communications link; service must still be provided by a patrol car on the ground.

In Kansas, 250 men of the Kansas Highway Patrol are responsible for about 28,000 miles of paved roads in the state. The major Interstate is I 70. It is a free Interstate from Topeka West, for about 350 miles (the most westerly part not yet completed). Aircraft patrol is used but contact with the ground vehicle must still be made.

Usually, notification of a disabled motorist is via another motorist passing a patrol vehicle and reporting. The patrol vehicles are equipped to render aid, but if more is required, the waiting times can be quite long. It was estimated that in the western part of the state, a 1-hour wait for an ambulance is not considered unusual. No estimates were given for tow service waiting times, but they must be presumed to be substantial. The highway patrol personnel expressed considerable interest in the possibility of using STOL-type aircraft for patrol, contact, enforcement, and emergency service application.

In the state of Oregon, 49 men are assigned to patrol about 300 miles of I 5 between the California and Washington state lines, on a 24 hour basis. In the state of Washington, 38 men are assigned to patrol 287 miles of

I 90; 73 men are assigned to patrol 284 miles of I 5. In both states, the patrol vehicles are equipped and the patrol officers are trained and instructed to help out disabled motorists. In Oregon, patrol vehicles carry supplies of gasoline, while in some parts of Washington (Seattle area) the cars are equipped with pumps to dispense one gallon; the motorist is given an envelope suggesting he pay for the gasoline. In both states, where additional services are needed, the patrols have lists of available tow/ambulance operators and will call in the nearest one or, if there are several, use rotation.

On I 15 between the California/Nevada border and Barstow, the California Highway Patrol has 1 vehicle patrolling the eastern 65 miles of the highway for 16 hours a day; the next patrol is about 45 miles and is likewise patrolled by 1 car 12 hours out of the 24 on weekdays and 24 hours on weekends. The next three patrol posts, through Victorville and the Cajon Pass down to the outskirts of San Bernardino are each about 16 to 18 miles in length and are patrolled on a 24-hour basis, with a car on the post at all times. Generally, post assignment is based on prior accident experience. The major part of I 15 runs through rather desolate desert country.

The role of the other motorist in reporting a disabled vehicle to the California Highway Patrol is very prominent, particularly in the more desolate portions. The patrols are prepared to render service depending on the severity of the need. For example, if the need for an ambulance exists and cannot be met in a reasonable time, the victim will be placed in the patrol vehicle and transported, perhaps to meet the ambulance (*3*). On I 15 outside of the immediate San Bernardino area, the nearest tow vehicle or ambulance is very likely to be 50 or more miles away—which leads to occasionally quite long waiting times for such specialized vehicles, and the necessity for the patrol vehicles to render whatever service they can. The AAA operates several service vehicles in this area as well, but considering the distances involved, when the need arises, the probability of one of them being nearby is rather low.

The waiting times for ambulances, fire apparatus, and tow vehicles in the (more densely populated) more highly traveled San Bernardino area on I 15 were stated to be generally less than 30 minutes, 15 minutes, and less than 30 minutes, respectively.

(*4*) and (*5*) bear witness to the concern in people's minds about the emergency service problem on the expressways. In (*4*), answers to the following questions are provided by cognizant officials in Florida, Michigan, Washington, D. C., Colorado, Oregon, Wisconsin, Minnesota, and Virginia. (*24*) adds Washington and New York City to the list. Except for Oregon, Minnesota, and Virginia, the answers were applicable to the urban or near-urban areas. In most cases, the officials foresee the necessity for maintenance vehicles to patrol. Few numbers or times involved are given.

The questions are:

1. Do you have emergency maintenance vehicles patrolling controlled-access highways to help motorists in distress? What is the extent of their assistance?
2. What provision is made for removal of disabled vehicles from the right-of-way? How are fire, ambulance, and towing services provided for?
3. Are patrolling provisions different for urban expressway sections than for rural sections? Are patrols maintained around the clock?
4. What coordination is there between the highway department and policing agencies?

An excellent study (*2*) was made by the Office of Planning, Bureau of Public Roads. Some pertinent information has been extracted for this study.

The fact that patrol operations on toll highways are financed wholly or in part by the administering authority of the respective facilities accounts for the generally high level of patrols on these facilities. However, on the much greater mileage of the free Interstate, the patrol functions must be supported by the State's agency administering the highway police organization (in 19 states, these are independent organizations; in others, they belong to the departments of public safety and other similar state departments). There is also some diversity in the manner of financing. In 20 states, funding is derived from highway user funds; in 11, from motor vehicle fees; in some cases, from general funds; and in the remainder, from driver license fees plus general funds (or other funds). There are also some differences in the functions for which the state police force is responsible. In some states, these functions are restricted to traffic law enforcement and related activities, whereas broader police powers have been granted to the state police departments in most other states.

Likewise, there is no consistency in whether the Interstate or other major highways are patrolled where they traverse incorporated municipalities. As of 1964, 21 state police agencies did not patrol at all within such municipalities; of the others, 5 patrolled only the Interstate Highways.

The diversity of the level of patrols as dictated by the financing limitations is reflected in the amount of services rendered by patrol personnel on the toll roads versus on the freeways; in New Jersey during 1964, for example, about 52 percent of the total functions of the patrols' activities were devoted to motorists assists on the state's toll roads. The comparable percentage for patrols on the other roads was less than 1 percent devoted to assists to motorists (*2*). Since the rendering of services costs money and detracts from the patrol effort, the importance of the financing and the reasons for the differences between toll facilities and freeways become apparent.

Fire protection is handled much in the same manner as tow services, except that fire units are not called in rotation; units having jurisdiction in the locality of the fire are called. The problems of delays in the initial notification and in the unit's arriving at the scene are also analogous to the tow services.

It is also interesting to note the differences in the manner of patrolling the Interstate Highways and how specific cases are handled. For example, depending on the locality and staff available, line or beat patrols may be used, or much of the highway patrol's time is spent on view—that is, stationary and conspicuous to both directions of traffic. In some states, every vehicle found stopped by the side of the road

is investigated; in some cases, the driver is ticketed for illegal parking; in others, if the driver is sleeping, he is awakened to determine that he is alive and well, and then left alone. The latter is principally true in the more desolate areas, since they feel that it is better to have the driver rest on the shoulder than to continue or exit from the Interstate onto a minor road, where he will not have the protection of the patrols.

In more desolate areas, the highway patrol personnel unanimously praised other motorists for their willingness to help in notification of someone in need—even at an inconvenience to themselves. They also stressed the comparatively greater self-reliance of the motorist there as opposed to the Northeast, and/or in urban areas.

DEMAND

An extensive study of the demand for emergency services has been reported in (*6*). In this study, data pertinent to vehicles stopping on various kinds of roads were analyzed as to the causes of such stops, and their frequency of occurrence. The latter was related to the nature of the road in terms of its Average Daily Traffic (ADT) and Average Trip Length (ATL). As a result of the analysis and based on the empirical data collected, a model was constructed to allow for estimating the expected number of emergency stops on various types of highways—including Interstate and Interstate-like highways. Figure 3 represents this model. To use the model, it is necessary to know the ADT of the facility. For most rural Interstate Highways, it can be expected to be 10,000 or less; therefore, the 10,000 ADT line is shown more prominently than the others. Since ATL is not frequently known for such facilities (as opposed to toll facilities where exact ATL data can be derived from the counts of traffic entering and leaving, the revenue collected), it may be necessary to make an educated guess on the basis of known ATL's on similar facilities. Assume that the ATL is between 40 and 50 miles. Then, on the basis of Figure 3, the average number of stops per mile per day on that facility can be expected to be 1.1 to 1.3. For ADTs other than 10,000 it is possible merely to interpolate between the other ADT lines shown. Because of the gradual slope of the 10,000 ADT line, and even more gradual slope for lines of lesser ADTs, it can be seen that knowledge of a precise value of ATL is not essential, since the value of stops/mile/day changes slowly for these low-ADT values.

In (*6*), care is used in defining an emergency stop as a stop made for reasons other than leisure and not necessarily resulting from an emergency. It is shown that the stop-type distribution is such that only about 42 percent of the expected stops will be of the type that require service, or 58 percent if the need for information is included. Hence, as a first approximation to the preceding example, the service demand (exclusive of information) could be ex-

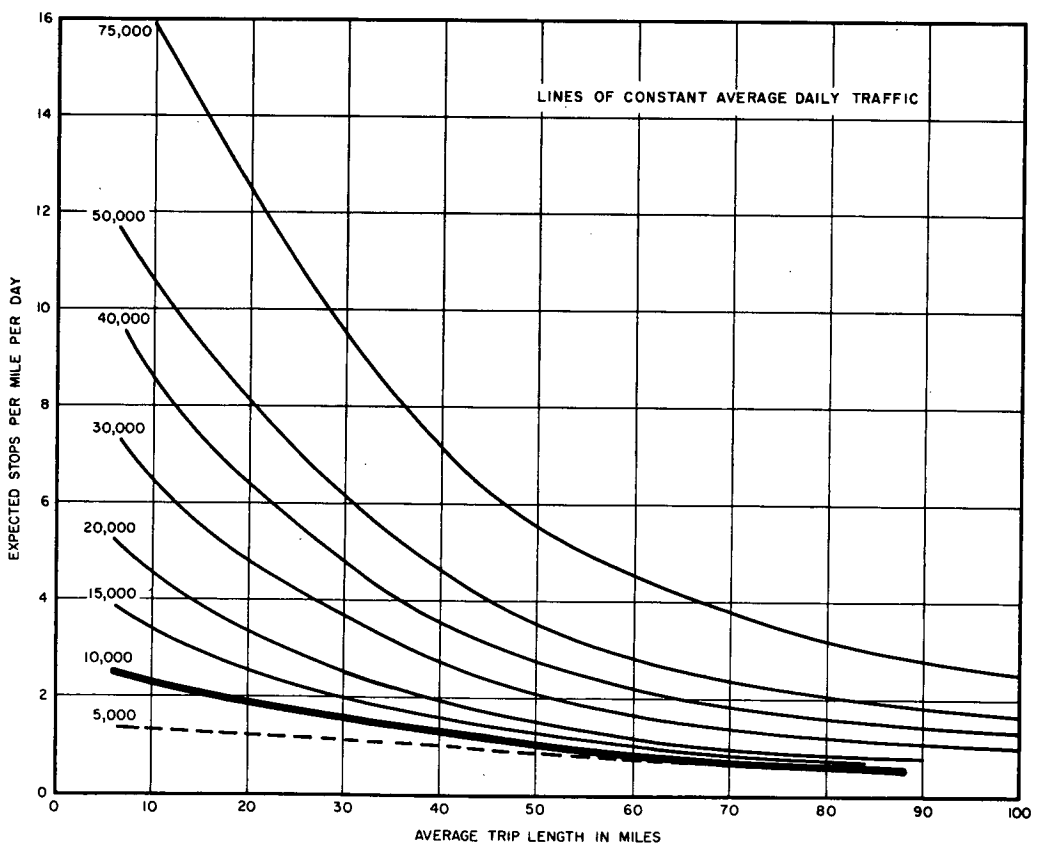


Figure 3. Expected number of stops per mile per day vs average trip length on facility.

pected to average between 0.46 and 0.55 per mile per day. The types of problems that this would cover include gas, oil, water needs, tire problems, mechanical problems, medical problems, and fire. From the same table, the distribution of these stops can be readily calculated to be approximately as indicated:

TABLE 2
STOP-TYPE DISTRIBUTION

TYPE OF SERVICE NEED	%
Mechanical problems	35.7
Tire problems	35.7
Gas, oil, water needs	23.8
Medical	2.4
Fire	2.4

These figures are based on the long-term distribution of types of stops on various facilities. (*6*) shows that they remain fairly constant even though the rate of occurrence of all stops varied considerably. However, there are stop types that occur on some facilities that do not occur on others; for example, in the midwest and Southwest, motorists stop and sleep on the shoulder, in spite of the occasional rest areas provided for that purpose. (This type of stop is rarely found in the more urbanized Northeast.) The state highway police permits sleeping on the shoulder because the distances are long, the driving is monotonous, the driver may not know where rest areas are located, it is safer to sleep on the shoulder than to drive when exhausted, and passing patrols can still periodically check his safety. However, such a stop cannot be truly considered an emergency stop and, hence, is of lesser interest here.

ACCIDENTS

No specific mention of accidents has been made thus far. Beyond question, the severity of the need for aid, and the need for prompt aid is more likely to occur as a result of an accident than otherwise. In fact, of the stop types mentioned, only medical and fire clearly demand a rapid response. The former categories, even if not cared for immediately will generally only result in discomfort, annoyance, and loss of time to the motorist.

Accident statistics can be used to prove almost anything. Of interest here is the service demand on the highway as a result of accidents. Therefore, accidents must be viewed with all of the other (nonaccident) incidents that require roadside services. However, accurate statistics pertinent to the latter types of incidents are available principally from toll facilities.

From several toll facilities, we discover that between 3 and 6 percent of all incidents requiring service are due to accidents. One might be tempted to suspect that this figure is too low. Consider, however, a study of in-lane accidents and disablements (*7*), which shows that of all in-lane incidents, only about 25 percent were due to accidents. Since the rate of accidents on the shoulder is incomparably lower than that in the driving lanes, (*6*) and Appendix C, the over-all figure of 3 to 6 percent for the facility becomes considerably more credible.

Assuming, then, that the accidents might boost the stopped vehicle model demand figure by 6 percent, multiply that figure by 1.06; for the preceding example, the expected number of service demand units, per mile per day becomes 0.49 to 0.58. Of course, for a facility where the ratio may be different from what we are using, a correction factor is easily applied.

The demand for service must be modified by the urgency with which it is needed. A one-half hour wait for a battery boost is not serious; on the other hand, the same wait for a car on fire is obviously serious, as is the case of an injured motorist, one suffering from a heart attack, asthmatic condition, etc. Let it be assumed, therefore, that the service required by all accidents * and by fire and medical problems constitute an urgent service demand and that the remainder (mechanical, tire, and gas/oil/water) constitute the normal service demand. Table 3 breaks down and summarizes the service demand units of both kinds for the hypothetical example used (0.49 to 0.58).

Applied to a hypothetical 100-mile long facility for which the originally assumed ADT and ATL figures apply, one can expect about five urgent service incidents and 44 normal service incidents on that facility on an average day.

* This is obviously a pessimistic assumption since "accidents" include those accidents where minor property damage (less than $100) and/or no personal injury is involved.

TABLE 3
SERVICE DEMAND UNITS

TYPE OF SERVICE NEED	% OF TOTAL	SERVICE DEMAND UNITS	GROUPED AS TO URGENCY
Mechanical problems	33.7	0.165	
Tire problems	33.7	0.165	0.440 Normal
Gas/Oil/Water	22.4	0.110	
Medical aid	2.3	0.011	
Fire	2.3	0.011	0.049 Urgent
Accident	5.6	0.027	

WAITING TIME

Following an incident, urgently needed service should be supplied as rapidly as possible. The time taken consists of two parts: (1) the time needed to communicate the need for service, and (2) the time spent waiting for the service. Communicating the need for service was the subject of NCHRP study 3-4; hence, discussion will be limited to a statement of conclusions applicable to the service problem principally on the rural Interstate and Interstate-like highways.

Whereas in urban areas several means are available for communicating a need for service, such as emergency telephone, call box, hailing other motorists etc., on the rural Interstate Highway, the disabled motorist generally has only two means: the patrol and his fellow motorist. It is also possible that the motorist's need for service may occur near a public telephone; however, for urgent service needs, he may not be able to use it. Furthermore, the probability of the need arising within reach of one of the rest areas with telephone, or at an exit near a service station, is small.

The help available from the other motorists cannot be discounted. It is known that they are very helpful, particularly in rural areas, in helping directly and/or going out of their way to notify the police or service station.

The patrol, however, still remains the basic detection medium on most of the rural Interstate System. Hence, the patrol frequency will have a direct bearing on how long a motorist may have to wait for aid.

Consider, therefore, an extension of the patrol model of (*6*) to include the response time. The expanded model and its development are shown in their entirety in Appendix A because of their applicability to the subject.

Fundamentally, the appendix relates the following variables:

1. *Patrol Time Constant* (τ)—This is the average time interval between any two successive passes of a patrol vehicle past any given point on the facility.
2. *Probability of Detection* (P_d)—This is a number between 0 and 1 denoting the likelihood that a disabled vehicle on the facility is detected by a patrol. For example, a P_d of 0.5 denotes a 50-50 chance of detection.
3. *Response Time* (T)—This is the time interval between the onset of the stop and detection by the patrol vehicle; if it can be assumed that the patrol will service as well as detect, it could be called "Service Time" as well.
4. *Stop Duration Distribution*—This is generally represented by a plot showing statistically how frequently stops of various durations generally occur. The characteristics of this plot are generally expressed by its mean (μ) or average stop duration, plus two other variables (α) and (β), which describe the spread of the distribution.

Consider for the moment the normal service demand categories: mechanical, tires, and gas/oil/water. These categories will not generally suffer excessively if not quickly serviced, but in time, a percentage of them will either help themselves or be helped. However, since we do not know the percentages of self-helpers, all of the potential service demands must be considered. A large number of motorists will first attempt to help themselves before turning to external help. In addition, about 15 percent indicated self-help as being their second choice for aid in need.

It has been pointed out previously (*6*) that the level of service that is to be offered ultimately will result from the policy decision of person(s) responsible for offering that service but under the constraints of limited funds, manpower, and subjectively established objectives.

ARRIVAL OF DESIRED SERVICE

If the patrol constitutes the primary communication medium and there is a waiting time involved for the service need to be discovered, it would be advantageous to prevent any further waiting time by letting the patrol perform the desired service. Obviously, this is not always possible (*6*). It can be readily conceived from the service types and demand distribution previously discussed that the ordinary (but properly trained and equipped) patrol could easily satisfy most of the normal service demands and probably a limited number of the urgent demands as well. In this manner, the greatest number of "service demand units" would be satisfied in a minimum time, and the technique of Appendix A to relate the level of service to the patrol effort required would apply directly.

There is an additional aspect of interest: the incidence of the service demand in time during the day. Obviously as the traffic level increases, so should the incidence of service demand. Figure 4 shows the hourly distribution of the service demand as a percentage of the day's total. Two curves are shown, one for a summer month, one for a winter month. This figure shows that even though there is a slight shift in the time of the peak, approximately 80 percent of the service demand incidents are confined between the hours of 8 and 22.

Comparison of the incidence of specific stop types for the summer and winter months shows that the relative distribution of the disablement types does not change significantly, though tire problems percentage-wise increase in the summer and out-of-gas problems increase in the winter months.

Of the various service types, it may be of interest to determine the relationship, if any, between the frequency of need for the police officer, tow truck, or ambulance service. From the incidence of accidental events requiring these various services on several different facilities, it was found that the distribution was very nearly identical; specifically, 52 percent require only the police, about 46 percent require a tow truck, and only between 1 and 2 percent require an ambulance. The presence of the police officer is assumed along with the latter two services.

AVAILABILITY AND DEMAND COMPARED

It was previously reported that in the state of Texas during a 4-month period an average of 5.5 assists were rendered to motorists by state highway patrols on about 500 miles of Interstate Highways. During the same period and on the same roads, 20.8 accidents (average per day) were investigated. This indicates a total average of 26.3 per day of emergency motorist contacts, or service demand units (sdu's) supplied. It has been previously shown that

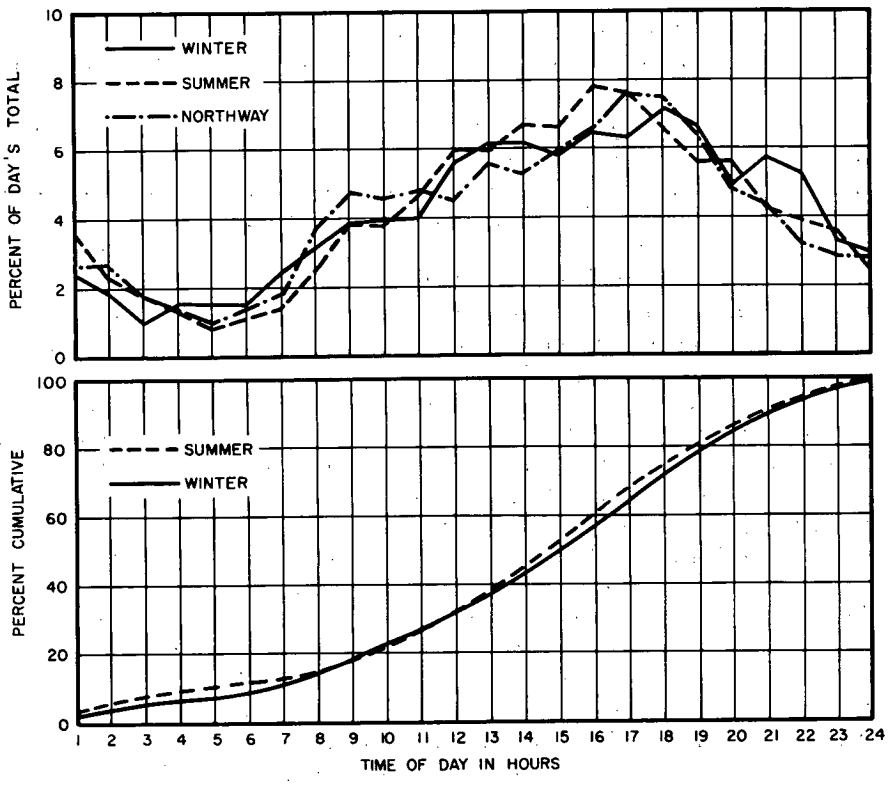


Figure 4. Percentages of total emergency services vs time of day (ambulance not included).

the magnitude of the expected demand on a typical Interstate Highway (ADT of 10,000 and ATL between 40 and 50 miles), to be about 0.49 to 0.58 sdu's per mile per day. For 500 miles, this becomes about 245 to 290 sdu's, which is an order of magnitude greater than those of actual sdu's rendered. Of the sdu's expected, only about 10 percent were of the urgent variety; thus, the number of urgent sdu's expected for these selected highways should be about 25 to 29, which is close to the number of emergency motorist contacts made in Texas.

Superficially, one might suspect that the expected demands are being met perfectly, at least for the urgent demands. However,

1. Of the assists rendered, how many were not of the urgent type?
2. What were the waiting times involved, and were they tolerable?
3. Were there any emergency sdu's that were not satisfied?

All of these questions must be answered to determine whether the demand is being met or if any part of it is not being met adequately. Detailed logs of patrol units provide answers to the first question. Answers to the second question are more difficult since people under stress are generally poor judges of time and may feel that waiting more than 15 minutes is intolerable. Answers to the third question are the most difficult.

Consider Figure A-2, relating the patrol frequency to the probability of stops of various lengths of (average) time not being detected at all. If the conclusion that an average patrol time constant of three hours is valid, it is found that stops with a mean duration of 1 hour have a probability of about 0.72 of not being detected at all.

Conversely, a stop of this class has a 0.28 probability of being detected sometime during its duration. It can also be said that whatever aid is rendered by patrol will be rendered to a maximum 28 percent of all such stops. This undoubtedly includes all of the accidents * and probably most of the other urgent cases. These account for 0.027 and 0.022 sdu's, respectively. For the 500-mile highway, these account for 13.5 and 11 sdu's, respectively. The remaining 0.089 sdu's (or about 45 cases) reflect the normal emergency services demand.

If it be assumed that the urgent sdu's must be supplied, the demand would be 24.5 per day average. Assuming that the urgent sdu's were actually supplied, then 26.3 — 24.5 = 1.8 of the normal sdu's (average per day) could also have been supplied (about 4 percent).

It must be concluded that much aid is presently being obtained by motorists from sources other than patrols. This

* It is realized that patrols do not usually detect accidents during their normal patrols; rather they are notified by some means such as: another motorist, radio dispatch, etc. This activity merely changes the effective patrol frequency on any arbitrarily chosen section of the highway. It decreases the average response time in accident cases, but at the expense of increased response times in other cases.

conclusion, as well as the underlying causes, are strongly supported by the results of the nationwide motorist questionnaire.

Similar exercises could be performed for other Interstate Highways for which ADT is known, an ATL can be estimated, and the patrol activity is known as to frequency and activity distribution. No two highways or highway sections would turn out exactly the same, because of differences in ADT's, accident experience, and the resulting patrol post assignments, man-power available, etc.

Since manpower relative to the length of the facility is a fair indication of the magnitude of the patrol effort (and, hence, emergency service capability), comparing the figures for several toll facilities with those from Interstate Highways from a number of states shows a vast difference. Thus, the turnpikes average about 2.7 miles per man (*2*) whereas, on the free Interstate in Florida, the comparable figures are 10 to 17 miles per man; in Oklahoma about 30 miles per man in rural portions and down to 4 miles per man in urban areas; in Kansas about 60 miles per man; in Oregon and Washington from 6 to 7.5 per miles per man; and in the desert areas of California over 30 miles per man. These numbers are seen to be, for the most part, an order of magnitude larger than those for the toll facilities.

A further bit of proof that the service demand units needed are considerably larger than those supplied is found in (*2*): whereas 52 percent of the patrol efforts on the toll facilities in New Jersey were devoted to motorists assists, less than 1 percent of the patrols' time was devoted to this activity on the nontoll roads. Even allowing for slight differences in the distribution and rate of occurrence of disablements (*6*) on the nontoll versus toll roads, consider that the Interstate portions of the free highways almost invariably command higher traffic levels and, hence, higher patrol levels. Therefore, more of the patrols' activity time would be spent on the Interstate, which carries traffic somewhat similar to that on the toll facilities. Hence, the emergency service demand can be expected to be similar and we can conclude that a considerable portion of the demand is not satisfied by the patrols.

Whereas it is possible to indicate quantitatively the extent to which the service demand is met by patrols, the concept changes for cases requiring tow vehicles and ambulances. Here the satisfaction of the demand quantitatively is not in question—all cases requiring tows or ambulances will eventually receive the necessary service. We must consider adequacy in terms of the average response times.

Again, toll facilities lead the way by contractual agreements with tow and ambulance operators operating from locations spaced at reasonably regular intervals near the facility. The short distances involved result in quite short response times; the dense patrol results in relatively quick detection and notification.

An article (*3*) appeared in the Los Angeles Times titled "AMBULANCE DELAYS LET DEATH WALK HIGHWAYS." This article describes the ambulance situation in Southern California. It points out that most of the densely populated areas such as around Los Angeles, San Fernando Valley (including US 99), and others have generally excellent ambulance service (sometimes as low as 6 to 7 minutes). The Mojave Desert area (Interstate 15, from San Bernardino to Las Vegas, Nevada) plus several other areas, suffer from a shortage of ambulances, long distances, and a time lag in reporting of the need. It points out that the reason for the lack of ambulance services is largely economical; the number of calls do not allow an operator to operate at a profit in these desolate areas.

The AAA maintains several desert patrol service vehicles to ensure that their members have adequate service (and will aid nonmembers as well). However, a tow vehicle may travel 80 to 100 miles to the scene after notification. This indicates a potential waiting time of 2 to 3 hours (in the desert where summer temperatures frequently exceed 110°F), provided that the service vehicle is immediately available.

From the foregoing, from interviews with cognizant officials, and from (*4*) and (*5*), it is apparent that in urban and near-urban areas the problems of delay in rendering emergency services are almost negligible compared with the remote areas. In fact, the problems of detection and service in remote areas are diverse and demand diverse treatment. In examining the possible objectives of a Disabled Motorist Detection System in (*6*), one of the objectives discussed qualitatively was increased probability of survival. Since the concept of the need for a response in some minimum time is central to the emergency services, this section of (*6*) is presented as Appendix C.

Fundamentally, this appendix describes the probability of survival if such survival is contingent on aid. It states that of all occurrences demanding emergency aid, there will be those whose condition will deteriorate (not survive) irrespective of aid; there will be those whose condition will not be aggravated by lack of aid; and finally, those for whom aid will assure survival and lack of aid will result in nonsurvival.

This hypothesis states, therefore, that to decrease the response and/or service time to cater to the former is unrealistic and nonproductive. To increase the response time further into the realm of the second category of needs will have a relatively small deleterious effect. The most benefit is derived by maximizing the response to the last category—that is, those that can be helped and to whom help is essential. There is an example of how this hypothesis is actually practiced. The California Highway Patrol will carry an accident victim to meet an ambulance halfway if time is saved in getting the victim to a hospital. This is equivalent in reducing total response time. For the same (though less dramatic) reasons, most other state highway patrol personnel help the disabled motorist by giving him some gasoline, jumping his battery, giving him a push, helping with a flat tire, and a myriad of other services, including allowing a motorist to rest briefly in the patrol car. These activities reduce the over-all response time. The value of the servicing patrol has been discussed thoroughly in (*6*).

Since the adequacy or inadequacy of the available tow service and ambulance services is being discussed, it is easily concluded that such actions by the various state high-

way patrols in the rural/remote areas are an attempt partially to fill the service gap that appears to exist. (*6*) deals with some specific examples involving the comparative costs of implementing patrol/service efforts for a range of highways, including a rural expressway representative of the Interstate-type highway. The cost estimates will, of course, vary for various areas, and service levels hypothesized. It is suggested that an estimate of the costs be made for any particular highway situation by following the table-form of cost estimates of (*6*).

CHAPTER THREE

FINDINGS—NORMAL NECESSITIES

AVAILABILITY

Normal necessities are considered to be the necessities of the vehicle and its occupants—gasoline, automotive service, food, lodgings, rest rooms, and telephones.

Since a motorist can usually drive for relatively long periods of time without food or rest, it appears that the need for automotive supplies may be greater than the need for motorist services.

Figure 1 shows signs that are sometimes found when entering highways that are the subject of this study. There are no services directly on the highway, except in areas where the highway follows an older roadway. Fundamentally, however, the motorist must leave the highway to obtain services; furthermore, the business establishments supplying such services will (or will not) locate at a particular location depending on their estimate of the economic potential of the area. This study is (to a considerable extent) based on the services that actually exist near many Interstate and Interstate-like highways to serve the traffic on these highways.

AUTOMOTIVE NECESSITIES

The availability of automotive services is based on the following factors: (1) there must be sufficient business potential for an operator or oil company to establish and operate a gasoline station, and (2) assuming that a station is there, it must be in operation (open).

Since gasoline stations cater to transient and local traffic, the local population density and the amount of traffic will have a bearing on these factors. There are two ways of examining the availability of gasoline stations to the Interstate traveler: (1) the total number of establishments per unit length of highway, or (2) the number of individual locations (exits) at or near which one or more stations are located. The former reflects the economic aspects of locating the service (and shall be examined elsewhere) but the latter—as far as the motorist is concerned—represents the true availability.

Table 4 provides a sampling of specific Interstate and Interstate-like highways in this respect.

Figure 5 shows the availability of gas (food and lodgings) along I 94 through Michigan versus mileage, exits, and the distances involved. Similar figures were made for the other highways from which the distances in Table 4 were calculated.

The foregoing does not account for the availability of a particular gasoline station that the motorist might want, or give any assurance that the station is open for business 24 hours a day, 7 days a week. It does not account for the bunching of services—particularly gasoline stations—at interchanges serving the Interstate and another major local road.

Another major consideration is that of signing for the service; each state has its own standards regarding distances between signs for services and the actual service, whether the service must remain in operation 24 hours a day, and even whether to sign for it at all. In some states, the policy is not to sign for the station if it is readily seen from the highway. In at least one state, the service establishment must petition the highway department for signs, certifying that they will meet certain minimum criteria. If the motorist is not aware of the service, it is, effectively, not available to him.

The bunching phenomenon is based on the oil marketers' philosophy that competition is healthy. It is illustrated numerically by Figures 6 and 7, showing the density of stations on several selected (mostly) Interstate Highways in terms of the number of stations per 10-mile segment of highway. For example, in Figure 6, the density on I 35 through Texas ranges from 0 South of Waco, to more than 10 through Waco and approaching Dallas. On I 94 between New Buffalo and Ann Arbor, on the other hand, the density varies between about 2 and 8 stations per 10-mile segment. On I 70 between Topeka and Salina, the density ranges from 0 to 3.8 (the latter entering Salina), with the average about 0.6 to 0.7 station per 10-mile interval.

Comparison of the average distances between exits with GAS services and the preceding figures should adequately illustrate the bunching effect: on I 35, 6.1 miles versus 3.7 miles; on I 70, 19 miles versus about 15 miles. The fact that the former figure is larger than the latter indicates the

TABLE 4

TYPICAL INTERSTATE HIGHWAY STATISTICS—GASOLINE AVAILABILITY (BY OBSERVATION)

HIGHWAY	FROM—TO AND REMARKS	APPROX. DIST. (MI)	NO. OF RURAL EXITS		AVG. DIST. BETWEEN GAS (MI)	MAX. DIST. NO GAS (MI)
			TOTAL	WITH GAS		
I 40	Oklahoma, from about 20 miles East of Oklahoma City Eastbound to Henryetta	44	8	2	14.7	23
I 17, US 18	Arizona, Westbound from outskirts of Phoenix	60	14	3	15	24
I 70	Kansas, Westbound from outskirts of Topeka to Salina	95	17	5	15.8	22
I 10, US 90	From Iowa, Louisiana to Houston, Texas; about 15 miles through Beaumont, Texas excluded-services available at all exits	130	18	13	9.3	39
I 35, 35 E, US 77, US 81	Texas, outskirts of Austin to Dallas, excluding Waco (reason same as above)	188	33	29	6.1	31
I 80	From Oakland/Vallejo to Sacramento	50	7	6	7.1	11
US 99	California, outskirts of Bakersfield to Fresno	115	40	30	3.8	14
US 50, US 120, US 99	Oakland to Merced, except through towns such as Manteca, Modesto	110	50	33	3.1	13
I 94	Michigan, from New Buffalo to Ann Arbor. 2 or 3 of the exits may have gas available directly at the exit	171	64	41 (at least)	4.2	19
US 17	New York, from Harriman to Liberty	53	28	21 (at or near exit)	2.6	5.5

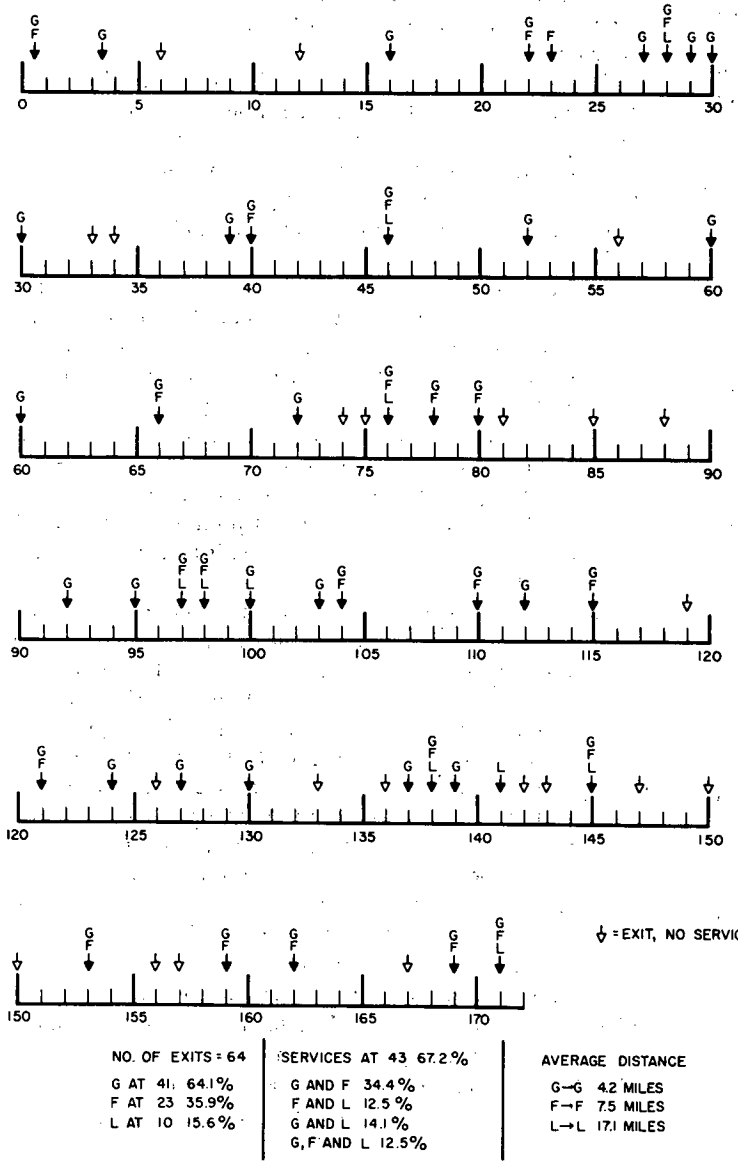


Figure 5. Service availability on I-94 Michigan from Buffalo to Ann Arbor (by observation).

bunching—that is, the greater the difference, the greater the bunching effect.

Signing standards vary between states as well. In some states, notification of services is indicated by the legend ROADSIDE BUSINESS, or SERVICES THIS EXIT, or simply BUSINESS ROUTE. None of the states surveyed indicates how far the service is from the main Interstate Highway. After exiting, the motorist may see another sign indicating the direction to the services, to GAS, or to a locality (within which he must presume the announced services must be located). Only rarely is the distance indicated. In other states GAS is not signed for if the station is visible from the highway. In no case was there any indication of the distance to the next available service (as seen on most toll facilities) nor brand indication.

The oil companies frequently go to considerable lengths to assure visibility and brand identification at the same time by erecting very tall, large, lighted signs, which are frequently visible for more than 5 miles, particularly at night.

Roadside advertising, where permitted, is used extensively and principally by name companies. This advertising generally contains the brand name and the distance. Series of billboards announcing the advent of Texaco, Shell, Esso, Gulf, etc., herald the approach to most cities.

FOOD AVAILABILITY

Restaurant businesses frequently cluster. The motorist will generally find food services of all kinds at entrances and exits from the main trip generators. However, for some of

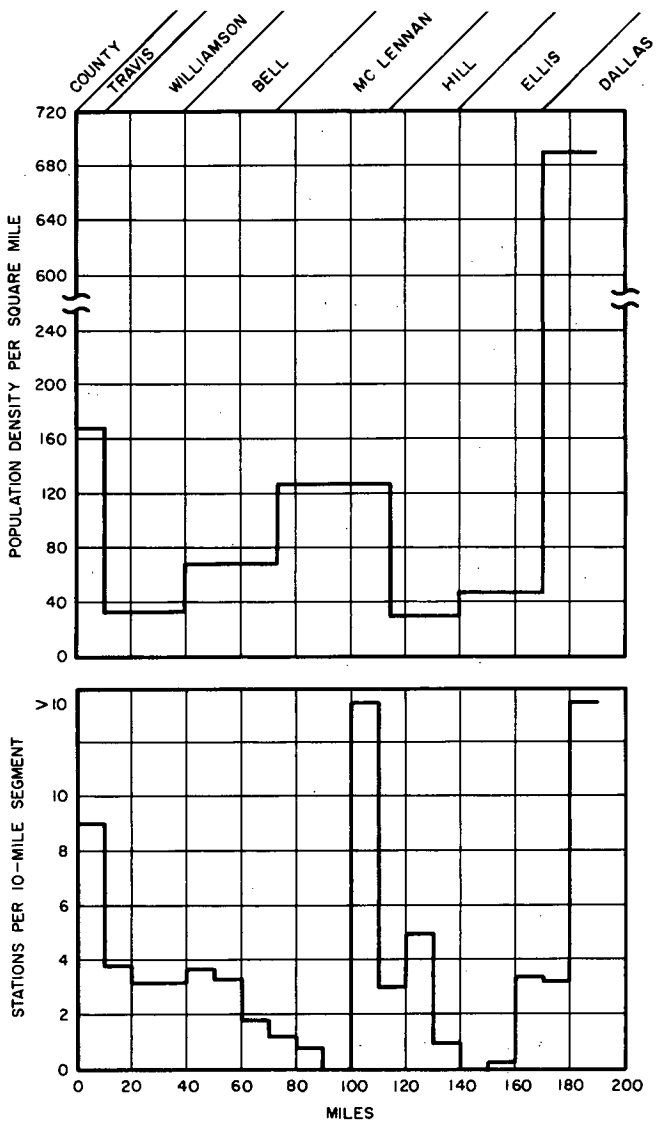


Figure 6. I-35 Austin to Dallas (by observation and derived).

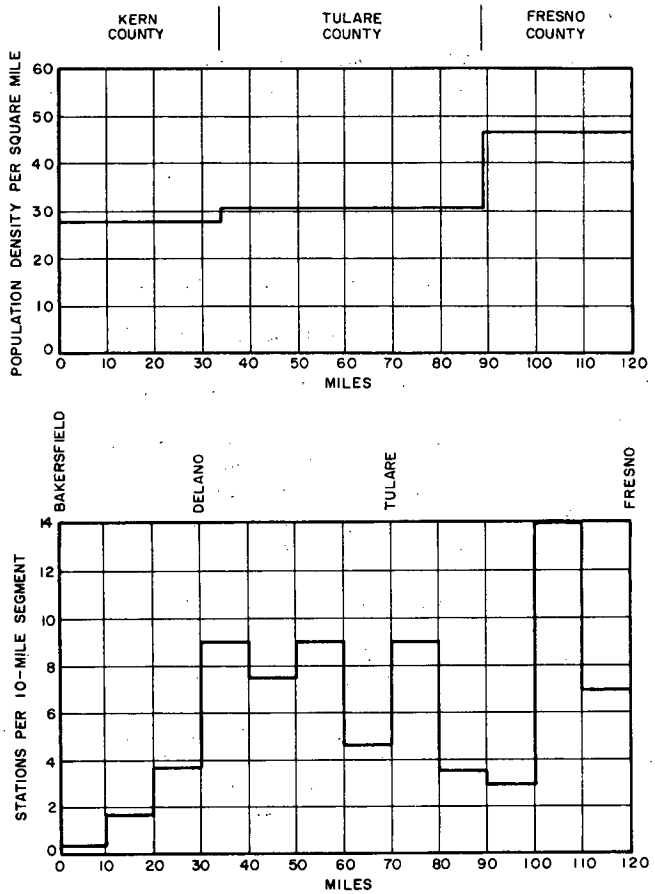


Figure 7. U.S. 99 Bakersfield to Fresno (by observation and derived).

the rural Interstate and Interstate-like roads, it is of interest to examine the mean distance between the availability of food services—regardless of type service, cost, or even the fact that at some periods (such as during the night) many of them may be closed. Table 5 shows these distances as well as maximum distances without food availability.

These figures vary considerably—between a low of 2.7 miles for the Interstate-like US 17 in New York State, to about 30 miles in more remote areas. The weighted average for the roads sampled is 21.4 miles.

LODGING AVAILABILITY

Gasoline is sold to both local inhabitants and transients though more to the former than the latter. The restaurant business does likewise, though probably catering somewhat more to the transients; the lodgings business is directed practically exclusively toward transients. Strictly speaking, the lodgings business includes motels, hotels, tourist homes, and other related accommodations. However, within the framework of this study, the primary interest is with the service directed primarily toward the automobile traveler; hence, the motel or motor hotel is the type of establishment that will be primarily considered here.

Clustering at entrances or exits to trip-generating population centers, centers of industry and commerce, and recreational areas is very evident, much as in the case of the restaurants. Disregarding for the moment the number of rooms, quality, cost, and peripheral facilities of motels, consider simply the availability of lodgings along the highways sampled based on either signing or visual perception of the lodgings, or both, which is the way a motorist not familiar with the highway may look for accommodations. Table 6 shows availability of lodgings.

The figures in the table are sufficiently high compared with those in Table 4 figures to be representative of the distances between the localities where these motels are located; from the standpoint of the motorist's travel habits these distances are but of academic interest.

The motel business has come a long way from the cabins of the pre-war years usually located miles from cities, and catering mainly to the transient motorist. They have

TABLE 5

TYPICAL INTERSTATE HIGHWAY STATISTICS—FOOD AVAILABILITY (BY OBSERVATION)

HIGHWAY	FROM—TO AND REMARKS	APPROX. DIST. (MI)	NO. OF RURAL EXITS		AVG. DIST. BETWEEN FOOD (MI)	MAX. DIST. BETWEEN FOOD (MI)
			TOTAL	WITH FOOD		
I 40	Oklahoma, from about 20 miles East of Oklahoma City Eastbound to Henryetta	44	8	0 (1 at Henryetta)	44	44
I 17, US 18	Arizona, Westbound from outskirts of Phoenix	60	14	1	30	40
I 70	Kansas, Westbound from outskirts of Topeka to Salina	90	17	4	19	32
I 10, US 90	From Iowa, Louisiana to Houston, Texas; about 15 miles through Beaumont, Texas excluded-services available at all exits	140	18	4	26	65
I 35, 35 E, US 77, US 81	Texas, outskirts of Austin to Dallas, excluding Waco (reason same as above)	190	33	5	31.3	82
I 80	From Oakland/Vallejo to Sacramento	50	7	3	12.5	28
US 99	California, outskirts of Bakersfield to Fresno	115	40	7	14.6	34
US 50, US 120 US 99	Oakland to Merced, except through towns such as Manteca, Modesto	110	50	22	4.7	15
I 94	Michigan, from New Buffalo to Ann Arbor. 2 or 3 of the exits may have gas available directly at the exit	171	64	22	7.8	22
US 17	New York, from Harriman to Liberty	53	28	20	2.7	5

TABLE 6

TYPICAL INTERSTATE HIGHWAY STATISTICS—LODGING AVAILABILITY (BY OBSERVATION)

HIGHWAY	FROM—TO AND REMARKS	APPROX. DIST. (MI)	NO. OF RURAL EXITS		AVG. DIST. BETWEEN LODGINGS (MI)	MAX. DIST. NO LODGINGS (MI)
			TOTAL	WITH LODGINGS		
I 40	Oklahoma, from about 20 miles East of Oklahoma City Eastbound to Henryetta	44	8	0	44	44
I 17, US 18	Arizona, Westbound from outskirts of Phoenix	60	14	1	30	52
I 70	Kansas, Westbound from outskirts of Topeka to Salina	90	17	2	32.3	53 (none signed or seen)
I 10, US 90	From Iowa, Louisiana to Houston, Texas; about 15 miles through Beaumont, Texas excluded—services available at all exits	140	18	4	21.7	63
I 35, 35 E, US 77, US 81	Texas, outskirts of Austin to Dallas, excluding Waco Temple (reason same as above)	190	33	4	31.3	88 (Waco-Dallas; none signed or seen
I 80	From Oakland/Vallejo to Sacramento	50	7	1	25	39
US 99	California, outskirts of Bakersfield to Fresno	115	40	7	13	39
US 50, US 120 US 99	Oakland to Merced, except through towns such as Manteca, Modesto	110	50	21	4.7	25
I 94	Michigan, from New Buffalo to Ann Arbor. 2 or 3 of the exists may have gas available directly at the exit	171	64	9	17.1	38
US 17	New York, from Harriman to Liberty	53	28	14	3.5	15

evolved into large, modern complexes rivaling and surpassing downtown hotels with their facilities, services and conveniences. Independent operators soon found that it was more profitable for them to join chains, or obtain franchises from big, nationally known companies. They have also quickly learned that competition can be profitable.

Smaller operations find it profitable to locate near the major ones, because they receive the overflow business. This is one of the reasons for the clustering (*8*).

Although more long-distance auto travel appears to be done for pleasure rather than business (Appendix B), one of the most successful chain motel operators estimates that about 70 percent of their weekday patronage is from business travelers. As shown (*9*) the percentage of business trip patronage during the week is 59 percent and 45 percent on weekends (this includes business and business and pleasure categories). Only about 30 percent (*10*) is shown in comparable categories. Thus, it depends on the selection of motels surveyed to determine the prevailing mix of business versus pleasure patronage. Some of the most successful motels near industrial complexes show nearly all business patronage, whereas there are motels in resort areas that have almost 100 percent pleasure patronage.

From (*8*), the following breakdown (Table 7) is obtained for the regional distribution of business versus pleasure trip patronage; it can be seen that regional variation is considerable. It can also be seen that for the U. S. as a whole, pleasure travelers predominate among motel patrons.

Motels have also been getting larger. Even though the chain operations account for about 2 percent of the motels, they account for over 20 percent of the rooms available. Of the chains, Howard Johnson's and Holiday Inns are the most prominent. According to (*8*), average sales for the motels serving primarily the Interstate Highways in 1962 were $14.83 per room; the average number of rooms is about 29, though the more successful motels usually have 2 or 3 times this many. An interesting tabulation of the features distinguishing the most successful motels also helps to explain the lodgings that the motorist is usually confronted with.

The motels with the highest per-room sales have one or more of the following features (usually more):

50 or more rooms (size-big)
constructed recently (modern)
located downtown (business-customer potential)
located on commercially zoned land
located on divided highway
located near other motels (competition)
located adjacent to restaurant or gas station (convenience-related services)
located at intersection (ease of access)
impressive exterior appearance-better than competition's

The aspect of combined services is coming into its own only now. Through experience, operators have found that the availability of a restaurant in conjunction with the motel (or next-door) was advantageous; likewise, a gas station. Such group offering of services appealed to the motorist since he could fulfill all of his basic needs in one easy stop: have his car serviced, eat a meal, and find overnight accommodations. To make it even more attractive, combined credit card operations were initiated by major chains whereby the holder of a gasoline credit card could charge his lodgings. The following such cooperative arrangements are known to exist at this time (also indicated are other credit cards accepted):

Howard Johnson's and Texaco; also American Express
Holiday Inn and Gulf; also American Express, Diner's Club
Quality Courts and Phillips 66; also American Express, Diner's Club
Best Eastern/Best Western Motels and American; also American Express, Diner's Club, Carte Blanche, Air Travel, Bank of America
Sheraton Inns and Shell
Emmons Walker (no oil company cards); American Express, Diner's Club, Carte Blanche
Travel Lodge (no oil company cards); American Express, Diner's Club, Carte Blanche, Bank of America
Superior Motels (no oil company cards); American Express, Diner's Club

The major chains offer some other inducements to lure their guests; for example, elaborate, free reservation systems, whereby the guest can reserve ahead to any other member of the chain; swimming pools; uniform standards of quality in facilities, furnishings, and service; and peripheral services such as meeting rooms, catering to large groups, playgrounds for children, parking, ice, television and telephone in every room, etc. In addition, they help themselves by their nationwide referrals and extensive advertising via all the media. Their success is shown by their high occupancy rates (usually above 90 percent) compared with the industry as a whole (which averaged about 60 percent in 1963).

An interesting development on the west coast fairly recently shows a slight trend back to the simpler accommodations of the former motel industry at lower prices. The Motel "6" operation has currently 27 motels with about 2,000 units in California, Nevada, Utah, and Arizona; more are planned for Arkansas, Colorado, Illinois, Iowa, Kansas,

TABLE 7

BUSINESS VS PLEASURE TRIP PATRONAGE (*8*)

REGION	PLEASURE %	BUSINESS %	COMBINED AND OTHER %
New England	96.4	approx 3	less than 1
Central Eastern	39.6	43.3	17.1
Southeastern	62.6	21.1	16.3
Florida	64.5	18.1	17.4
North Lake	93.0	3.5	3.5
North Central	65.1	20.0	14.9
South Central	27.4	56.2	16.4
Southwestern	43.0	20.0	37.0
Mountain	56.8	24.6	18.6
Northwestern	62.3	17.8	19.9
Total U.S.	57.9	25.0	17.1

Minnesota, Missouri, Nebraska, New Mexico, Oklahoma, and even Hawaii. The premise is that by the elimination of frills and offering clean, comfortable accommodations at an attractive price ($6 for two persons) regardless of season, customers will be attracted. The success of the existing units bears this out.

Signing for lodgings is presently only of the generic variety, except for some experimental signing schemes using totem pole identification of the facilities, or separate boards for the various services. As long as billboards remain, most motels do a fine job not only of advertising their existence, but also of supplying the much needed information as to how far away they are, and how to get there. By driving experience, it has been found that Holiday Inns' billboards were most informative in locating their facilities, though there were many others that appeared to be equally explicit. On the other hand, on several occasions following the generic directions only, or simply a services legend, either no facility was located within a reasonable distance of the main highway, or the facility that was located was deemed unsatisfactory.

It is felt that the proposed signing standards will be adequate for the major well-known motel names, with their distinctive symbols familiar to the motorist; however, they are likely to hurt the local or independent operator. The latter group has expressed their fears in the hearings held pertinent to the Highway Beautification Act (Spring, 1966) in the various states.

DEMAND

Whereas the demand for emergency services is clearly based on their rate of occurrence, normal necessities are more subtle since they strongly depend on the arbitrary and highly subjective judgments, likes, and habits of motorists. These include how much they travel, gasoline buying habits and preferences, eating habits, and socio-economic status. The three principal needs will be considered separately.

Gasoline Demand

Most cars (passenger vehicles as opposed to trucks) have gasoline tanks varying in size somewhat in relation to the vehicle's power, weight, and average consumption. Most have a range of between 200 and 300 miles between refuelings. This figure exceeds the prevailing ATL. Hence, the average motorist embarking on the average trip may have any amount of gasoline in his tank—from near empty to full; correspondingly, his need to refuel should occur at any random point along his path. Of course, this is not so because of the human element. An in-plant survey of about 800 motorists has indicated the magnitude of this effect. First, there is the individual preference of many motorists to fill up at more frequent intervals; 67 percent of the above sample indicated that they generally fill up when the gauge drops to ¼ full. Furthermore, motorists have a tendency to fill up at the beginning of their trip; fully 87 percent of the above sample. Therefore, trip-generating areas can be expected to produce a much higher demand than in-between stretches. That this is true is attested to by the clustering of gasoline stations on the outskirts of cities, towns, and villages. Figure 6 shows the number of stations (per 10-mile segment of highway) and the population density of the counties that the road traverses. Undoubtedly, population densities of smaller subdivisions such as townships would show much better correspondence, since similar correspondence was not as evident in cases where the counties were larger. Figure 8 shows actual figures of gallonage pumped from the New York State Thruway reduced to the average gallons per vehicle per day (based on the ADT of each station). It can be seen that the peak per-vehicle gallonages are encountered between the major trip generators: between NYC (left, off the graph) and Albany, and between Albany and Syracuse. For the same reasons, the lows occur at these points because motorists commencing their trips there tend to fill up there rather than on the facility. The same is true for those terminating their trips at these points. A similar characteristic was found from gallonage data on the Ohio Turnpike. An additional factor may be the usually higher price for gasoline on the toll facility.

Next, we consider the presence of existing operating stations along a particular highway and (assuming that they are operating successfully) attempt to relate their numbers to the ADT at their location. For this purpose, points at two-mile intervals were chosen and the station density in the 10-mile sectors centered at these points were calculated and

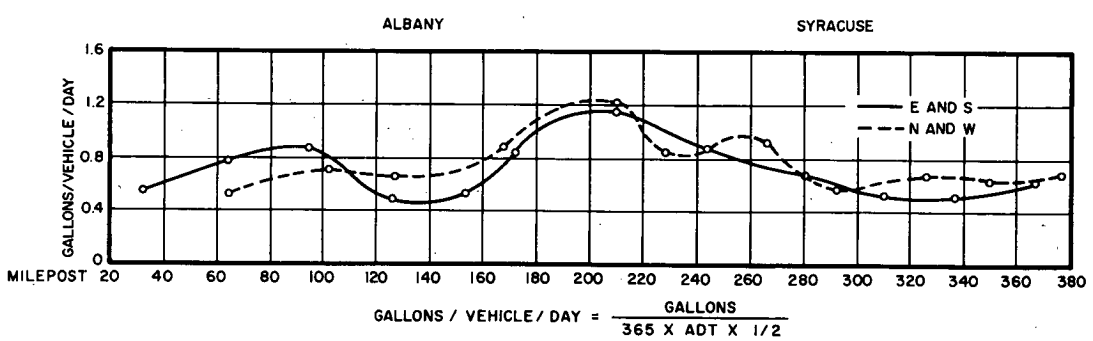


Figure 8. Gasoline sales per vehicle per day (average based on ADT and annual gallonage figures of New York State Thruway Authority).

plotted versus the ADT for the sector. For each of the 5 or 6 highways thus considered, the density at each point was plotted versus the ADT. It turned out that all of the plots suggested a trend similar to the one shown qualitatively in Figure 9.

This plot indicates a seemingly nonlinear inverse relationship between the ADT and the station density, which intuitively seems to make little sense. Consider, however, a slight revision to this plot whereon the number of traffic units per gasoline station (the ratio of ADT to the station density at regular intervals on each of the curves as in Figure 9) is plotted versus the ADT at that point for the several roads surveyed in Figure 10.

This figure points out that as the ADT increases (such as approaching a city), the number of gasoline stations established there to service this traffic increases more slowly. In other words, the stations in the higher ADT areas attempt to cater to more vehicles each. This hypothesis is supported by the usually much more elaborate, large, multipump, multi-isle stations near cities, and the fact that more of these remain open 24 hours as opposed to those in-between population centers. The figure does not imply that for slight increases in ADT, stations experience dramatically large increases in business. They would do so only if they (the stations next to the major highway) had no competition within the trip-generating complex that caters to much of the traffic starting or ending their trips there. This is supported by a survey (*12*) that shows that about 65 percent of the motorists usually buy at the same service station, and that they buy all or nearly all of their gasoline there.

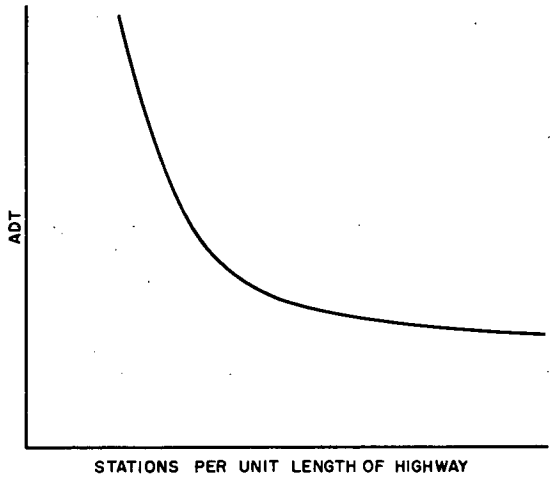


Figure 9. Gasoline stations per unit length of highway vs ADT (derived).

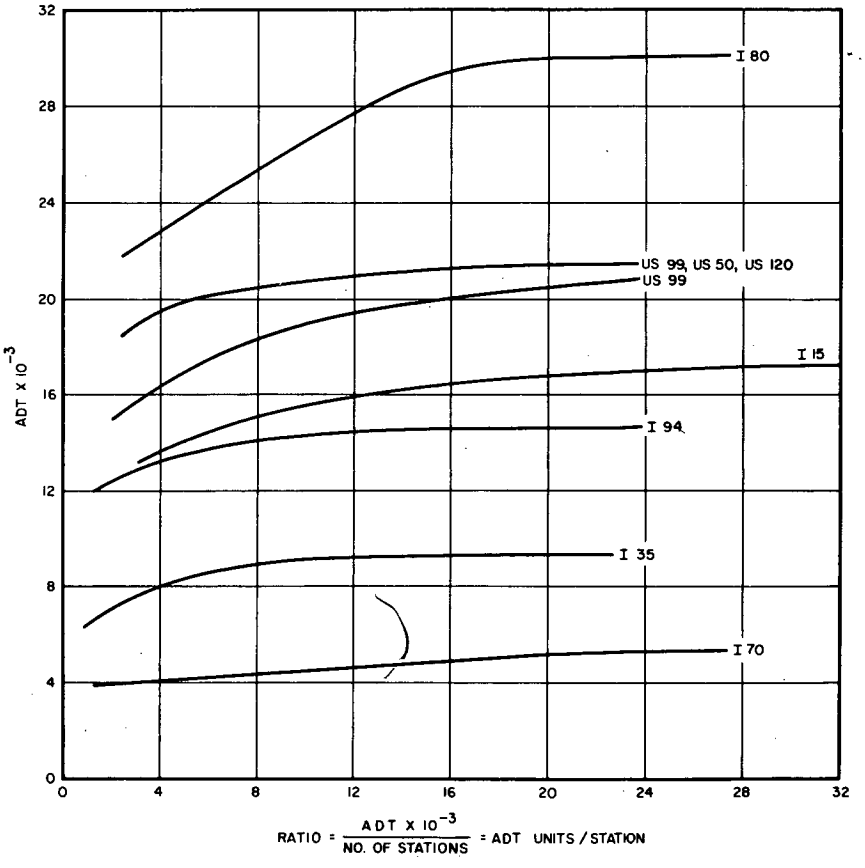


Figure 10. Demand as defined by number of existing stations vs ADT (derived).

Another question indicated that 74 percent individually used the same brand of gasoline.

The actual presence of any number of gasoline stations in a given location does not prove that there exists enough business to keep them in operation. According to the American Petroleum Institute, the failure rate among gasoline stations is between 35 and 40 percent (*13*).

Since accurate gallonage data as well as ADTs are available from the toll roads, we resort to NYSTA and Ohio Turnpike data. Figures 11 and 12 show the least-squares fitted curves relating the gallons per vehicle per day to ADT, and gallons per day per 1000 vehicle miles to vehicle miles, respectively, for the New York State Thruway. Both representations clearly show the decrease in the per-vehicle delivery with increasing traffic. This is consistent with Figure 9, of course, when compared to the ADT plot versus mile post for the facility. A similar relationship (both in curve shape and numerically) was obtained from comparable Ohio Turnpike data. Whereas the Ohio Turnpike points were not included in the calculation of the curves, the points have been inserted into Figures 11 and 12 to show how well they fit.

It must be remembered that the preceding quantitative demand figures are based on actual demand on a limited-access toll facility serving exclusively patrons of that facility. They cannot be applied directly to stations serving the Interstate Highway, since such stations always serve local traffic in addition to that from the Interstate. It is strongly suspected on the basis of the foregoing considerations of motorists' preferences for buying locally and lower per-vehicle sales (on the main highway) in more densely populated areas, that the percentage of local business relates to the population density of the area (related to main highway level or secondary highway traffic level) monotonically as indicated qualitatively in Figure 13. An extensive economic survey of several carefully selected localities, with the cooperation of the business establishments involved, would be necessary to establish the shape of the curve or the values along the abcissa. Unfortunately, such an analysis (involving extensive interviews and recording of data) could not be accomplished within the time and monetary limitations of this study.

Food Demand

The need or demand for food is much more subjective than that for gasoline, since a hungry motorist can proceed for many miles to find the desired food services. Also, the eating habits of motorists differ greatly. As in the case of gasoline, it was not possible to obtain actual operations data from a group of restaurants serving Interstate traffic. A very extensive survey would be required to determine the mix of local versus transient (Interstate) patronage.

As in the case of gasoline, toll facilities provided a valuable source of reliable data allowing for some relation of the business done by the restaurants to the traffic on the facility served (almost exclusively) by these restaurants. Additional information collected aids in establishing an over-all composite demand-for-food picture, which follows.

1. By interview with executives of one of the largest and best-known food (and motel) chains, it was found that the average check size in their restaurants is about $0.80. This is not equivalent to per-person expenditure, since many parties of two or more persons are covered by one check.
2. The average percentage of traffic entering a service area, on the basis of Thruway and Ohio Turnpike data is about 20 percent. This does not mean that this traffic is the restaurant business—but the restaurant business is definitely a part of this traffic.
3. The gross receipts per vehicle per day in the turnpike

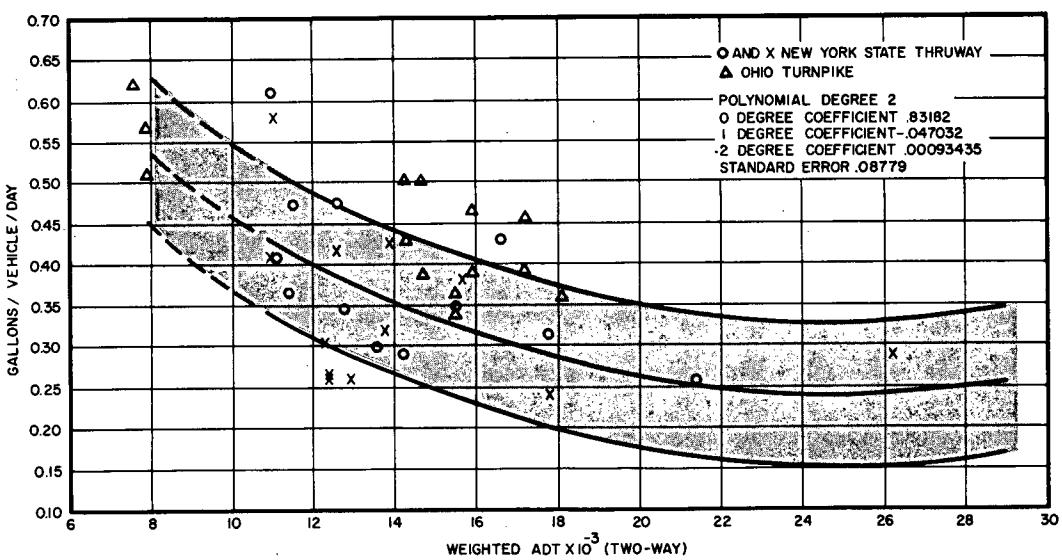


Figure 11. New York State Thruway and Ohio Turnpike, 1965 gallons per vehicle per day vs ADT (calculated).

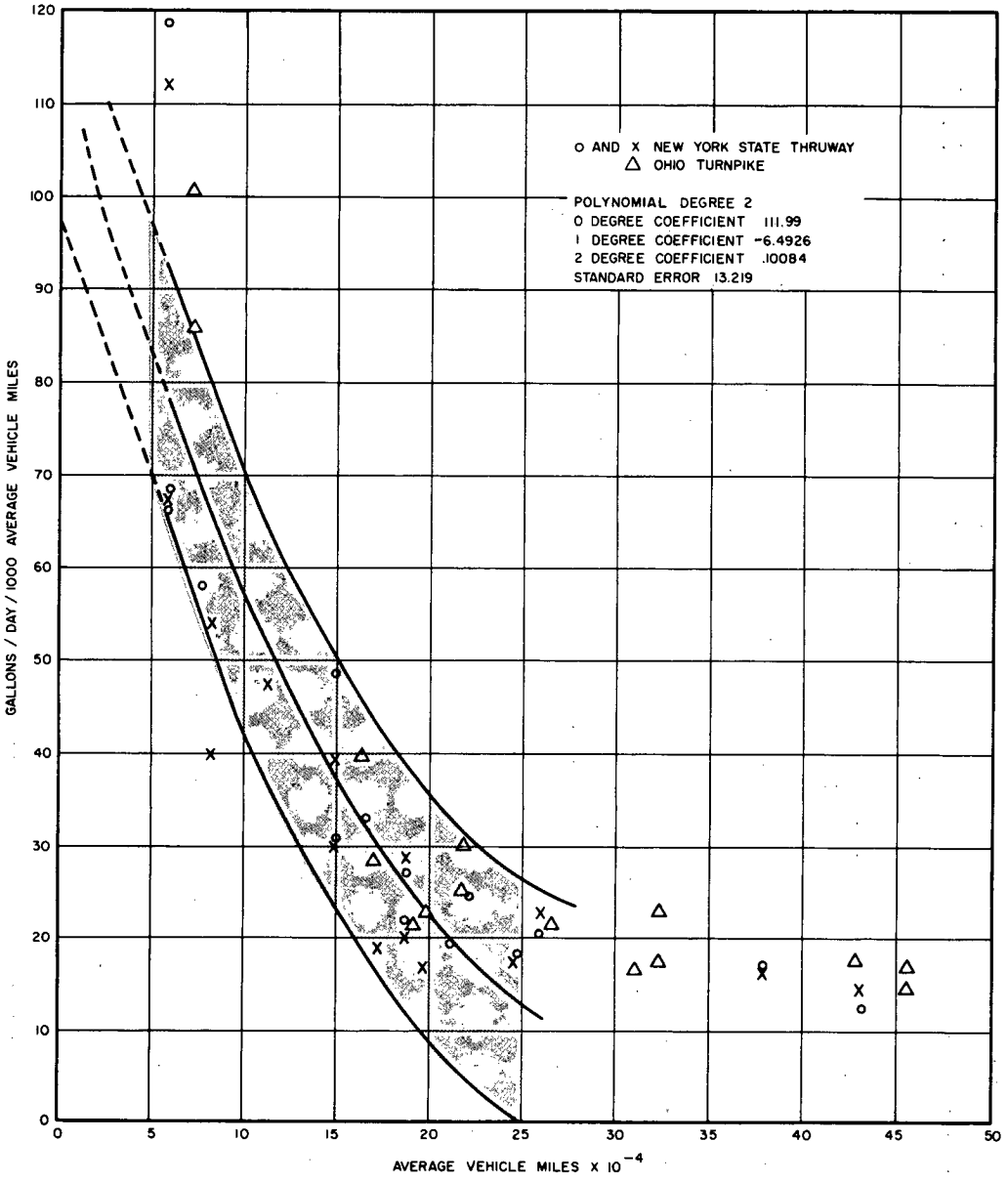


Figure 12. New York State Thruway and Ohio Turnpike, 1965 gallons per 1000 vehicle miles per day vs vehicle miles (calculated).

restaurants amount to about $0.10. Since about 20 percent enter the service area, this means that the average food outlay for those entering the service area is $0.50 per vehicle per day.

4. Of the cars stopping at the service areas on turnpikes (*14*) 34 percent buy food, 28 percent use rest rooms, 21 percent buy gasoline, and 17 percent stop for various other reasons.

5. If 34 percent of the vehicles buy food, the expenditures per vehicle per day becomes about $1.50.

6. The average car occupancy on the Ohio Turnpike has been slowly decreasing over the years; presently, the average is estimated at about 2.5 passengers per vehicle. This is comparatively high, because (*15*) indicates that (nationally) for all trips in excess of 100 miles and/or overnight in 1963, the average was about 1.9. It is strongly suspected that the inclusion of local traffic would lower this to between 1.2 and 1.5.

7. Therefore, for an average vehicle occupancy of 2.5 as on the Turnpike, the average per-person food expenditure becomes about $0.60. This figure is in line with $0.80 mentioned in item 1.

8. Trip length appears to have a dominant role in establishing the percentage of motorists who buy food when stopping. About 75 percent of motorists on trips up to about 200 miles buy food when stopping. On the average trip (70 to 90 miles), about 50 percent of the motorists stop for food at least once. On trips in excess of 200 miles,

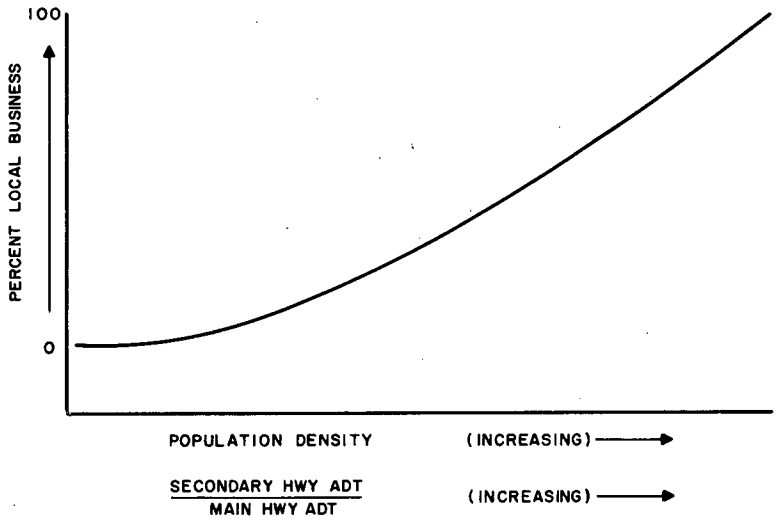


Figure 13. Percentage of local business related to population density and local/transient traffic mix (hypothesized).

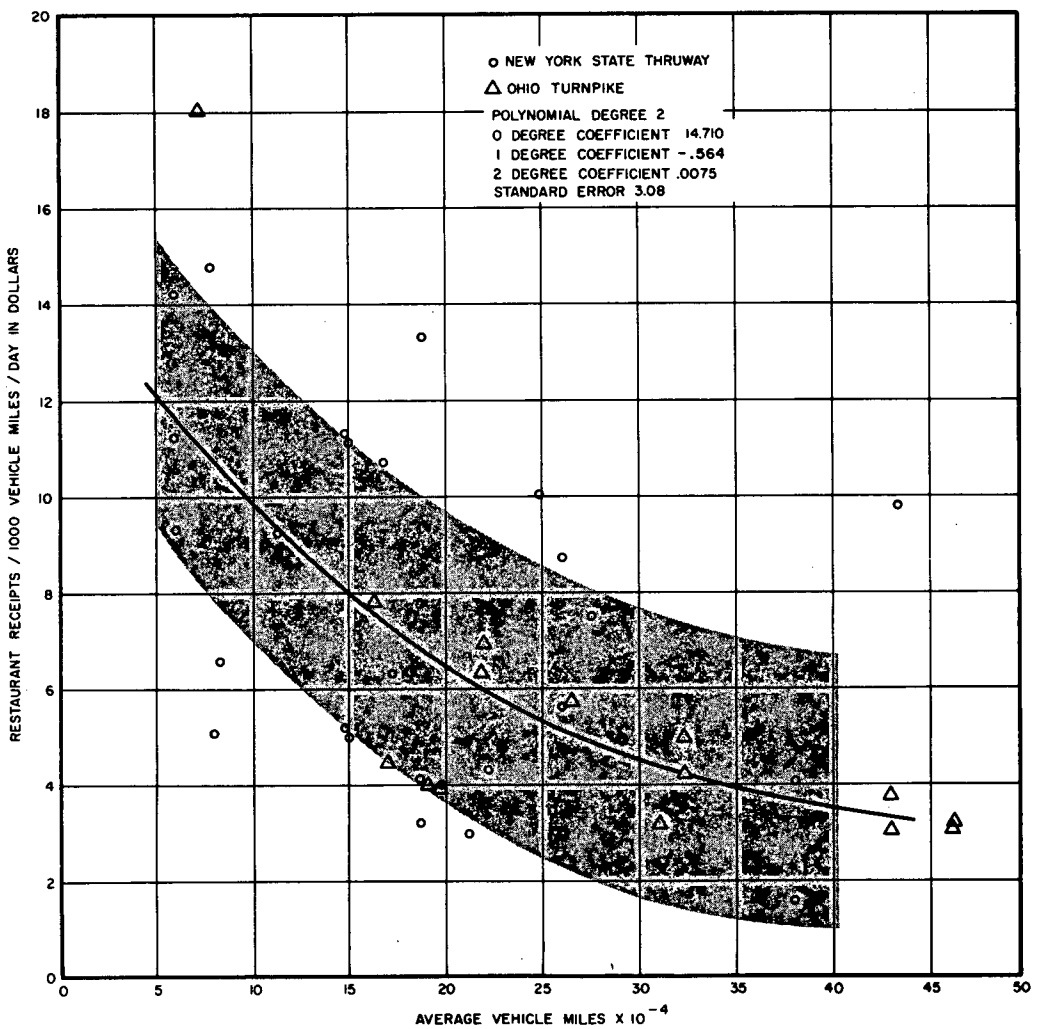


Figure 14. New York State Thruway and the Ohio Turnpike 1965 restaurant receipts per 1000 vehicle miles per day vs vehicle miles (calculated).

almost all stop at least once. On trips of less than about 165 miles, food buying drops off sharply (*16*). This would seem to indicate that motorists have a tendency to stop for food at 3- to 4-hour, or greater intervals.

On the turnpikes, it is generally attempted to have service areas with restaurants approximately every 30 miles. Even beyond the ADT figures, there are some differences in the percentage of traffic entering depending on whether the service area is upstream from, downstream, or in between principal traffic generators (city, metropolitan areas). On the New York State Thruway, a study by the NYSTA indicates that these percentages were 18 percent for upstream traffic, 24 percent for downstream traffic, and 21 percent for intermediate points.

Next, for the two turnpikes, it is attempted to relate the gross receipts for the restaurants with the traffic. Figure 14 shows points for both plotted in terms of gross receipts per 1,000 vehicle miles per day (at the particular location) versus the vehicle miles per day (at the same location). The observed trend is for a decrease in receipts with increasing traffic level. It can be seen that points from both facilities fall reasonably well into the pattern suggested by the least-squares fit curve.

The numbers being based on toll facilities operation, must not be considered as being completely representative of the free Interstate System. Restaurants serving the latter, for the most part, also serve local traffic, and will therefore most likely bear a similar relationship to local population density and the traffic mix as gasoline stations. However, the toll facilities considered bear a certain resemblance to the free Interstate Highways in their physical configuration and the nature of the traffic they carry. Hence, it is reasonable to assume that similarities in the fundamental demand for food will exist.

The nationwide questionnaire yielded some answers pertaining to the motorists' preferences and desires concerning food services. For example, when asked what service type they prefer for each meal, 86 percent chose restaurant service for dinner but only 40 percent preferred restaurant service for lunch; the remainder was almost equally divided between cafeteria, counter service, and picnicking. These preferences seem to imply a desire for less formality during lunch, perhaps faster service, lower cost, etc. It is also interesting to note that counter service was preferred by the highest percentage (23 percent) for breakfast, and lowest for dinner (less than 3 percent).

Efforts to obtain figures that would indicate the net number of meals served at breakfast, lunch, and dinner have been unsuccessful. Such figures would be useful to lend relative weights to the preference for specific service types shown.

Lodging Demand

The demand for lodging services will be considered in terms of actual researched usage of the available facilities and in terms of what the motorists want on the basis of motorist surveys.

As given by (*8*), there is a distribution for all of the U. S. of the percentage of business patronage versus pleasure travelers. Table 7, which shows these percentages, was prepared to show that the variation among regions causes motel operators to cater to the different demands of the two types of travelers. Table 8 gives the income distribution of the same patrons.

TABLE 8

INCOME DISTRIBUTION VS TRIP TYPE

PURPOSE OF TRIP	UNDER $6,000 %	$6,000 TO $10,000 %	OVER $10,000 %
Pleasure	24	33	43
Business	19	42	41
All (business, pleasure, other)	23	34	43

It is interesting to note that the percentage of travelers in the over $10,000 category remains nearly constant regardless of trip purpose. There are likewise fewer under $6,000 people who stop in motels when on business as opposed to when on pleasure trips. The middle group tends to use motels more on business than on pleasure trips.

Figure 15 presents intercity passenger traffic volumes (1950-1964) in terms of the various transportation modes that make up this volume (*15*). The percent of automobile traffic increased from 86.2 percent in 1950 to 90 percent in 1958, leveled off, and finally dropped slightly after 1961 due to a sharp increase in the percent of air traffic. This increase in air traffic has prompted the establishment of many motels near airports.

A comparison in Table 9 is made between the number of motels and the number of rental units (rooms) in several selected states versus the vehicle miles of travel on the

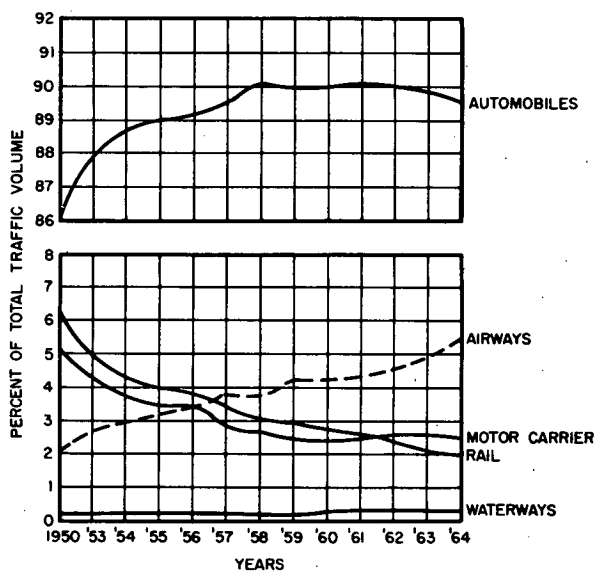


Figure 15. Volume of domestic intercity travel divided among various transportation modes.

TABLE 9

LODGING TYPE VS VEHICLE MILES

STATE	MOTELS %	RENTAL UNITS %	VEHICLE MILES ON INTERSTATE %	VEHICLE MILES ON FEDERAL AID HIGHWAYS %
New York	5.1	5.4	5.4	6.0
North Dakota	0.4	0.4	0.4	0.5
Kansas	1.3	1.1	0.9	1.5
Florida	9.4	8.8	2.9	3.1
Texas	5.6	5.8	6.7	5.9
Washington	2.4	1.6	2.5	1.8
California	10.3	11.9	12.3	8.4

Interstate and other major highways in that state. In all cases, percentages of the total U. S. figures are shown (*17* and *18*).

Comparing the percentages in the first and second columns shows whether the motels in a particular state are generally larger than the national average. That is, if the percentage of rental units (rooms) exceeds the percentage of motels, one can assume that the motels tend to be of the larger type. Note, for example, that Washington appears to have proportionately more small motels than California and New York, which tend toward larger ones. Next, a state with a highly seasonal tourist business (as Florida) indicates a much higher percentage of motels as well as rental units than vehicle miles of travel on the Interstate Highways. In a sense, comparing the rental units figure with the vehicle miles figure may be indicative of whether the facilities available can satisfy the demand. The last column is shown because it represents the percentages of U. S. total on the total Federal Aid System in each of the states and the figures in the third column may reflect the degree of completion of the Interstate System in the state.

The over-all questionnaire of motorists disclosed several items of interest. About 73 percent indicated that they do not generally make prior reservations. Table B-14 shows that there are distinct regional differences in whether motorists make reservations: New Yorkers lead with 32 percent and North Dakotans trail with about 14 percent making reservations. There are also occupational differences shown in Table B-17 with almost 35 percent of the professionals making reservations but less than 11 percent of the military. Figure B-29 shows that some age groups likewise tend to make reservations more than others.

When questioned about price, about 2 out of 3 respondents indicated that they expected to spend $11 or less, and about 95 percent indicated less than $15. It is suspected (based on a number of correlations) that this relatively high number may reflect per-room rather than per-person expenditures. This is supported by the predominantly "for pleasure" travel habits, as with family groups. In polling its members, the AAA reported (*20*) that 45 percent of the vacation parties had two persons, but 89 percent had two or more; 31 percent had one or more children in the vacation party. More than half of these parties stayed at motels while in transit, and 1 in 3 did likewise at the destination. The AAA survey also inquired about facilities most desired by the travelers in their motels. The facility most frequently checked was a restaurant (on the premises or nearby); the swimming pool came in 7th after television, coffee maker, free ice, telephone in room, no tipping, and wall-to-wall carpeting.

AVAILABILITY AND DEMAND COMPARED

This section compares the ability of facilities to supply the existing demand. Indications of an over or under supply of these facilities or apparent deficiencies are noted.

Gas

The spatial distribution of service stations was considered previously. It is pointless to consider the quantitative ability of gasoline stations to pump fuel, for it is rare when a station runs out of its supply. An unusual condition occurred during the Great Northeast Blackout of 1965. This event, which plunged most of the Northeasterly U. S. into darkness brought out forcibly just how much dependence is placed on electrical power. All gasoline pumps are electrically operated; hence, barring an emergency power supply stations could not dispense any gasoline for the duration of the blackout.

Urban areas abound in gasoline stations. Price wars in such areas plus the high mortality rate of stations and sales gimmicks such as stamps and give-aways testify to the competitive nature of the business.

Some answers about the motorist's feelings pertinent to these various merchandising techniques are given in (*12*). As for price wars, of 39 percent of respondents who do not buy all or nearly all of their gas at one service station, only about 8 percent (or slightly over 3 percent of the total sample) buy where price is cheapest. In response to the direct question of whether motorists shop around for price, only about 6 percent admitted that they do so regardless of brand, less then 5 percent among stations of the same brand, and about 6 percent for both. Of the respondents who had

been specifically exposed to price wars (38 percent), only about 26 percent (or just under 10 percent of the total sample) took advantage of such wars. Most of these people (70 percent or 7 percent of the total sample) bought wherever price was cheapest, regardless of brand.

When it comes to gimmicks, opinions differ. Asked about trading stamps, 63 percent stated that "most people are inclined to favor buying at a station giving trading stamps." Asked about give-aways (glasses, dishes, etc.) however, 58 percent stated that ". . . people probably/definitely would not buy at such stations . . .;" their primary reason was ". . . products are cheap . . . choice is limited. . . ." Obviously, it must be concluded that in areas where the service station operators see fit to adopt such techniques, the supply exceeds the demand.

Rarely are such merchandising techniques used in the rural and/or remote areas. They are not necessary because the immediate competition is smaller, but because a greater proportion of the passing traffic is served by each station. By way of an explanation, refer to the curves in Figure 10. Note that they fall in different regions of the figure for the various specific highways. Consider the characteristic ATL's that these highways may have. Of these highways, I 70 (bottom curve) probably has by far the longest ATL—in the summer, amounting to about 200 miles. The top curve, I 80, carries principally Oakland/Vallejo to Sacramento traffic plus the daily traffic to San Francisco and out of San Francisco commuting traffic; hence, it is suspected that the ATL on this highway is relatively short—perhaps 30 to 40 miles. The next lowest curve is US 99, which is the main inland valley artery, connecting Bakersfield, Tulare, Fresno, Modesto, Stockton, and Sacramento, plus many smaller towns. Again, it would be suspected that the ATL would be relatively short on this highway, but probably higher than on I 80. Finally, I 35 between Austin and Dallas is estimated to have relatively high ATL's because (as opposed to US 99, which has many smaller towns between the larger trip generators), there are no major trip generators between these two cities except Waco, and Temple. Incidentally, stations within these complexes are not included.

No ATL figures on the other highways plotted have been found. However, note that if the hypothesized figures are reasonable, then the higher the position of the curve in Figure 10, the lower the ATL, and conversely. This means that the higher the curve, the more local in nature the traffic, and the more competition; therefore, each station serves a smaller percentage of the main-line traffic (ADT on main highway).

With much further study and accumulation of data, it might be possible to relate the position of the curve (ATL) to the percentage of main-line ADT entering the station. This represents a purely empirical relationship between the ADT, ATL, and the number of service stations per unit length of highway.

Figure 11 will indicate an imaginary Interstate Highway that has traffic characteristics similar to the New York State Thruway and Ohio Turnpike; if a location is assumed where the ADT is about 10,000. The gasoline demand would be between 0.4 and 0.5 gallons/vehicle/day, or 4,000 to 5,000 gallons per day. It must be remembered that this is based on a station density of about 1 pair per 30 miles, covering both directions of traffic. Therefore, for the pair, the average demand would be between 8,000 to 10,000 gallons per day or, for a single station or groups of stations thus spaced on an Interstate. Note that the availability of stations for the highways sampled averages out to about 7.4 miles between exits with stations. However, a direct comparison with the turnpikes is not valid since the turnpikes have exits interspersed with the service areas, with stations frequently operating nearby and competing with the stations on the facility. A more valid comparison would be possible if the average distance between service areas and/or exits on the turnpike was compared with the average distance between exits with gasoline availability on the Interstate. For about 280 miles of the New York Thruway (Spring Valley to just east of Syracuse), this average distance works out to about 8.9 miles, or somewhat longer than the 7.4 miles on the Interstate and other controlled-access highways sampled.

So far it has been merely determined that the apparent demand is sufficient to support a certain station density—information more of interest to the marketer of gasoline than to the motorist. It appears that the vast majoriy of U. S. motorists find little trouble in fueling their cars. This is attested to by the more than 760 billion vehicle miles (*17*) which are estimated to have been driven in 1965; of these, about 67 billion (or just under 9 percent) were driven on the rural Interstate Highways.

Evidence of a possible deficiency lies in the incidence of out-of-gasoline stops that occur. It has been shown that the expected rate of occurrence of such stops on a typical Interstate is about 0.11 per mile per day. The question is, had there been more gasoline stations available, would this number be smaller?

Consider the incidence of out-of-gasoline incidents on the New York State Thruway; their rate ranges from a low of about 0.5 per million vehicle miles in the lower ADT areas (15,000) to a high of 1.32 per million vehicle miles in the higher ADT area (over 25,000). More such stops occur near the trip generators than between NYC and Albany. These portions of the facility carry more local traffic—short trips between two or three exits. Supporting information is available from the questionnaire poll. Almost four times as many admitted having run out of gas on short, local trips than on long trips in excess of 100 miles. These local trips are usually conducted within the zone of residence of the motorist and he is usually familiar with the area. Also, such zones generally abound in service stations. The conclusion is that these incidents are principally due to negligence, lack of foresight, and lack of attention on the part of the driver. Consequently, stations even at 1-mile intervals would not guarantee that this part of the problem would be solved.

There are, however, conditions beyond the driver's control, which may leave him without fuel on the rural portions of the Interstate Highways. One of these occurs when stations close down for the night because of the low level of demand. This has been observed not only at stations immediately adjacent to the Interstate Highway, but also at stations removed therefrom; thus, the motorist runs the

risk of being stranded off the main highway with his chances of receiving aid quickly considerably reduced, since secondary roads have fewer passing motorists who might help, and fewer patrols.

The other situation occurs on low ADT Interstates with already infrequent GAS availability (20 miles, average). If only two such stations in a row close for the night, the motorist whose normal range is 250 miles, must refuel before he gets down to ¼ full.

The reasons for the stations closing are economic. There simply is not sufficient demand during the night in the rural areas to offset the cost of the attendant wages.

In summary then, it can be stated that the gasoline availability may become a problem in rural areas and at night. The frequency of stations is adequate, but the actual ability of the motorist to obtain the needed commodity is sometimes lacking. The other problem lies with the signing; it is small comfort for the motorist in need of fuel to be directed to a station via standard signs and find a dark, closed establishment. Furthermore, for the stations not directly adjacent to the main highway, he is not informed of the distance to the station—sometimes not even after he exits. Furthermore, he is not informed of how far the next station is along the main highway.

To investigate this aspect, the calculations in Appendix F were performed and plots prepared. These plots show the availability of gasoline on 10 different facilities in terms of the expected distances between them (Figure F-1). They indicate, for the various facilities, the likelihood that the motorist may find himself more than some chosen distance from a service station. Referring to several of these plots, it can be seen that the various facilities exhibit quite diverse characteristics. For example, on I 80, between Oakland/Vallejo and Sacramento, the probability that a motorist will be in a segment of more than 10 miles between gasoline available exits is only about 0.22; conversely, the probability that this distance is 10 miles or less is about 0.78; but that it is 5 miles or less is only about 0.14. Thus, the probability that he is in an interval of 10 miles or less, but more than 5 miles is about 0.64 or roughly 2 out of 3.

For another example, refer to the plot for I 10 across the Texas-Louisiana border. It is found that the distance between stations is more likely to be greater than 10 miles.

Food and Lodging

It is difficult to define objectively sufficiency of food and lodgings in the face of the demand shown to exist, since the demand itself is highly subjective (rather than objective) from two directions: the choice of the motorist and the offerings of the food establishment or motel operator.

The former has been shown to have likes and dislikes and preferences for various service types and quality levels. The latter is in business to make a profit.

One could conclude from low business volume or occupancy that the demands at some particular location are more than satisfied; in other words, that there is excess service capacity. This would be true only if each motorist in need of a particular service would satisfy his need at that location. Even if motorists chose not to cater to their need at that location, preferring instead to continue to another location for reasons of their own, the existing demand would be satisfied. This is where competitive merchandising of goods and services comes in and actually serves to create demand. Increase in advertising, improvements in facilities, services and conveniences, competitive pricing, and other inducements for the motorist to patronize the establishment frequently increase patronage—thereby creating additional demand for the particular locality. Conversely, reduction in the level of services or goods, higher prices, and reduction in the effort to bring the establishment to the motorist's attention usually have the opposite effect—that is, the demand is reduced.

Thus, the level of the demand is determined ultimately by the customers' desires. Hence, it must be considered as a matter of choice of services and shall be discussed as such. Since the factors underlying the conclusion (whether the demand is satisfied) are purely economic, the situation at all times will tend to fluctuate. That is, as the potential for additional demand increases (for example through increased traffic levels) at some location, business establishments eager to cater to this demand will move in rapidly. Conversely, as the demand falls off, economic pressures will simply drive the existing businesses out. The former condition can be observed at interchanges of newly built highways through previously less traveled territory; the latter, in the localities bypassed by such new highways.

An example of the latter situation exists on US 1. This was the major North-South highway before I 95. Gasoline stations and other travel-oriented establishments along many portions of US 1 are doing very poorly. According to a report (*21*), many have closed and those remaining are doing 25 percent of their former business. Similar instances were observed elsewhere; examples appear along US 17 in New York State, which (though not an Interstate) is being upgraded to Interstate standards.

CHAPTER FOUR

FINDINGS—SUPPLEMENTAL SERVICES

AVAILABILITY

This section considers the availability of rest areas, choices of quality, quantity, and specific kind of service, service and directional information, advertising, and the effect of the Highway Beautification Act of 1965.

Rest Areas

In line with the prevailing (though not universally enforced) policy of prohibiting parking on the shoulders of Interstate Highways and in recognition of the need for occasional stops to avoid highway fatigue, safety experts encourage the establishment of safety rest areas at regular intervals along the Interstate Highways. The Federal Government provides states with financial aid for the acquisition and paving (though not for equipping) of the rest areas. Finally, the states' desire to contribute to the rest, relaxation, and enjoyment of tourists should be an inducement. Thus, the range of the types of existing rest areas extends from a paved parking area to elaborately equipped, attractively landscaped, picturesquely situated picnic areas established and maintained solely for the pleasure of the auto traveler. Whereas many states maintain rest areas on primary and even secondary highways in addition to the Interstate Highways, the latter are of prime importance here.

In Arkansas there are 25 rest areas, being built, or planned for Interstates 55, 30 and 40 (less than half complete); two are complete on I 55, two are under construction on I 30, one is under construction on I 40, and 13 are in the planning stage (*22*). Two types (A and B) of rest areas are planned for the Interstate Highways. Both are landscaped, have on and off ramps, separate parking for cars and trucks, picnic stoves and tables, trash receptacles, drinking water, flush toilets, and a tourist information center (type A) or a bulletin board (type B) displaying scenic and historical points of interest in the area and the state. The former information centers will be located at the entrance points of the Interstate into Arkansas and be operated by the State's Publicity and Parks Department. Of the 25 such parks, seven will be type A and the remainder will be type B. The State's estimate for all of the 201 planned rest areas (including the preceding 25) is about $5.8 million (*22*).

In California, 254 rest areas are to be built within the next six years, each ranging in cost from $5,000 to $100,000 depending on size and facilities. At the end of 1965, the California Division of Highways had 23 rest areas in operation, 17 under construction, 58 programmed for construction, and 4 programmed for rights-of-way purchase (*23*). Three different sizes are planned; the largest of these will occur in pairs along the Interstate or dual primary highways.

The largest of these will have parking facilities for 20 to 30 cars and 4 to 6 trucks, and have 6 to 8 picnic tables, sanitary facilities, refuse receptacles, paved sidewalks, and, whenever feasible, water and shade trees. All structures will be designed to complement the natural setting (*23*).

Ultimately, all of the rest areas will be spaced so that in combination with other facilities (towns, major interchanges where commercial services are available, etc.) an opportunity to rest will be available to the motorist at intervals of 30 minutes driving time. In addition, stopping places (parking facilities only for a limited number of cars) may be provided at the entrances to cities so that the traveler could legally stop to consult maps (*23*).

In Connecticut and Ohio, safety rest areas offer bulletin boards, public telephones, picnic tables, garbage disposal receptacles, landscaping, parking facilities, and rest rooms. Ohio has night lighting and telephones (heavily protected against vandalism) in some areas. Both states have bulletin boards with state maps and other tourist information; in addition, in Connecticut, businesses catering to the needs of the traveler may advertise with the approval of the State's Development Commission as to content and form. The requirement for such a business is that it must be capable of catering to 12 or more persons and must apply individually for permission to advertise (*26*). Through interviews with motorists on I 90 in Ohio (*27*), shows the motorists highly complimentary about the rest areas. The only suggested improvement voiced by about 35 percent of those interviewed was "improve the rest rooms."

To date, rest areas in Florida consist of parking areas only, spaced 35 to 40 miles apart. However, a major project is underway (at a cost of $850,000) to construct 10 equipped rest areas on Interstate Highways 4, 10, and 75. These will be constructed in pairs and will be landscaped, fenced, have rest rooms, picnic pavillions, and a uniformed attendant in each (air-conditioned) building (*28*).

In Georgia the rest areas contain parking spaces, tables and benches in shade, water (if available on location), grilles and fire wood, rest rooms, and (sometimes) telephones. Such areas are generally about 40 miles apart. Most of the rest areas, however, contain only parking facilities and have an average spacing of 15½ miles.

Rest areas in Kansas have been repeatedly described by motorists as being the most beautiful and completely equipped in the country (Appendix B). There are 11 such rest areas on Interstate 70 spaced about 30 miles apart, though there are stretches of about 40 miles with no facilities (*29*). As of May 1966, a 95-mile stretch of I 70 west from Topeka had six rest areas plus one telephone area. At least two of the rest areas also had phones. By observation, the longest distance between any two of the rest areas was

about 30 miles. The rest areas are usually picturesquely located, landscaped, and include sheltered picnic tables, trash receptacles, stoves and wood, chemical toilets, drinking water (manually operated pumps) and bulletin boards with state-published information. Low-level lighting is available at some areas, telephones likewise (though according to the State Police some of the telephones are being removed because of vandalism). It has been observed that all of these facilities were clean and well-kept; maintenance is handled by the state or local contractors. It was also observed that similarly equipped, though much smaller, rest areas were maintained equally well on smaller roads with ADT's of less than 1,000.

By 1972, Michigan expects to have 98 rest areas on the State's 2,000 miles of freeways; 14 of these, located at entrance points to the state, will also be tourist information centers. Of these, 58 will be on the Interstate System; the remainder will be on state highways. In 1964, 46 were completed and operational. The rest areas vary in size from 8 to 28 acres, 2 to 4 of which are lawns, trees, and shrubs. Facilities include chemical toilets, drinking fountains, telephones, a state map bulletin board, from 5 to 10 picnic stoves, and 20 to 25 picnic tables. Parking spaces are provided for up to 50 cars and 24 trucks. These rest areas cost the state $175,000 per unit (or $190,000 if flush toilets are installed rather than chemical ones). Daily visits and maintenance by an attendant is contemplated at an average annual cost per rest area of about $8000 (*30*).

Interstate 94 in North Dakota has 14 rest areas and two information stations, spaced at 30- to 40-mile intervals. They are equipped with picnic tables, shelters, flush toilets, cooking grills, and informational billboards plus separate parking for cars and trucks (*31*).

Interstate 35 in Oklahoma has three rest areas consisting of parking facilities only. However, it is planned to have five or six pairs of completely equipped rest areas on this stretch (which is somewhat more than 100 miles), including the usual picnic equipment, rest rooms, bulletin boards, telephones, and night lighting. In addition, as more of Interstate 40 is built, rest areas will also be installed modeled after a show piece rest area which is planned for construction near Okmulgee on I 40.

On Interstate 5 in Oregon there are 36 rest areas spaced at intervals of about one hour's driving time. Of these, one has complete facilities, excluding an attended information booth. The others have one or more of the following: paved or shoulder parking area, dry-pit rest rooms, drinking water, and picnic tables. Several more rest areas are planned for I 5 and some construction is in progress. All of these will have modern rest rooms with running water and telephones. A pair of such rest areas will cost about $0.5 million. Informational bulletin boards may be included with state maps, and information similar to that available on the Ohio Turnpike pertaining to nearby services.

In Texas, safety rest areas are known as roadside parks and are signed as such. They are landscaped and contain picnic tables and fireplaces. There are no rest rooms, water, lighting, or telephones. Water and toilet facilities may be added in the future. On I 10 east of Houston, about five rest areas were observed at 30-mile intervals. In addition, there is a Texas Tourist Bureau at the Texas-Louisiana border.

In Virginia on I 95 (but excluding the toll Richmond-Petersburg Turnpike) there are currently four rest areas, two for each direction of travel. Five more are proposed (three for Northbound and two for Southbound traffic). The existing rest areas have parking for trucks and cars, drinking fountains, rest rooms, picnic tables, trash receptacles, and bulletin boards with state maps. Telephones are available at some of the sites.

In Nebraska as of September 1965, there were eight functioning rest areas on Interstate 80 (four in each direction of travel). By the time I 80 is completed in 1972, it is planned to have 14 pairs of these rest areas with an average spacing of 30 to 35 miles. These areas (both existing and planned) are completely equipped, landscaped, and universally have water, heat, lighting, and telephones. Some sites (near state lines) will have weigh stations for trucks and information centers (*32*). Some sites also have 24-hour restaurants and 24-hour attended gasoline stations, contrary to the provisions of paragraph 111, Title 23 of Public Law 85-767, 1958. It is assumed that they are on incomplete portions of the Interstate System.

In Wisconsin as of March 1966, there were five facilities along I 94 and two along I 90. Four of the five on I 94 were upgraded versions of parking areas. The State's standards for rest areas call for them ultimately to be fully equipped, to have lighting, flush toilets, etc. Six additional sites are planned between Milwaukee and Madison conforming to the new standards (*33*).

In the State of Washington, 35 sites for rest areas along the Interstate System (I 5 and I 90) are proposed. Their design is to conform to the AASHO "Policy on Safety Rest Areas for the National System of Interstate and Defense Highways." The areas are to be spaced at intervals of 25 miles or a half hour's driving time in each direction of traffic, this spacing shall be considered secondary to the natural advantages of a site such as the availability of water, adequacy of drainage, trees, and enough space for on and off ramps and parking to meet safety requirements (*34*). In addition, view points, or places where a motorist may pull over and park briefly to enjoy the scenery shall be provided at selected locations. If any of these is found to be used by a high volume of traffic, they may be converted to actual rest areas, with all the facilities (*35*).

In a study conducted at the University of Washington in 1962 it was recommended that safety rest areas contain informational billboards and/or manned information booths (*36*).

Signing: Official and Advertising

Directional signs along the Interstate Highways conform to the AASHO standards in colors, size, and type of legend. The deviations encountered are principally in the amount of information presented, and sometimes in the placement of signs relative to the roadway. Since the directional signing is not of primary interest to this effort, no detailed discussion will be entered into, except for a few general observations. Some of the differences found in various states

are due to the nature of the Interstate Highways observed; where an existing highway is being upgraded to interstate standards, some signs previously used still remain (examples are US 77 to I 35, US 40 to I 80).

Differences in signing for services are much more pronounced, as was previously indicated by the differences in signing for gasoline. In the various states that do sign for services, there are no uniform criteria as to when and how to sign for services. For example, in Texas it was pointed out that ". . . the term Business Route is self explanatory . . ." along I 35. In California, signs announcing a roadside business were observed, and elsewhere a variety of signs were seen such as "Tourist services this exit," and similar other legends. In states where services are signed for by the gas-food-lodging signs, no notification of "next gas—xx miles" was given as is done on many toll roads.

Billboard advertising, on the other hand, can be found at this time along the vast majority of the Interstate mileage, and other major roads as well. Conspicuous exceptions are some state parkways and some toll roads that are a part of the Interstate System that control roadside billboard advertising directed at their facilities (example: New York State Thruway). The reasons for control are, in part, considerations of: (1) safety—since billboards are considered to be distracting to the driver, and (2) the provisions of the Highway Beautification Act of 1965.

The degree to which billboard advertising along highways—particularly Interstate Highways—is controlled by the states shall be examined in somewhat more detail further on. At this point, it should be observed that billboard advertising services generally present all of the essential information that the motorist wants. They are first informed of the type of gas, how many miles away it is, the exit, and the town. If the gasoline station is operated in conjunction with a restaurant or diner, there may be additional notations indicating the service type and hours of operation.

Much billboard advertising is unrelated to highway users' services. Undeniably, many scenic vistas and stretches of highway are overburdened with outdoor advertising displays.

The Highway Beautification Act of 1965 (HBA)

The effect of the HBA, if implemented by the states, will be to remove nearly all outdoor advertising from within 660 feet of the highway; notable exceptions being on-site advertising and zoned or unzoned industrial or commercial areas where such advertising may be permitted by agreement between the respective state and the Secretary of Commerce. It should be noted that about ¾ of the Interstate system mileage is not generally adjacent to such areas, being predominantly rural in nature—which is precisely where the services problems are found to be most pronounced. The Federal Highway Act of 1958 encouraged the states to effect control of roadside advertising along the Interstate Highways by offering bonus funds amounting to 0.5 percent of the Federal share (90 percent) of the state's applicable Interstate Highway building expenses. The bonus was based on the state entering into an agreement with the Secretary of Commerce to adhere to the provisions of the act—specifically, Section 122. As of 1965, 25 states had entered into such agreements; this would apply the provisions of the section pertinent to roadside advertising to about 44 percent of the total Interstate mileage.

The HBA, however, applies to all of the Federal Aid highways, including the Interstate, and it provides for possible penalties for nonimplementation through the withholding of a portion of the state's Federal Aid funds.

During the hearings held in the winter of 1966 in each of the states, the outdoor advertising industry and representatives of independent businesses (as opposed to chains) tended to reject the provisions of the act as being too restrictive and potentially disastrous to their livelihood.

An inventory of about 350,000 roadside signs in 14 states has resulted in a distribution of such signs as to their primary intent (Table 10). The table breaks down the traveler-service-oriented signs and lumps those that are not service oriented. It can be seen that about 32 percent of the signs are service oriented.

Sections of Interstate have been observed where billboard control has been exercised by the states; this was witnessed by skeletal remains of billboards near the right-of-way and the new large, usually illuminated, billboards beyond the 660-foot limit. However, because the costs of such billboards and their installation and lighting can be high, only the major nationally known business establishments were represented (for example, Howard Johnson's).

TABLE 10 *

DISTRIBUTION OF HIGHWAY SIGNS

TYPE OF ADVERTISER	% OF TOTAL
Highway-Traveler Oriented	26
Motels and Hotels	13
Food and Drink Establishments	4
Tourist Oriented Businesses and Services	2
Tourist Attractions and Recreation	4
Other Roadside Businesses	3
National Brand Advertising	26
Petroleum Industry	6
Others in this group include the automobile industry, food products, soft drinks, alcoholic beverages, tobacco products, etc.	
Local	33
Including insurance, financial and credit, agricultural supply, churches and religious messages, nonbusiness organizations, automotive retail, and other local business	
Miscellaneous	15
This includes public services, undetermined blank billboards, and others	

* From Mr. F. Thiel, BPR.

The proposed signing standards for services (separate, multicolored signs for the gas, food, lodging types of services) are intended to give the motorist sufficient service information. Only singular examples of such signs are in existence at this time and their effectiveness and success is yet to be determined.

An additional source of information available to the motorist on the Interstate Highways can be found in safety rest areas, usually in the form of state-published maps, directives, tourist promotional material for the state's facilities, etc. Some states maintain manned information booths at such rest areas near the state's boundaries.

A further source of information available to the motorist is maps published by major merchandisers of roadside services—for example, some oil company maps contain their brand symbols along the main highways wherever their stations are located. Similarly, major restaurant/motel chains (Howard Johnson's and Holiday Inns) publish their own maps with all of their facilities listed, directions how to get there, etc. Such maps are generally available free.

Telephone

A telephone is considered an emergency need in cases of trouble; yet is considered a normal necessity when needed for information or to confirm a reservation; and it is considered a supplemental need when the motorist's inability to use it will not cause him any serious hardship.

There is generally no uniformity in the placement of telephones along the Interstate Highways. However, it must be considered a certainty that any normal service facility will have a telephone. In addition, telephones are available at many existing safety rest areas and will be available at those being built or planned by the states.

Pay telephones in safety rest areas along major highways and on the shoulder of suburban, otherwise uninhabited intersections are becoming more prevalent, which testifies to their producing sufficient revenue to justify their existence. The chief problems associated with these remote telephones are: (1) vandalism, and (2) the costs of installation. Vandalism is the primary reason that telephone companies are reluctant to install telephones in remote locations. In California, there is a case on record where the entire telephone booth was stolen. Instruments are being constantly stolen and damaged. It was noted that the telephones in the rest areas on I 90 in Ohio were encased in heavy-gauge steel cages, which in turn were firmly attached to the structure of the shelter. A relatively new development observed in several locations in New York State are stand-up units where one or more instruments form a part of an integral inverted-pyramid-shaped structure on a pedestal.

On the rural sections of the Interstate Highways, particularly in the less densely populated areas where the traffic levels are relatively low (less than 8,000 or 10,000 ADT), it can be safely assumed that the availability of public telephones is largely equal numerically to the availability of all of the other services plus (in states where phones are included in rest areas) rest areas.

Choice of Services

The outskirts of cities provide the motorist with many choices of gasoline, restaurants, diners and drive-ins. In rural areas, the approach is different because the available services are spread out. The available gasoline station may be brand "X" and the motorist desiring this brand runs the risk of not seeing another brand "X" station for many miles. Hence, even though he may still have enough gas to go on for an hour or so, he would be wise to fill up. Conversely, he may be near empty as he approaches a brand "Y" station. Being unfamiliar with the highway, he would be wise to fill up with brand "Y" in preference to running out of gas.

In showing the availability of gasoline stations in terms of mean distances between successive stations, only the availability of gasoline itself was considered. For example, on I 94 in Michigan, the average distance was found to be 4.2 miles. A motorist with a specific preference for Texaco, for example, would travel an average of 15.7 miles between stations of this brand; Enco averages 18.1 miles; Standard 16.9 miles, Sunoco 21.6 miles, Phillips 66 24.2 miles; Mobil 26.1 miles; Shell 37.3 miles, Sinclair 39.6 miles; and Gulf and American 43.1 miles each.

DEMAND

The nature of the supplemental services is such that the demand can be best gauged by the actual usage of such services as they are available, and by the subjective preference of the motorists. Therefore, an indication of this demand shall be based on usage studies of rest areas performed previously in several states, and on the results of the over-all questionnaire, which contained several questions pertaining to motorists' desires, preferences, and habits.

Rest Area Usage

The following determination of demand by usage will be based principally on two studies: Oregon and Nebraska (*32* and *37*), plus several items of information from other states.

The Oregon study involved seven rest areas on sections of US 99 and US 30; these were somewhat lacking by the modern Interstate rest area standards in terms of facilities, ease of access, and capacity. The Nebraska study involved six modern rest areas, completely equipped, though data from only two was used, since the others had features that made them atypical.

The Oregon study (*37*) indicated that the ADT on US 30 was 3,418, of which 4.1 percent entered the rest areas. On US 99, the ADT was recorded as 6,829 and the percentage entering was 2.0 percent. The reason for the higher entry rate on US 30 is believed to be its more remote character (hence, longer ATL due to lower proportion of local traffic). For all of the rest areas, it is found that the rate of entry increases somewhat proportionately with the remoteness—which is synonymous with decreasing ADT and increasing ATL. This inverse relationship is substantiated by a study in Michigan (*30*) and the Nebraska study (*32*).

In the latter, rest areas on a highway section with an ADT of 2,628 had an entry rate of 2.9 to 4.0 percent; for a rest area where the ADT was 1,406, the entry rate was 5.4 to 10.6 percent.

Contributory reasons for the poor entry rate in the Oregon areas were given as poor access, availability of alternate stopping places nearby, and overcrowding. The latter would seem to indicate that (at least at times) the rest areas were used to capacity, and that at the time they were under-designed. Table 11 lists the entry rates in rest areas of several other states for comparison:

TABLE 11

ENTRY RATES

STATE	%
California	2.4
Ohio	12
Georgia	2.5
Michigan	12
Tennessee	4
North Carolina	3
North Dakota	1.2
South Dakota	1
Virginia	3.8
Nebraska	5.7

Another reason is suggested for Oregon's low rates of entry: most of the states with high rates have the most complete facilities at their rest areas (Ohio, Michigan, Nebraska), including bulletin boards (Ohio and Michigan) and night lighting (Ohio and Nebraska). A 1961 survey conducted by the Ohio Department of Highways indicated that rest area entry rate increased from 8 to 12 percent when the night lighting was installed; 75 percent of motorists interviewed stated they would not have stopped (during hours of darkness) had there been no lighting (*37*). Entry studies in Ohio during the summers of 1959 and 1960 gave entry rates ranging between 6.5 and 17.4 percent—all consistently higher than those in Oregon. Studies of entry rates at five fully equipped rest areas in North Carolina yielded rates of entry of 5.5 percent for cars and 7.6 percent for trucks.

It is expected that new rest areas on Oregon's Interstate System will have entry rates substantially higher than the 2.9 percent recorded on US 30 and US 99. First month's operation of a new rest area showed a 5-percent entry rate compared with the previous 2 percent for the old rest area in the same location on US 99 (*37*).

To ensure adequate peak demand facilities, the peak period in Oregon's study was found to be between 11:45 A.M. and 12:15 P.M., with an over-all peak enterance during the same period of 5.2 percent of the day's total (the range was from 3.4 to 8.4 percent for the various rest areas). The differences between individual areas appeared to be due to the predominant cause for stopping: in areas with higher peaks, motorists stopped most frequently to eat (40 to 50 percent), and secondarily to use rest rooms (9 to 15 percent). Areas with lower peaks, on the other hand, indicated that use of rest rooms as the prime reason for stops (28 to 35 percent) and eating secondary (about 30 percent). Similar, though numerically higher, peaks were recorded in the Nebraska study (*32*), where peaks of 13 percent to about 16 percent were encountered. It was interesting to note that the westbound peak occurred between 12:00 noon and 1 P.M., but the eastbound peak occurred between 1 and 2 P.M. This is believed to be due to the fact that eastbound traffic originates in a different time zone and, hence, gives cause to the peak entry at the rest area between noon and 1 P.M. Mountain time—hence, 1 to 2 P.M. Central time.

The Oregon study also isolated the magnitude of the peak 5-minute period to be 6.8 to 10.1 percent of the daily total, averaging 7.9 percent for all the areas studied. This peak is perhaps a useful indicator of the parking spaces that should be provided. Furthermore, since some of the entering traffic consists of trucks, an allowance must be made for their greater space requirements. Table 12 illustrates the mix of the entering traffic and compares it with the mix of the passing traffic (based on both the Oregon and Nebraska studies).

In Oregon, the percentages of the mix were found to be similar at the various rest areas, though the percentages entering related to the ADT varied. Again, the low percentage of trucks is accounted for by the poor entrance/exit configuration of the old areas. A 1-day test on a new rest area gave 5 percent of trucks and buses stopping rather than the original 1.3 percent. A North Carolina study indicated over 7.6 percent of trucks and buses entering. Finally, (*30*) indicated that in Michigan 30 percent of the traffic entering was commercial.

The occupancy of vehicles entering the rest areas in Oregon was noted and averaged to be 3.0 persons; this is significantly higher than the (then) Oregon state average of 2.1 to 2.4 persons per vehicle. Little variation was found in the occupancy between the various rest areas, indicating no particular relationship to ADT or ATL. The Nebraska study showed an average of 2.5 persons per vehicle using the rest area, and a 1958 Montana study of out-bound tourist parties gave a figure of 3.1.

The conclusion would seem to be that rest area stops are made more by family groups and, hence, are predominantly on pleasure-oriented trips. There is evidence that smaller parties stop at rest areas as well, because the average occupancy at Oregon's National Parks is five persons per car, which is substantially higher than the average occupancy of rest area stops.

Examining the stop purpose by the use of individual facilities, it is found that of motorists entering, 4 to 17 percent did not find the facilities they wanted and they did not stop. Of the motorists stopping, the percentages in Table 13 took advantage of the facilities available.

Note that usage is not equivalent to primary reason for stopping; by interview at the Oregon rest areas, it was found (*37*) that even though 24.8 percent stopped primarily to use the rest room facilities, 63 percent actually

TABLE 12

MIX OF ENTERING TRAFFIC

	TYPE OF VEHICLE	% OF ALL VEHICLES ENTERING REST AREA	% OF THAT VEHICLE PASSING THE AREA WHICH ENTERS
Oregon	Passenger vehicles	85.9	2.8
	Vehicle/trailer coach combinations	8.0	10.6
	Light vehicle—other trailer combinations	4.0	4.5
	Trucks and buses	2.1	1.3
Nebraska	Passenger vehicles	83.5	10.0
	Trucks (including pickups)	16.5	8.9

used them. About one-half the vehicles' occupants actually used the facility.

By interview, it was found that the distance traveled since the last stop was 30 miles or more for 70 percent of the vehicles, 45 miles or more for 61 percent, and 60 miles or more for 45 percent.

To determine the influence of other possible stopping places (cities, exits, state parks, other rest areas), it was found that time and distance between major cities had a strong effect on the stops, but small towns and parks had very little. Motorists questioned at rests on the more developed portions of the highway averaged 75 miles and 102 minutes since their last stop; those at more remote areas averaged 66 miles and 90 minutes since their last stop.

The average length of a rest stop was 43 minutes; 49 percent of the stops were less than 20 minutes and 64 percent were less than 30 minutes. By type, 96 percent of the rest stops averaged 10 minutes or less; eating stops averaged 38 minutes (*32*). However, two of the areas permit overnight stops. Eliminating these, the average for the remainder drops sharply to 27 to 33 minutes. Scenic sites, likewise, have been noted to encourage longer stops, and Oregon has many such scenic sites. In Nebraska, on the other hand, the average length of the stops was 14.4 minutes (*32*).

Signs (61.3 percent) or previous visits (28.0 percent) were found to be the primary means of locating the rest areas.

From the nationwide questionnaire, it is found the most desired facility at a rest area is the rest room—with strong stress on cleanliness as evidenced by the many written-in comments. This convenience is desired by almost 94 percent of the motorists responding. The next highest item is drinking water, wanted by 84 percent. This figure is much higher than the actual percentage usage recorded in both the Nebraska and Oregon studies. Telephones rank next in order of being ostensibly wanted by the motorists with about 66 percent checking that convenience. Picnic tables and night lighting are desired approximately equally by about 55 percent each, and informational aids by 36 percent of those responding.

Again, written-in comments repeatedly indicated that they would like to see conveniences for travel trailers at the rest areas—from dumping stations to overnight parking.

Informational Needs

From the results of the questionnaire, once again, it is interesting to extract an indication of whether the informational media satisfy the motorist's needs. Referring to Figure B-10, it is seen that of the various travel annoyances checked by the respondents, official signs are checked most frequently as a prime annoyance, indicating obvious dissatisfaction. This conclusion is supported fully by the AAA study of their membership (*20*), 62 percent of which listed confusing or inadequate direction signs as their prime annoyance. The other annoyance frequently checked first or second was inept and inconsiderate drivers. Even though this category was not offered as a choice to the AAA

TABLE 13

USE OF FACILITIES

	REST ROOMS (%)	DRINKING WATER (%)	EATING (%)	RESTING (%)	INFORMATION (%)
Oregon	62	59	37.7	21.3	No information available
Nebraska	73.7	55.8	25.9	16.9	27

membership, this category was the one most frequently mentioned under other annoyances.

On the other hand, billboards (advertising) which were offered as an annoyance choice was unchecked most frequently, and checked as the last of the six annoyances suggested next most frequently. This clearly indicates that about two out of three of the motorists responding either do not consider billboards annoying at all, or consider them the least annoying of the annoyances suggested.

Written-in comments, likewise, mentioned billboards repeatedly as being informative, and otherwise useful.

To determine the value of advertising as an information medium to the motorist, several studies were undertaken recently (*9, 10, 27, 19, 38,* and *39*), mostly by means of interviews with motorists, users of services, and businessmen supplying these services for a living.

Thus, (*38*) shows that of first-time users of motorists facilities, almost 35 percent were informed of the facility by roadside signs, with travel guides being second (17 percent), knowledge of the facility third (14 percent), and sighting of the facility itself fourth (12 percent). About 61 percent responded "yes" when asked whether they used outdoor advertising in selecting their lodgings, and 56 per cent answered likewise in reference to selecting their food services. About 46 percent stated that they used outdoor advertising in the selection of service stations, with sighting the facility being second with about 28 percent.

It was interesting that (*27*) the motorists interviewed had been exposed to two sections of the same facility, I 90 in Pennsylvania (where there is no billboard control) and in Ohio (where there is). It was found that nearly half did not notice (or know) the difference between the regulated and unregulated portions of the highway; yet, when asked "Should commercial advertising be allowed at all?" only 24 percent answered "yes" and 71 percent answered "no."

(*9*) is somewhat similar to (*38*) because motorists sample is questioned about methods of selecting and locating lodgings and automotive services; the responses are split by trip purpose (business, pleasure, combined), week-end, and week-day. Thus, for example, about 14 percent of business travelers compared with 33 percent of pleasure travelers rely on billboards to select their lodgings; 20 percent of the former and 47 percent of the latter rely on highway signs to locate them. Service stations appear to have to rely more on appearance, since 38 percent of all motorists use this as their primary method of selection versus 27 percent for billboards; only 31 percent of all motorists rely on highway signs to locate their service stations—on-site signs being used by 53 percent. By trip purpose, business travelers select their service station by appearance first (32 percent) and highway signs next (26 percent); pleasure motorists favor appearance more heavily (48 percent) versus billboards (24 percent). In location of the service station, again, the pleasure motorist is more reliant on on-site signs (63 percent) versus roadside advertising (31 percent) than the business motorist who also relies on on-site (47 percent) versus roadside signs (29 percent).

(*19*) explores the attitudes of patrons of several selected Wyoming motels toward outdoor advertising. It is shown that to the question of whether they had found hotel and motel advertising signs useful, about 45 percent responded "very useful" and 40 percent responded "somewhat useful." Respondents who had prior reservations relied less on billboards (33 and 45 percent for "very" and "somewhat useful," respectively) than those who did not (50 and 38 percent, respectively); the latter accounted for about 70 percent of the sample. It is also of interest to note that about 82 percent of the respondents were first-time patrons. To determine the effect of outdoor advertising on the patrons' choice of motels, the patrons were questioned as to their primary, secondary, etc., means of first having learned about the motel. The responses were somewhat diverse, since one of the four motels surveyed was chosen primarily from a travel guide or directory, one was chosen primarily because of prior knowledge of its existence, one primarily due to its appearance from the highway, and one because of roadside advertising. However, when considering the first and second choices in the selection, highway advertising appears as a means of selection in 3 of the 4 motels—and misses out on the fourth by a small margin to "personal recommendation."

Asked how the patrons selected their motels, appearance was the chief factor, numerically, for all respondents and amounted to about 29 percent compared with 38 percent for (*9*). In addition, the respondents were questioned on their assessment of the usefulness of billboards as related to various services or products which they might advertise. The percentage distribution of responses is tabulated in Table 14.

Two additional tables distinguish between respondents reacting favorably toward billboard advertising (about 34.2 percent) versus those who do not. Of the former, 62 percent favored such advertising, about 15 percent stated that outdoor advertising is useful because it breaks monotony, and almost 14 percent favored it because it provides information on facilities or services. Of the latter, about 47 percent were unequivocally opposed, and about 26 percent gave "ruins scenery or natural beauty,—mars landscape" as a reason.

The largest group (44.2 percent) was ambivalent in their opinions. Almost 11 percent indicated that "Signs for services, or facilities are necessary; signs for products are not."

(*10*) also surveys a number of motel patrons inquiring into the reasons for their selection and location of their motels. The results distinguish between motels relying heavily on outdoor advertising versus those that do not. Table 15 tabulates answers to the questions of whether the motel patrons had difficulty locating motorist services.

Choice of Services

The results of the nationwide questionnaire in Appendix B clearly show that 77 percent of motorists prefer to use the brand of gasoline to which they are accustomed (*12*) corroborated this with a figure of 74 percent. The questionnaire also indicates that there is a range of prices which people wish to spend for their meals and lodgings, and thus that they prefer various types of service and levels of comfort.

To some extent, this variety of tastes tends to encourage

TABLE 14

USEFULNESS OF BILLBOARDS VS SERVICES

OPINION OF USEFULLNESS	MOTEL AND HOTEL (%)	RESTAURANT (%)	SERVICE STATION (%)	TOURIST ATTRACTION (%)	SCENIC ROUTE (%)	NATIONAL ADVERTISED BRAND (%)	BILLBOARDS IN GENERAL (%)
Very useful	45.3	35.1	42.8	25.4	23.4	14.2	18.1
Somewhat useful	40.0	40.7	26.6	38.0	32.7	21.3	52.2
Not at all	10.2	15.0	20.2	23.4	31.8	50.6	18.0
No answer	4.5	9.2	10.4	13.2	12.1	13.9	11.7

clustering by the competing businesses catering to the traveler. Thus, aside from the advantages of location at the trip-generating/trip-terminating points, the traveler/tourist is likely to continue on to such an area knowing that he will most likely find a choice of facilities there, rather than settling for a single establishment, for better or for worse, somewhere in the country.

It was seen that the percentages entering the rest areas trip length preceding the stop—hence, the over-all trip length, and the purpose of the trip. (*40*) not only provides an interesting insight into this aspect, but also substantiates some other (travel habit) related trends observed earlier.

(*40*) shows that there is a slight difference (between business and pleasure trips) in the average trip length for longer trips; about 85 percent of all the trips are of 1 hour duration or less; at this point, a recreational trip is likely to be about 3 percent longer than a work trip. About 97 percent of all trips last for 2½ hours or less and the difference between work and recreational is down to about 1 percent. On the other end of the trip length spectrum, about 50 percent of the trips last for 15 minutes or less, beyond which point the percentage of work trips versus recreational goes up rapidly.

Several other concepts potentially useful to this study are presented in (*40*). For example, it is shown that the traffic spatial distribution relative to the population centers at the end points of a road segment is such that the low point occurs between the two, but closer to the smaller population center. An empirical formula is developed relating the zone population to the number of external trips generated per person external to the zone. Peak travel periods are defined, and a number of other items pertinent to car ownership, average occupancy, relation of travel habits to income, etc., are discussed.

Many of these concepts may be found useful in defining the expected demand for any services needed in some particular location. For example, very high ADT's and low ATLs would denote (in accordance with the preceding) mostly work trips as opposed to recreational trips and, hence, comparatively little demand for elaborate traveler-oriented services.

TABLE 15

DIFFICULTY IN FINDING SERVICE

TYPE OF SERVICE	YES, HAD DIFFICULTY (%)	NO, NO DIFFICULTIES (%)	NO ANSWER (%)
Motels	7.7	85.4	6.9
Restaurants	10.9	79.9	9.2
Gasoline stations	3.4	86.4	10.2

AVAILABILITY AND DEMAND COMPARED

Comparison in three general areas shall be discussed briefly: rest areas, informational needs, and the choice of services.

Rest Areas

The section dealing with the demand for rest area facilities has established the features needed in a rest area to satisfy motorists' stated and apparent needs. They could be summed up in one word: *completeness.* Rest areas conforming to the standards promulgated in (*41*) will fulfill these conditions in terms of facilities, layout, access, recommended spacing, etc. and satisfy the needs of the majority of the motorists.

This has been shown to be true by the considerably increased use of rest areas resembling those suggested in the AASHO Policy Statement (*41*) as opposed to those which are lacking in space, access, comfort facilities, shade, water, etc; or which are not properly kept up to high standards.

In the availability section, it has been established that apparently the majority of states are taking steps to improve existing areas, and to plan and build new ones. Not all of the presently existing areas are up to the standards of (*41*); however, more of them appear to be approaching those standards or have plans to do so in the future.

The nationwide motorist questionnaire has likewise confirmed that the principal features wanted in rest areas are those recommended by (*41*).

In addition, however, a sizeable number of motorists responding to the questionnaire desired trailer accommodations: parking for trailers, dumping stations and even overnight parking. Other questions not related to the rest areas

directly, likewise indicate that there appears to be a sizeable segment of the traveling public taking to the road with trailers. As of this writing, no such facilities are known to be provided or planned for in the Interstate Safety Rest Areas.

Some states are considerably ahead of others in the number and quality of the rest areas that they provide; of these by observation and motorist comment via the questionnaire, those in Kansas appear to be among the best.

For reasons of economy it is entirely feasible to provide median rest areas serving both directions of traffic in lower ADT areas. The low ADT will make the adverse effect of left-hand exit-entrance ramps quite tolerable, and allow rest areas to be available at realistic intervals to the traveling public at half the cost of equivalent rest areas serving unidirectional traffic. Such rest areas are provided, for example, in Kansas and in other states where advantage can be taken of wide, naturally landscaped medians.

Informational Needs

Whereas it is not the purpose of this study to consider official (directional and informational) signing, it was noted in the section on availability that consistency in signing, both directional and informational, was lacking on the Interstate Highways in the various states. This inconsistency seems to be contrary to the primary intent of the Interstate System: ". . . within the continental United States . . . to connect . . . the principal metropolitan areas, cities and industrial centers . . ." (*42*): this definition clearly implies an encouragement for intercity, intermetropolitan area, interstate travel by automobile. Hence, the interstate traveler is expected to be exposed to signing in various states, and the interpretation of various signing philosophies should not be left to him. The motorist is not satisfied with the existing signs. This is evidenced by the fact that official signing is designated as the prime annoyance on the highways in responses to nationwide questionnaire.

An entirely different picture exists (at this time) in the presentation of service information; except for some singular examples, most states at this time restrict their service signing at most to GAS, FOOD, LODGINGS. The motorist, on the other hand, through his responses to the questionnaire has clearly indicated that he wants more detailed information: brand name, distance from highway, etc. He gets much of this information at this time through commercial outdoor advertising, still prevalent along a substantial part of the Interstate System. He does not particularly object to billboards, especially as they satisfy his informational needs for services. Objections are generally voiced against nonservice-oriented billboards.

There has not been enough experience with the new services (official) signing to assess their potential success if they were adopted uniformly throughout the Interstate System. However, because of motorists' desires in terms of services (specific brands, names) and service information (distances, directions, availability), it is not believed that the proposed standards will be adequate. They will not inform the motorist of: (1) the next services, generically; (2) next services, of the type he seeks (3) the standards for the signing (these apparently may vary from state to state and even within a state).

Along stretches of the Interstate in states that have removed billboards within 660 feet of the right of way, large billboards can be found occasionally beyond the 660-foot limit (for example, I 90, Ohio). Because of their cost, however, they are for the most part limited to large, well-known establishments such as Howard Johnson's. They also frequently present information for several of the advertiser's units, often 50 miles and more distant, which exceeds the 12-air-mile limit of the Draft Standards.

In summary, therefore, it appears that: (1) present official service signing is lacking in uniformity and detail desired by the motorist, and (2) the existing signing is complemented by roadside advertising. Implementation of the Draft Standards (it is believed) will be a considerable improvement on the present official service signing, but will not equal in informative value the sum total of service information presently available to the motorist via official signs and roadside advertising.

Choice of Services

Through the nationwide questionnaire and a number of references quoted in conjunction with the applicable services, it is clear that the motorist has specific likes and preferences. Brand loyalty certainly exists. Differences also exist in the amount of money that various motorists wish to spend for the various services, in the degree of comfort, and amounts of frills that they want and are willing (or not willing) to pay for. These differences can frequently be related to trip purpose, age of motorist, motorist's region of origin, occupation, etc.

These various demands are catered to amply in the urban and near-urban areas, which abound in clusters of services vying for the motorist's patronage. In driving through many such clusters, it was impossible to record orally all of the service stations, motels, and restaurants and their location on magnetic tape—this indicates the density of such clusters. It is not so, however, in the rural portions of the Interstate, nor will it ever be. It was shown that the relative scarcity of services in rural areas is based on the existing demand being concentrated in the clusters and specifically based on the competitive marketing practices of offering a choice to the motorist. The reduced level of demand in rural areas does not economically support a multitude of services for the few motorists to choose from. Therefore, in any given location his choice is sharply reduced. Thus, the motorist who travels with a single gasoline credit card and little or no cash may find himself in an embarrassing position with his brand of gasoline unavailable.

CHAPTER FIVE

AREAS OF IMPROVEMENT

Thus far, the following areas have been indicated as requiring improvement:

1. Emergency service in rural areas,
2. Availability of gasoline,
3. Presenting service information.

This chapter suggests methods for implementing these improvements. Also, it is believed that driver education is essential to reduce the emergency service demand, foster safety, and improve the efficiency of the highway system.

IMPROVING PATROL CAPABILITY AND EFFECTIVENESS

More Effective Patrol

It has been shown that on the rural stretches of the Interstate System, which comprise almost 75 percent of the total system, the density of the patrol effort is quite low. This is largely due to personnel limitations. Therefore, it would be desirable to devise a means whereby more miles of highway could be surveyed by fewer patrol personnel with greater frequency. It is suggested that on long, sparsely settled sections of the Interstate network this could be best accomplished by using aircraft patrols.

Such patrols are presently used in some states on a limited basis, and have been used experimentally in others, Illinois, California, Oklahoma, Kansas, for example; used mostly for speed limit enforcement. Aircraft do not obviate the need for the highway patrol vehicle; rather, they supplement and extend its capabilities.

The chief drawbacks of the road patrol vehicle are its relatively low speed potential and inability to oversee more than a small portion of the highway at a time. An aircraft overcomes both of these handily: it can cruise well in excess of 100 mph, afford the patrol personnel a view of several miles of highway at a time, and sometimes, of several parallel highways, or crossing highways.

Aircraft patrol also has disadvantages: adverse weather, darkness, and the inability to land at the roadside. (*43*) reports on the use of light aircraft in the patrol of some desert area highways in California. Ordinary light aircraft were used with the pilot-observer flying up to about 6 hours in 2 or 3 installments.

In recent years, the Short Take-Off and Landing type aircraft (STOL) have been found to be much more suitable for such a task. They can take off and land in extremely short distances from unprepared fields and cruise at speeds as low as 30 to 40 mph and as high as 150 mph. Table 16 gives the salient characteristics of 13 such aircraft, varying in size, carrying capacity, endurance (range), price, and country of origin.

The STOL qualities would allow the aircraft to be landed on most any moderately flat field adjacent to the highway, most requiring less than 1,000 feet. Since much of the rural Interstate network that would benefit from such patrols has relatively low ADTs (compared with urban areas), landings could be made on the median or even on the highway itself.

In this manner, considerably quicker contact with the motorist in need of aid could be made, and if emergency aid were needed urgently, it could be supplied almost immediately after detection. To communicate that need, flashers, banners, conspicuous signs, or some other visual means would have to be devised. A limited-range radio beacon could also be considered. If the need were nonurgent, the aircraft could instruct a ground vehicle to proceed to the scene to render the needed service.

A beneficial side effect of such an operation would be that the ground vehicle would no longer be used for routine patrolling. Rather, it would proceed to wherever it was needed as directed by the aircraft; thus, reduced wear-and-tear on the vehicle would be added to the advantage of rapid detection.

(*6*) has considered the use of aircraft in the detection of disabled vehicles and recommended the use of aircraft as potentially useful for that purpose. Several hypothetical highway situations were analyzed, and the use of aircraft was found advantageous and priced comparably with other detection means (particularly for the rural cross-country facility).

It is suggested, therefore, that a detailed operational study be conducted to determine the potential operational effectiveness and cost effectiveness of several types of aircraft operating in conjunction with varying numbers of ground patrol vehicles on rural facilities of various lengths. Response times, manpower requirements, initial and operating costs, and any fringe benefits as well as problem areas should be explored in detail.

Improved Capability of Ground Patrol

It is suggested that, on the rural and remote portions of the Interstate network, the State Highway Patrol vehicles be properly equipped, and the State Highway Patrol personnel properly trained and instructed to render all emergency services except those requiring an ambulance—in preference to waiting for a service vehicle. Increases in manpower are indicated to prevent a lessening of the primary duties of the State Highway Patrol particularly in states that are presently understaffed. A possible partial solution is a two-man patrol team. One man would be a trained State Highway patrolman whose primary duties and powers would be unchanged. The other person would be trained in supplying emergency services; he would not receive the policeman's training or possess his powers. Many possi-

TABLE 16

CHARACTERISTICS OF STOL AIRCRAFT

MANUFACTURER	MODEL DESIGNATION	PRICE [a] ($)	DIMENSIONS				WEIGHT (LB)		PASS. CAP.[b]	PERFORMANCE						POWER PLANT
			LENGTH (FT)	WING SPAN (FT)	HEIGHT (FT)	WING AREA (SQ FT)	EMPTY	GROSS		SPEED (MPH) MAX.	SPEED (MPH) BEST CRUISE	FUEL CAP. (GAL.)	ENDURANCE AT BEST CRUISE (MI)	STOL DIST. (50 ft) T.O.	STOL DIST. (50 ft) LANDING	
Wren A/C Corp.	Wren 460 [c]	31,875	27.3	36.6	9.0	175.4	1680	2800	4	160(sl)	153(75%)	84	1170	590	610	1 Continental O-470-R at at 230 hp
Helio A/C Corp.	H250 Courier MU2 [d]	33,900	31.5	39.0	8.8	231.0	1890	3400	6	167	133	60(120)	534(1167)	660	493	1 Lycoming O-540-A1A5 at 250 hp
	H295 Super Courier	38,980	31.0	39.0	8.8	231.0	2010	3400	6	167	150	60(120)	580(1270)	495	193	1 Lycoming GO-4XO-GID6 at 295 hp
Dornier-Werke DmbH (Friedrichshafen)	Do 27 H-2 [e]	N.A.	32.5	39.4	9.3	208.7	2700	4080	5–6	165(sl)	132	53	510	738	640	1 Lycoming GSO-480-B1B6 at 340 hp
	Do 27 Q6	N.A.	31.5	39.4	9.3	208.7	2490	4080	5–6	152(sl)	131(75%)	58	800	968	640	1 Lycoming GO-480-B1AG at 270 hp
Maule A/C Corp.	M-4 Jetasen [f]	10,425	22.0	29.7	6.0	152.5	1100	2100	4	157	130–150	42	750	1100	800	1 Continental O-300-A,B at 145 hp
	M-4 Rocket	13,995	22.0	29.7	6.0	152.5	1190	2100	4	165	130–150	42	750	585	600	1 Continental IO-360-A at 210 hp
Fairchild Hiller	Porter	N.A.	33.5	49.8	10.5	306	2360	4320	4–6	145	135	—	750	—	—	340 AP Lycoming GSO 480 at 350 hp
	PC-6/BH 2 Heli-porter (Turbo Porter) [g]	104,000	36.0	49.8	10.5	310	2340	4850	8	174	157	128	—	640	540	1 UACL PT6-A20 at 550 eshp
	PC-6/C-H2 Heli-porter (turbo Porter)	95,000	35.8	49.8	10.5	310	2460	4850	8	174	157	128	—	615	540	1 Air Research Type 311-25D at 575 eshp
DeHavilland A/C	DHC-2 Beaver [h]	50,000	30.3	48.0	9.0	250	2850	5100	8	160	130	95	—	1015	920	1 P & W R985 at 450 hp
	DHC-2 MK 3 (Turbo Beaver	90,600	35.3	48.0	11.0	250	2760	5100	11	163	140(sl)	191	677	1000	870	1 UACL PT6A at 587 eshp
A. B. Malmo (Sweden)	MFi 10B Vipan [i]	N.A.	26.0	35.0	6.6	169	1435	2590	4	146	138(75%)	53	567	—	—	1 Lycoming O-360-A1D at 180 hp

[a] Fly away factory. [b] Includes pilot. [c] This is a modification of a Cessna 182 airframe. See *Business and Commercial Aviation*, March 1966. [d] Note fuel capacity option. Minimum flight speed 31 mph. See *Business and Commercial Aviation*, June 1965. [e] Mil. version of Q6 with auxiliary tanks. Also manufactured in Spain as CASA C127. No. U.S representative. [f] Steel tube, fabric covered fuselage, metal covered wing. [g] Excellent performance carrying capability. See pilot report, *Business and Commercial Aviation*, July 1964. [h] Proven large heavy aircraft. No maintenance problems. [i] All metal honeycomb sandwich construction. No known U.S. representative.

bilities exist, including separate patrol vehicles. AAA operates several service vehicles in the desert areas of the Southwest. Similar patrols exist on most toll facilities.

An increase in the patrol effort would have the beneficial effect of having more State Highway Police on-view, simultaneously aiding in their primary task of discouraging crime and allowing them to provide the needed emergency services.

The patrol vehicle, which would be expected to provide service, should be fully equipped with all necessary implements and be capable of pushing or pulling a disabled vehicle. Fire-fighting equipment should be available and the service personnel should have extensive first-aid training. The vehicles and personnel thus supplied and trained should be able to satisfy all of the emergency services except those requiring an ambulance. It should be noted that in areas where ambulance service is not readily available (within 15 minutes or less), patrol vehicles could be modified to accept a litter or station wagons could be used.

Regardless of the methods used, the motorist in need of emergency aid must receive it as quickly as possible. If the patrol density is not sufficiently high to ensure quick detection, then additional means of communicating the need must be devised—electronic, aircraft, etc. (6).

Rotary Wing Aircraft

Although helicopters are quite expensive compared to fixed-wing (light) aircraft of similar load-carrying capacity, their vertical take off and landing capabilities make them potentially very useful where it is impossible to land a STOL aircraft. They are already used by various city police departments, and by radio stations to observe and report on the urban freeways.

Because of their high cost, relatively slow cruising speed, and (relatively) short range, their use for patrol over the long stretches of rural highways is not recommended. However, their demonstrated litter-carrying capability makes them ideal as emergency ambulances. A helicopter assigned to a stretch of highway on a standby basis could drastically reduce the response time of a single land-based ambulance and reduce the time required to bring a victim to a hospital.

Therefore, it is suggested that, in conjunction with the fixed-wing patrol study suggested, a parallel study be performed to evaluate the cost and operational-effectiveness of using a light helicopter, stationed centrally, to perform the functions of an emergency ambulance (to be summoned by a land or aircraft patrol) and to compare this effectiveness to the cost of supplying and/or subsidizing a sufficient number of landbased ambulances to achieve the same level of service.

Table 17 shows the principal characteristics of several helicopters which might be so utilized.

The Cooperative Motorist

Finally, it is suggested that the Good Samaritan instincts of motorists on the highway be exploited to advantage, in an organized and scientific manner. The passing motorist is already instrumental in rendering much aid to disabled fellow motorists. In the rural areas, he is instrumental in

TABLE 17

PRINCIPAL CHARACTERISTICS OF SEVERAL HELICOPTERS

MANUFACTURER	BELL		BRANTLY		HILLER		HUGHES	
Model	47J-2	47G	B-2	305	UH-12E	E-4	269	300
Dimensions:								
Main Rotor Diameter	37'2"	37'2"	23'9"	28' 8"	35'5"	35'5"	25'	25' 3"
Over-all Length	43'4"	43'4"	21'9"	32'11"	40'9"	40'9"	22' 4"	22' 4"
Over-all Height	9'4"	9'4"	6'9"	7' 9"	10'1"	10'1"	7'11"	7'11"
Gross Weight	2,950	2,950	1,670	3,000	2,800	2,800	1,600	1,670
Empty Weight	1,833	1,777	1,020	1,575	1,759	1,813	913	950
Performance:								
Maximum Speed at sea level (mph)	105	105	100	100	96	96	86	87
Maximum Recommended Cruise Speed at 5,000 ft (mph)	91	84	90		90	90	46-52	(economy)
Maximum Rate of Climb (ft per min)	870	880	1,400		1,290	1,290	1,450	
Service Ceiling (ft)	11,000	11,200	10,900		15,200		10,500	14,000
Range with Maximum Fuel at 5,000 feet (mi)	258	295	250		267(500)		200(3.3 h)	
Fuel Capacity (gal)	48	60	30	45	46(86)		25	
Crew/Passengers	1/3	1/2	1/1	1/4	1/2	1/3	1/1	1/2

acting as a communications link to the authorities, highway patrol, or tow service. To reduce the response time, it is suggested that the motorist be supplied with an easy method of transmitting the message of having discovered a disabled vehicle. Some ways in which such a system could be beneficial have been indicated in (*6*). Under a current program, tests are being conducted on several Interstate Highways to determine how passing motorists react to various incidents apparently requiring aid. To report such incidents, they are asked to flash their lights at a designated location. From the records of the rate of reporting, the traffic levels, and the type of incident staged, it is hoped that it will be possible to gauge the potential effectiveness of such a system.

GASOLINE AVAILABILITY

Two factors concerning gasoline availability are essential. First, the motorist must be made aware of the presence of stations by proper signing or other means on the Interstate; second, the motorist must be assured of being able to obtain gasoline upon arrival at the station. This means that the station must be open.

In rural areas, a 24-hour fully attended gasoline station is frequently uneconomical. Therefore, as a possible solution, automatic (self-service) gasoline dispensing should be considered.

Electronically controlled self-service automobile fueling was first tried in Sweden, and has been gaining in popularity ever since. A 1966 study by a British company showed that England had at least 12 self-service stations, Denmark 86, and Sweden 1,187—11 percent of the country's stations (*44*).

There are three basic types of self-service pumps, distinguished by their method of accepting payment. First, there is the coin-operated unit that operates much like any other vending machine: the customer inserts a coin (or coins) and then proceeeds to pour gasoline; the pump will automatically stop. Second, there is the remotely controlled pump: to use it, the motorist pays the attendant/cashier for the amount of gasoline that he wishes to purchase; the attendant actuates the pump (remotely, from his centrally located booth) to deliver the quantity paid for—in this manner the attendant can handle a number of pumps with ease. Finally, there are variations, utilizing special keys, charge cards, identification cards, etc. (none in U.S.); with these, the customer inserts his identifying device into the pump and proceeds to pump any amount he wishes. At the conclusion of the transaction, a duplicate of the charge slip is printed with the amount pumped and the customer's identification and presented to him.

A concept similar to the latter type has been adopted in this country for tank trucks to refill their supplies without an attendant being present (*45*). Also, fuel oil home delivery equipments meter and print the invoice automatically.

Many companies using these automatic self-service schemes also charge less for their product (about $0.02 per gallon)—a strong competitive inducement. The cost of the automatic pumps is higher than standard pumps by a factor of almost 4. One of the foremost manufacturers of automatic gasoline pumps, the Tokheim Corporation, states that their MAD-MAC (trade name) costs about $3,500 opposed to the average cost of an ordinary pump of $954. Other manufacturers: Wayne Pump Company, Bowser Inc., Bennet Pump, Division of John Wood Company, A. O. Smith Corporation (card operated units).

Because the pumps cost more, the gross revenue per gallon is less and the existing establishments are flourishing, we must conclude that the net earnings must be better. The answer lies in the reduced cost of labor; it is estimated that labor represents 50 percent of the cost of dispensing fuel in the conventional manner (*46*).

The problems associated with the immediate introduction of such units are largely legal; of the 50 states, only 10 do not explicitly prohibit automatic gasoline pumps; others permit them if attended. Most cities have ordinances prohibiting such devices. Tables 18 and 19 show the legal status of such installations in the states and some major cities, as of mid-1965.

Undeniably, an attendant would reduce the chances of fire and vandalism, eliminate the out-of-correct-change problem, and instruct customers in the operation of these pumps. However, to keep costs low, the attendant should be unskilled. In each of the 44 GASOMATS operating in the Rocky Mountains in Colorado, the attendant is a semi-retired person who lives on the property. He acts as a guard, change maker, and instructor (*47*).

The American Petroleum Institute advocates that ". . . No restrictions be imposed on the use of 'coin-operated' dispensing pumps except those essential to public safety . . ." (*48*).

In addition, the National Fire Protective Association has revised its standards to accommodate the self-service pumps if they are attended, if there is fire protection within a certain area, and if specific regulations pertaining to the pump and nozzles are met. (NFPA 30, Section 7260, Subsection 7261; Section 7250, Subsections 7251, 7252, 7253.)

By the acceptance of automatic dispensing equipment, it would be possible for any station to extend the availability of its prime product to 24 hours—as it should be, particularly in the rural areas. Automatic vending is already used for a multitude of items, including food, cigarettes, combs, etc.

The restrictive regulations by the states and municipalities (where such exist—see table) are safety oriented. Surely, it should be possible to demonstrate to the authorities that such equipments can be made quite safe; in fact, the manufacturers would be most happy to do so.

It is suggested that the use of automatic gasoline dispensing equipment be considered by the oil companies in areas where traffic levels are relatively low. It is further suggested that the credit card or special key-type system be adopted in preference to a straight coin-operated system. A further possibility is a token which would buy a fixed amount of gasoline—say five gallons. Such tokens or special-purpose coins would be sold by the major oil companies using the system, and be suitably notched/engraved/shaped/or weight controlled to make duplication and forgery difficult. Use of paper money is also possible (*49*).

The acceptance of the self-service gasoline pump by the European motorists should not be disregarded, nor the success of the (so far) admittedly few self-service or modified self-service stations in the U. S.

PROVIDING ADEQUATE INFORMATION ABOUT SERVICES TO MOTORISTS

The foregoing study has shown that the motorist:

1. Wants service information,
2. Wants the information to be complete,
3. Does not object to billboards as an information medium,
4. Is not satisfied with official signing.

Fundamentally, he has indicated that he is interested in more than the generic GAS-FOOD-LODGING classification. He also wants to know the brands of the service available, how far it is from the main highway, and whether it will be ready to serve him when he gets there.

The proposed Draft Standards * will fill a part of these requirements, at a considerable expense. They will inform him of the availability (and the better-known business brand names) of the type of the service. They will not assure him of the service being really available, nor will they inform him of alternate services available perhaps only a few miles further.

Presently, billboards erected by the businesses themselves perform this function along most of the rural Interstate and primary mileage at no cost to the taxpayer. However, with the implementation of the HBA, these billboards may cease to exist. Therefore, as an interim alternative, it is suggested that billboard control be applied principally to nonmotorist-service-oriented advertising.

The motorist is bombarded by a myriad of official signs, particularly when he approaches the urban areas. Addition of service signs will make the situation worse; in addition, the relatively small space allocated to each service represented will make recognition of all but the best-known symbols problematical and conceivably dangerous at the high speeds on the rural Interstate.

It is suggested that service information be presented at frequent intervals along the Interstate Highways. If a service area is not available for some distance (for example, more than 30 miles) identical information could be presented on bulletin boards next to the OFF ramps at selected exits. The presence of such a panel at an exit can be signed with a simple SERVICE INFORMATION legend.

The advantages of providing information in this manner are:

1. *Safety.*—The motorist will be stopped when reading the information. He can read as quickly or as slowly as he wishes and can choose among the information pieces available. He can go back and reread and he will not be trying to absorb detailed information while driving at 60 or 70 mph.

2. *Completeness.*—It is a simple matter to give any amount of information pertaining to service type, hours of operation, prices, how to get there, brand names, special features, and the like. All of these can be confined to a relatively small, inexpensive easy-to-read plaque, standardized in size (a miniature edition of the billboard). In addi-

* Complete title: "Draft of Standards and Criteria for Official Highway Signs Within Interstate Rights-of-Way Giving Specific Information for the Traveling Public;" published in the *Federal Register*, Vol. 31, No. 19, 28 January 1966.

TABLE 18

STATUS OF APPROVAL OF MAD-MAC AND APC SYSTEMS (STATES)

STATE	WEIGHTS AND MEASURES	FIRE
Alabama	Tentative	Prohibits
Alaska	OK H.B. 44, 2nd Edition	Prohibits
Arizona	OK H.B. 44, 2nd Edition	No reply. However a number of installations in state. Cities prohibit.
Arkansas	OK H.B. 44, 2nd Edition	Prohibits
California	Tentative	No state requirements. Most cities prohibit.
Colorado	OK H.B. 44, 2nd Edition	State approved, except city and county of Denver.
Connecticut	Won't issue tentative approval until approved by fire marshal.	Prohibits
Delaware	OK H.B. 44, 2nd Edition	Prohibits
District of Columbia	Must submit model before approved.	Prohibits
Florida	Tentative	Prohibits
Georgia	OK H.B. 44, 2nd Edition	Prohibits
Hawaii	OK H.B. 44, 2nd Edition	Prohibits
Idaho	OK H.B. 44, 2nd Edition	No State requirements. Some cities prohibit.
Illinois	Approved	Prohibits
Indiana	OK H.B. 44, 2nd Edition	Prohibits
Iowa	Won't approve until approved by fire marshal's office.	Prohibits
Kansas	OK H.B. 44, 2nd Edition	Prohibits
Kentucky	OK H.B. 44, 2nd Edition	Prohibits
Louisiana	OK H.B. 44, 2nd Edition	Prohibits
Maine	OK H.B. 44, 2nd Edition	Prohibits
Maryland	OK H.B. 44, 2nd Edition	Prohibits
Massachusetts	Tentative	Prohibits
Michigan	OK H.B. 44, 2nd Edition	Prohibits
Minnesota	OK H.B. 44, 2nd Edition	Prohibits
Mississippi	OK H.B. 44, 2nd Edition	No state requirements. City and county of Biloxi prohibit.
Missouri	OK H.B. 44, 2nd Edition	No state requirements. Most cities prohibit.
Montana	OK H.B. 44, 2nd Edition	Prohibits
Nebraska	OK H.B. 44, 2nd Edition	Must be attended by competent supervisor for self-service. Most cities prohibit.
Nevada	Tentative	Prohibits
New Hampshire	OK H.B. 44, 2nd Edition	Prohibits
New Jersey	Tentative	No reply.
New Mexico	OK H.B. 44, 2nd Edition	Prohibits. However, have heard that coin-operated pumps are installed.
New York	Must make personal contact.	Prohibits
North Carolina	Approved	Test installation in outskirts of Greensboro, N. C.
North Dakota	OK H.B. 44, 2nd Edition	Prohibits
Ohio	OK H.B. 44, 2nd Edition	Prohibits
Oklahoma	OK H.B. 44, 2nd Edition	State requirement—must be attended. Cities prohibit.
Oregon	OK H.B. 44, 2nd Edition	Prohibits
Pennsylvania	Tentative	Prohibits
Rhode Island	OK H.B. 44, 2nd Edition	Prohibits
South Carolina	OK H.B. 44, 2nd Edition	No state requirements. Most cities prohibit.
South Dakota	OK H.B. 44, 2nd Edition	Prohibits
Tennessee	OK H.B. 44, 2nd Edition	Prohibits
Texas	OK H.B. 44, 2nd Edition	No state requirements. Most cities prohibit.
Utah	OK H.B. 44, 2nd Edition	No reply. A number of installations in state.
Vermont	OK H.B. 44, 2nd Edition	Prohibits
Virginia	OK H.B. 44, 2nd Edition	No requirements.
Washington	OK H.B. 44, 2nd Edition	Prohibits. May allow attended self-service with competent supervisor on duty.
West Virginia	OK H.B. 44, 2nd Edition	Prohibits
Wisconsin	OK H.B. 44, 2nd Edition	State requirement—must be attended by competent supervisor for self-service.
Wyoming	OK H.B. 44, 2nd Edition	Must be attended by competent supervisor for self-service. Most cities prohibit.

APC = automatic preset control; H.B. 44 = *Handbook 44*, National Bureau of Standards.

TABLE 19

STATUS OF APPROVAL OF MAD-MAC AND APC SYSTEMS (CITIES)

CITY	WEIGHTS AND MEASURES	FIRE
Birmingham, Ala.	Tentative	Prohibits
Phoenix, Ariz.	OK H.B. 44, 2nd Edition	Prohibits
Little Rock, Ark.	OK H.B. 44, 2nd Edition	Prohibits
City of Los Angeles	Tentative	Prohibits
County of Los Angeles	Tentative	Prohibits
City of San Francisco	Tentative	Prohibits
County of San Francisco	Tentative	Prohibits
Wilmington, Delaware	OK H.B. 44, 2nd Edition	Prohibits
Miami, Fla.	Tentative	Prohibits
Atlanta, Ga.	OK H.B. 44, 2nd Edition	Prohibits
Honolulu, Hawaii	OK H.B. 44, 2nd Edition	Prohibits
Boise, Idaho	OK H.B. 44, 2nd Edition	Prohibits
Chicago, Ill.	Tentative	Prohibits
Wichita, Kansas	OK H.B. 44, 2nd Edition	Prohibits
Louisville, Ky.	OK H.B. 44, 2nd Edition	Prohibits
New Orleans, La.	OK H.B. 44, 2nd Edition	Prohibits
Baltimore, Md.	Tentative	Prohibits
Boston, Mass.	Tentative	Prohibits
Detroit, Mich.	OK H.B. 44, 2nd Edition	Prohibits
Minneapolis, Minn.	OK H.B. 44, 2nd Edition	Prohibits
Kansas City, Mo.	OK H.B. 44, 2nd Edition	Prohibits
St. Louis, Mo.	OK H.B. 44, 2nd Edition	Prohibits
Great Falls, Mont.	OK H.B. 44, 2nd Edition	Prohibits
Omaha, Nebraska	OK H.B. 44, 2nd Edition	Prohibits
Greensboro, N. C.	Approved	Prohibits
Fargo, N. Dakota	OK H.B. 44, 2nd Edition	Prohibits
Cleveland, Ohio	OK H.B. 44, 2nd Edition	Prohibits
Oklahoma City, Okla.	OK H.B. 44, 2nd Edition	Prohibits
Portland, Ore.	OK H.B. 44, 2nd Edition	Prohibits
Philadelphia, Pa.	Tentative	Prohibits
Columbia, S. C.	OK H.B. 44, 2nd Edition	Prohibits
Sioux Falls, S. Dak.	OK H.B. 44, 2nd Edition	Prohibits
Memphis, Tenn.	OK H.B. 44, 2nd Edition	Prohibits
City of Dallas, Texas	OK H.B. 44, 2nd Edition	Prohibits
Dallas County, Texas	OK H.B. 44, 2nd Edition	Prohibits
El Paso, Texas	OK H.B. 44, 2nd Edition	Prohibits
Ft. Worth, Texas	OK H.B. 44, 2nd Edition	Prohibits
Houston, Texas	OK H.B. 44, 2nd Edition	No regulations on self-service. Must request permit.
Richardson, Texas	OK H.B. 44, 2nd Edition	Prohibits
San Antonio, Texas	OK H.B. 44, 2nd Edition	Prohibits
Seattle, Wash.	OK H.B. 44, 2nd Edition	Prohibits
Cheyenne, Wyoming	OK H.B. 44, 2nd Edition	Prohibits

APC = automatic preset control; H.B. 44 = *Handbook 44*, National Bureau of Standards.

tion, a practically unlimited number of establishments could thus direct their message at the interested motorist: a 4 by 8 panel could easily accommodate about 50 6 by 10 inch messages.

3. *Elimination of Unnecessary Information.*—This should placate adversaries of the present-day billboards. The motorist would not be exposed to the service information unless he sought out such information by stopping in the rest area (or at an exit ramp, where such might be provided).

The suggested concept of providing information at safety rest areas has been strongly advocated by Wagner and Harder (*26* and *50*) and others. In fact, bulletin boards containing state maps and assorted tourist (state sponsored) information are already being furnished in several states. This recommendation supplements such information to include service information.

The form of individual 6 by 10 inch panels is not necessarily the most advantageous, though it does offer the advertiser the option to advertise or not, and to design, compose, and execute his message as he sees fit (within the constraints of size, legibility, letter size, etc.) and at his expense. The state would bear the burden of the display board and its maintenance.

It is suggested, in effect, that contrary to present laws, such controlled advertising be permitted in the safety rest areas to effectively implement the motorists' informational needs for services.

There is an alternative means in which nearly the same information could be presented; a relatively simple, symbolical strip map, utilizing much the same brand name identifiers as are to be used on the service panels under the Draft Standards (though much smaller), presented on the same bulletin board. An example of what a part of such a strip map might look like is shown in Figure 16. Such a strip map could easily cover all motorist-oriented services easily accessible to the Interstate Highway for 50 or 100 miles in each travel direction. In common with the Draft Standards, the setting and policing of standards of quality, maximum distances from the facility, etc., would be left to the state. This method of presentation certainly would not constitute advertising in the true sense—since the state would retain control of standards, and of course bear the cost of producing the map and updating it periodically.

The suggested distance of 50 or 100 miles again violates the Draft Standard-imposed 12 air-mile limitation. However, this study has shown that in rural areas, the distances between gasoline stations frequently exceed this distance (especially for stations of the same brand). That the motorist is brand conscious has been clearly substantiated; therefore, it is suggested that this law be amended to allow such service information to be provided in the same way as the state provides information concerning state parks, etc.

It is suggested that, with either the individual plaque or the strip map, GAS and FOOD service organizations be required to indicate their hours of operation, and LODGING services their telephone number. Distance to next Service Information should also be indicated.

If such Informational Bulletin Boards are provided at an exit ramp, an especially wide shoulder should be provided so that the motorist could pull over and consult the map in safety. Night lighting will probably eventually be found at most rest areas and would be desirable over the informational maps. On the exit ramps, it is desirable to place the maps in such a manner that the vehicle's headlights could provide sufficient illumination.

Of the two methods (plaques or strip map), the former obviously leaves more leeway to the advertiser, which should not prevent the state from requiring the same basic information to be provided: hours of operation (for GAS & FOOD) and/or telephone number (LODGINGS).

It is suggested that the legend at the bottom of Figure 16 be included individually, on each map since the availability of services will vary from area to area.

There is no doubt but that the former method is much less expensive to the state, and relieves it of the burden of map preparation, updating, etc. It would be in the services businesses interest to ensure that sufficient and current information be posted.

In accordance with the intent of the HBA of 1965, it is suggested that as billboards are removed in accordance with the requirements of the act, such billboards concerned with the services to motorists be allowed to remain temporarily pending the implementation of a better means of supplying the motorist with the services information he needs and wants. It has been shown elsewhere in this report that such action would likely eliminate almost ⅔ of the existing billboards.

Other Ways of Presenting Services Information

The suggested methods of presenting service information in rest areas are not the only ones possible. They have been suggested as being potentially useful, contingent upon changes in certain provisions of the Highway Law.

Various other more sophisticated methods are also available. Some of them are used in other than roadside applications presently. Three of these are mentioned briefly.

Direct Telephone

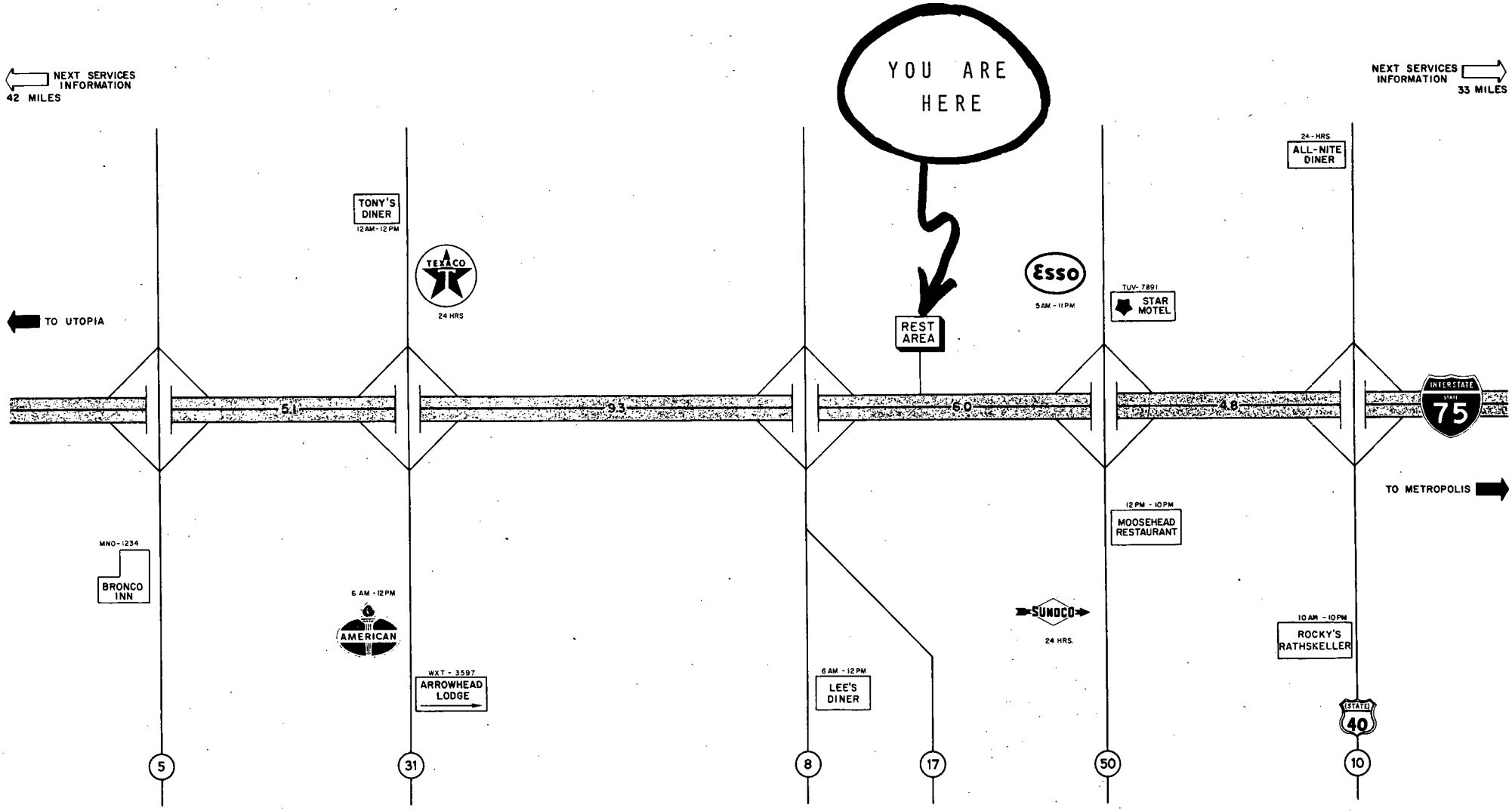
The benefits of a direct telephone line apply mostly to lodgings. Such lines can be found at this time at several major air terminals. For example, at Chicago's O'Hare Airport, a person can use any of several telephones, each connected directly to a major motel or hotel, to determine the availability of a vacancy at no charge. At Washington's National Airport, there is a selector console with transparencies of a number of establishments in and around the city. One need merely select an establishment, turn a wheel until the name of the establishment appears in a window, and press a button—a direct line to the desk of the selected establishment is available immediately.

It is hoped that pay telephones will soon be available at most rest areas. It is not considered economically feasible to use a system comparable to the one just mentioned in the rest areas of the rural Interstate Highways. However, it is suggested that a system such as the latter could find application in rest areas preceding a major service cluster. A city of some size, for example, of such a magnitude that to present all of the services contained therein would result in service bulletin boards of excessive dimensions.

A direct line to a chamber of commerce, tourist bureau, or other agency representing the businesses in such a cluster would serve a similar purpose. The problem of cost, installation, maintenance, and the protection from vandalism would most likely be substantial, and would have to be considered carefully.

Printed Matter

Many persons advocate handing out printed matter at the rest areas; it may have some merit, but it is costly, the stocks must be regularly replenished, and littering and abuse by the public is possible. A somewhat better solution may be a device such as the *directomat,* which is found in the service areas of the New York State Thruway. This device presents basic information in the form of back-lighted colored transparencies, each of which is number coded. The motorist selects the service establishment he desires, notes the number, and pushes the button. The machine prints and dispenses to him a small slip of paper with directions, prices, facilities, etc. The problems of initial



ALL SERVICE STATIONS SHOWN ARE WITHIN 1.5 MILES OF I 75
ALL RESTAURANTS SHOWN ARE WITHIN 1.5 MILES OF I 75
ALL LODGINGS SHOWN ARE WITHIN 3 MILES OF I 75

Figure 16. Services information map—a sample.

cost, keeping the information up-to-date, vandalism and misuse (particularly by children) remain to be resolved. But, this manner of presenting information allows many more establishments to announce themselves to the motorist in a small space. A machine such as the directomat could probably find use in rest areas approaching regions with many services sought by the motorists, yet which could not be displayed on reasonably sized service information bulletin boards.

Map Board Directories

Map board directories such as found in shopping centers and large buildings might be somewhat useful in a complex (urban) environment. Such a map board would consist of a large bulletin board map of the region. The motorist in need of a service would merely push a button denoting that service, and indicator lights at the locations of the establishments dispensing that service would light on the board. He merely needs to note his own location on the map and the relative location of the service he wishes to find. It is conceivable that the services could be broken down more finely than by type (by brand name, for example). The prime use of such a board may be in an area just prior to a city in what might be considered today as a "map reading" rest area. Again, such a system would be costly and the cost would have to be borne by the participating business establishments. It has been suggested that just prior to a city entrance, a simple rest/parking area be provided so that the motorist would have a chance to consult his local maps and plan his progress into or through the town.

One could easily devise even more complex means of supplying the motorist with service information, utilizing not only the motorist's visual, but possibly his aural channel. The need and/or feasibility of such different ways of presenting service information to the motorist and his ability to absorb the same are being investigated in NCHRP 3-12.

DRIVER EDUCATION

Driver education would indirectly contribute to alleviating the service problem, in addition to its primary benefit of increased safety, reduced accident rate, and better use of the Interstate System.

In the early days of the automobile, anyone who could reach the pedals, turn the steering wheel, and had the courage to do so could drive an automobile on the roads of those days—such as they were. Within the past 50 years, our highways have improved and multiplied, our vehicles have become sophisticated, powerful, and simple to operate. Fundamentally, however, the means of determining who can operate these vehicles has remainded substantially the same. High school driving instruction is available in many states, but is not a requisite for ultimately receiving a driver's license. Some regional AAA Clubs (for example, Connecticut) and several other organizations have conducted driving clinics with lectures, films, and demonstrations in various localities. Pamphlets are published by various State Highways or Public Works Department and distributed (for example, "Freeway Driving is Different," Connecticut). Sport Car Clubs throughout the country occasionally conduct driving schools. Occasional newspaper articles expound on driving and give tips—usually quoting the local police chief. A major television network presented a 1-hour self-test program during prime time. All of these are worthwhile and are steps in the right direction—but they do not uniformly reach all of the motorists. To obtain a driver's license (to operate a two-ton vehicle) in most states, the applicant's vision is tested, he is asked about some fundamental rules-of-the-road, and is then road tested. The road test frequently consists of starting the vehicle, using directional signals, driving two or three blocks at speeds of 20 to 30 mph, and parallel parking. After passing such a test, he is let loose on the nation's freeways—including the Interstate System—where speeds are much higher, no one ever parallel-parks, and everything—including accidents—happens much faster and is much more consequential.

An accident, by definition, is an event that occurs as a result of ". . . an unforeseen or unexpected situation . . ." with which the driver could not cope. No state is known to examine the applicant's ability to handle these unforeseen or unexpected situations. No state is known to test the applicant's ability to handle his vehicle at freeway speeds; or on wet pavement; or his reaction to unusual situations.

A valid comparison might be made between driver training (if any) and examinations and the Federal Aviation Agency prescribed training and testing of pilot candidates. The student pilot is not granted his private pilot's license until he has demonstrated his proficiency in not only straight and level flight, but also in handling his aircraft in various situations which, in the course of a normal (point A to point B) flight, he is not likely to encounter. This includes recovery from several kinds of stalls, flight under conditions of reduced visibility (on instruments), and (simulated) engine failure. He must show that he is able to navigate his craft and properly use the various equipments of his aircraft (flaps, radio equipment, etc.). He must properly prepare his aircraft and himself for a flight (preflight examination of the aircraft, flight planning, weather). Finally, he must fly a prescribed number of hours with a rated instructor and an even larger number by himself—solo passenger carrying prohibited, to acquire a measure of self confidence.

After licensing, the pilot is required to maintain his proficiency and is required to obtain a thorough physical examination at two-year intervals. The aircraft is also subject to stringent safety regulations, periodic overhauls, inspections, etc.

Only now are initial steps being taken by the Federal Government to assure uniform safety standards in automobiles. In recent years various states have adopted periodic inspection procedures as a prerequisite for allowing vehicles to be operated.

But the car itself does very little without the driver—and *his education and mode of operating his vehicle, trip planning and preparation are haphazard at best. The average driver's capability of operating his vehicle under all but the most normal conditions is marginal.*

Driver education comparable to pilot training would affect the service situation in several ways:

1. Proper attention to the automobile (comparable to the preflighting of an aircraft) would reduce the possibility of a mechanical breakdown which would result in a need for emergency aid. Condition of tires and their proper inflation, oil level, coolant level, tightness of fan belt, hydraulic fluid level in the braking system, working lights, and instruments are certainly items which could be easily checked systematically and quickly by any driver or a service station attendant.

2. Proper trip planning (analogous to flight planning) would reduce the possibility of the motorist having to take unnecessary risks to reach his destination by some particular time, of having his change for tolls, cigarettes, etc., and thereby reduce the probability of an accident and reduce the possibility of his need for ambulance and tow services. Trip planning would ensure that the motorist obtained fuel without having to frantically search for a station in unknown surroundings, thus reduce the possibility of his becoming an out-of-gas statistic. Trip planning would ensure that the motorist did not get lost, thereby reducing loss of time to himself, and the need to seek out a police officer or other source of information.

3. Improved normal driving skills (routine piloting of an aircraft) under realistic conditions, including proper entering and exiting from high-speed freeways, proper lane changing techniques, freeway cruising, anticipating (driving sufficiently ahead to compensate for the elevated speeds), keeping track of the vehicle's operating condition and one's own progress, would ultimately result in smoother flowing, safer, and faster flow of traffic. Fewer close calls, incidents, and accidents would be a certainty. Knowledge of one's own limitations and proper attention to the environmental conditions, traffic, lighting, etc., would eventually allow either increased legal speed limits, or their elimination altogether—since one of the most fundamental ingredients of safe and sane driving is good judgment. As pilots in the United States are subjected to the same requirements, so should drivers; maybe more so, since they come much closer to each other at very high relative speeds. A current safety slogan is "DRIVE DEFENSIVELY;" another is "WATCH OUT FOR THE OTHER GUY." These are valid slogans under currently existing inadequate driving skills and prevailing poor judgment. Implementation of a uniform, rigorous program of driver training and testing throughout the country could not fail to increase the efficiency, safety, and utility of our highways and once again reduce the magnitude of the emergency service demand. It would also eliminate drivers whose skills or abilities do not measure up to today's highways, driving conditions, and automobiles.

4. Proficiency in handling unusual situations (analogous to the private pilot's ability to recover from full stalls, performing simulated emergency landings, etc.) would immeasurably increase the motorist's probability of avoiding an accident, which, at his present level of proficiency, he would simply drive into. Demonstrated ability to recognize and compensate for slippery conditions, for reduced visibility, avoidance of a suddenly appearing obstruction, efficient and effective braking, and appropriate action in any unexpected situation should do much for safety, reduce the accident rate, and reduce the severity of those that occur. That the vast majority of drivers are lacking in these skills is amply attested to by the accident records of most any police department: immediately after the onset of precipitation, the accident rate jumps sharply. This simply means that the drivers do not adapt their driving techniques to the changing conditions.

It should also be noted that the second most prevalent annoyance checked by the respondents to the questionnaire in Appendix B was "Inept and Incompetent Drivers." The comments section of the appendix voices some additional strong opinions reflecting a need for improvement.

In summary, therefore, it is suggested that a more rigorous, realistic, uniform driver education would go a long way toward decreasing the emergency service demand placed upon the authorities, and would result in marked benefits in time, money and lives saved to the motorists; perhaps even the compulsory insurance rates might be reduced.

On the Interstate network, where the motorists with their increasingly greater mobility will more and more rub elbows with their fellow motorists, there is no room for a variety of standards in driver training, know-how, and ability. Just as uniform standards of highway design, signing, and construction are being applied in all the states, so should uniform and much higher standards of driving skill be furthered commensurate with the highways. The motorist himself would ultimately be the chief beneficiary.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

This study has examined the currently existing situation of services on the Interstate Highways. The demand for each service was studied from the actual use and the results of a nationwide motorist questionnaire. Extensive advantage was taken of the many reports, articles, surveys and studies pertinent to the services problem which were accomplished by various other researchers and agencies. This report successively examines the availability and the demand for each service, a brief comparison is made to assess the adequacy of the services available versus those demanded in quantity, quality, or both. Finally, four specific areas are suggested wherein improvement is indicated, and steps toward achieving such improvement are suggested. Three of these are based on the findings of this report; the fourth is a somewhat peripheral area, which however is believed to be quite pertinent to the operation of the Interstate Network, and has an indirect effect (principally) on the emergency services demand.

EMERGENCY SERVICES

The availability of emergency services in the urban, near urban, and somewhat more densely populated areas (such as much of the Northeast) is generally adequate; patrols are reasonably frequent, it is rarely very far to the nearest telephone, garage, hospital, or ambulance operator; exits are frequent; and some services or means to contact services are available at most exits.

On the other hand, in the lesser populated rural areas, the emergency service problem exists because patrols are less frequent, and tow/ambulance operators frequently find it uneconomical to keep the men and equipment ready for the relatively few calls that they receive.

It is recommended, therefore that a study be conducted to determine the feasibility of using STOL-type aircraft for purposes of patrol, and possibly service along the long stretches of the rural Interstate Highways. It is also recommended that the use of VTOL-type aircraft be considered for stand-by ambulance use. Furthermore, it is recommended that in areas where this deficiency exists, ground patrol vehicles be equipped, and personnel specifically trained and instructed, to perform most of the emergency services.

It is further recommended that the Good Samaritan instincts of other motorists be taken advantage of as a communications channel, by providing a simple method which would allow him to report another motorist in need of aid easily and safely. Refer to Chapter 2 for details underlying these recommendations.

NORMAL NECESSITIES

It was found that fundamentally the services rendered by commercial establishments are sufficient to meet the apparent demand. The only potential problem area is again found in the rural, low-population density areas where the ADT on the Interstate is low. The problem is that of a motorist running the risk of finding the gasoline station closed at night, with the next one being 20 or 30 miles away (and possibly also closed since the low volume does not justify its remaining open).

To solve this problem, it is recommended that the possibility of using self-service gasoline dispensing pumps be considered on a semi-attended basis, as an alternative to a station remaining open 24 hours. It is recommended that the official GAS should be a guarantee to the motorist that this commodity is indeed available to him, day or night. Refer to Chapter 3 for details underlying this recommendation.

SUPPLEMENTAL SERVICES

Among the supplemental needs studied, it is found that a problem area exists with official (directional) signing, as attested to by the motorists' response to the AIL and AAA motorist questionnaires. Signing for services at this time is also inadequate, but is supplemented by roadside advertising. With the removal of the latter in accordance with the HBA of 1965, it is believed—on the basis of the motorists' stated informational needs—that the Draft Standards for services signing will be insufficient.

It is recommended, therefore, that until better means of notifying the motorist of services are devised, roadside advertising pertaining to motorist services be retained. It is further recommended that service information be presented to the motorist in safety rest areas and at selected exits by means of a service information bulletin board. Two concepts of such a board are suggested and described in Chapter 4.

DRIVER EDUCATION

Since no study specifically of this subject could be conducted within the framework of this study, a firm recommendation cannot be stated or substantiated. However, it is strongly believed that the uniformity of the Interstate Network clearly indicates the need for more uniformity in the driver. Also, the great improvement in highways and automobiles demands a commensurate improvement in the driver. See Chapter 4 for details underlying this suggestion.

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APPENDIX A

PATROL EFFECTIVENESS IN DETECTION OF STOPPED VEHICLES

With the evolution of modern highways and greater travel, the problem of the stopped vehicle has become one of increasing importance. Traditionally, the means of detecting them, and thus of determining the magnitude and characteristics of the problem, has been patrol. This appendix will expand upon the results of patrol reports (*6*)* to show that they often do not show the correct picture. In addition, the characteristics of a patrol detection system shall be viewed in greater detail.

The mathematics will be contained in the body of the test. This is done because of the mathematical model perspective of this paper. The model, and hence its equations, are the necessary background and basis of the paper.

The type of patrol that is the subject of this appendix is one in which the patrol vehicles patrol adjacent facilities, entering and leaving the facility of interest at random. It will be shown later that in so doing, they generate a Poisson distribution in times between patrol vehicles. If the average number of vehicles that pass a point in a unit of time is λ, then the probability that n such vehicles will pass a point in a period of time, T, is:

$$P_n(T) = \frac{(\lambda T)^n e^{-\lambda t}}{n!} \qquad \text{(A-1)}$$

The probability that one will come in any small element of time, $d\tau$, is $\lambda d\tau$.

A vehicle that stops at time t_o will wait a time τ to be detected if no patrol passes in time τ and then one comes by in a period $d\tau$. The probability of this event is:

$$p_d(\tau)d\tau = p_o(\tau)\,p(\tau)d\tau \qquad \text{(A-2)}$$

in which

$p_o(\tau)$ = probability of no patrols in time τ,
$p(\tau)d\tau$ = probability that a patrol vehicle passes in the time element $d\tau$ at time τ.

Inserting the above equations into Eq. A-2 we get

$$p_d(\tau)d\tau = e^{-\lambda\tau}\,\lambda\,d\tau \qquad \text{(A-3)}$$

The probability that a vehicle is detected in each element of time $d\tau$ is independent of all of the other elements $d\tau$, therefore, to find the probability that a vehicle has been detected by time τ we sum over all the elements $d\tau$ from $t = 0$ to $t = \tau$. In mathematical terms this is:

$$p_d(t \le \tau) = \int_0^\tau \lambda\, e^{-\lambda\tau}\,d\tau = 1 - e^{-\lambda\tau} \qquad \text{(A-4)}$$

To this point the fact that a vehicle may leave before it is detected by the patrol has not been taken into account. For many situations the authorities that operate a facility may maintain that they are not interested in detecting a vehicle that is capable of going on by itself. This does not imply, however, that the following model does not apply to their needs. Vehicles that are permanently disabled may be detected by a patrol irrespective of the patrol frequency, but in the meantime the driver may have left the scene as a pedestrian.

In order that the above vehicle could have been detected, its intended stop length must have been greater than the

* The work reported in this paper expands on the results of investigations included in the National Cooperative Highway Program 3-4 Report "A Study of the Means of Locating and Communicating with Disabled Vehicles" by F. Pogust, A. Kuprijanow, and H. Forster.

time τ. The probability of this is p_s ($\geqq \tau$) and it modifies Eq. A-2 as

$$p_d(\tau)\,d\tau = p_d(\tau)\,p_s(\geqq \tau)\,d\tau \qquad \text{(A-5)}$$

To determine the form of the function $p_s(\geqq \tau)$ we hypothesize that the stop length within any given type of stop is distributed according to the gamma distribution. This assumption is made primarily because of the similarity between this distribution and data gathered at various facilities. With this distribution function the probability that a stop will last for a time t,

$$p_s(t) = \frac{t^{\alpha}\, e^{-t/\beta}}{\beta^{(\alpha+1)}\,\Gamma(\alpha+1)} \qquad \text{(A-6)}$$

The distribution function for $p_s(\tau)$ is

$$p_s(\tau) = \int_0^{\tau} p_s(\tau)\,d\tau \qquad \text{(A-7)}$$

and

$$p_s(\geqq \tau) = 1 - p_s(\tau) \qquad \text{(A-8)}$$

Combining the above into Eq. A-5 we get

$$p_d(\tau)\,d\tau = e^{-\lambda\tau}\lambda\,[1 - \int_0^{\tau} \frac{t^{\alpha}\, e^{-t/\beta}}{\beta^{(\alpha+1)}\,\Gamma(\alpha+1)}\,dt]\,d\tau \qquad \text{(A-9)}$$

$$= e^{-\lambda\tau}\lambda\,[1 - \frac{1}{\Gamma(\alpha+1)}\int_0^{\tau/\beta} v^{\alpha}\, e^{-v}\,dv]\,d\tau$$

The above is the probability that a vehicle will be detected at time τ. The main interest is that the vehicle be detected in time less than T. To find this all the probabilities that it was detected at all times less than T will be added.

$$p_d(\leq T) = \int_0^{T} p_d(\tau)\,d\tau \qquad \text{(A-10)}$$

Substituting Eq. A-9 in Eq. A-10 and integrating gives

$$p_d(t < T) = 1 - e^{-\lambda T} - \frac{1}{\Gamma M}(N^{-M}\Gamma_{RN}\,M - e^{-\lambda T}\Gamma_R M) \qquad \text{(A-11)}$$

in which ΓM is the gamma function, $\Gamma_x M$ is the incomplete gamma function, $M = \alpha + 1$, $N = \lambda\beta + 1$, and $R = T/\beta$.

If T goes to infinity then (A-11) gives the probability that a stop is ever detected, $p(d)$.

$$p(d) = 1 - (\lambda\beta + 1)^{-(\alpha+1)} \qquad \text{(A-12)}$$

Or the probability of not detecting a stop at all is

$$p(\bar{d}) = (\lambda\beta + 1)^{(\alpha+1)} \qquad \text{(A-13)}$$

Figure A-1 shows two stop length density curves of the assumed form in Eq. A-6. The parameters α and β were chosen so that the mode of the higher curve is at four minutes and 90 percent of the stops are less than 14 minutes. The second curve has a mode at 10 minutes and the 9th decile at 20 minutes. With these assumed forms the probability of not detecting a stopped vehicle can be determined from Eq. A-13, as a function of the patrol time constant,

$$\tau_p = \frac{1}{\lambda} \qquad \text{(A-14)}$$

τ_p is the average time between successive patrol vehicles. These curves are plotted in Figure A-2.

Eq. A-13 can be used to show the artifact introduced by collecting data by a patrol and using these data uncorrected. The assumptions of this model have been tested for the Richmond-Petersburg Turnpike and found to be valid. The results will, therefore, be applied to their patrol data to see how this changes the appearance of the problem.

The first point that should be handled before the above model is applied to actual data is vindication of the basic assumption that the patrol frequency is Poisson. From the Poisson assumption, it develops that the distribution of the times between successive patrol vehicles is an exponential function. To test this, the data that obtained from the Richmond-Petersburg Turnpike contained excellent information as to the patrol effort both as to time of patrol and type of actions taken. It was, therefore, possible to test the model hypothesis and use data from the same source. Figure A-3 shows the actual distribution function obtained from the data as data points. The solid lines are curves fitted to this data by the model assumption. The results indicate that the model results should give excellent results. The actual patrol time constant varies somewhat, however, for the majority of cases tested, it was found to be about 30 minutes. As Figure A-3 shows, some of the data had a 36 minute or 40 minute time constant, however, the similarity between the model and the data was not destroyed.

The data for the Richmond-Petersburg Turnpike for one month was analyzed. The number of assists in each category is listed in column 1 of Table A-1. The percent of total stops in each category is given in column 2. In general, the relationships between gas, motor, heat, and tire are somewhat consistent with the relationships found on

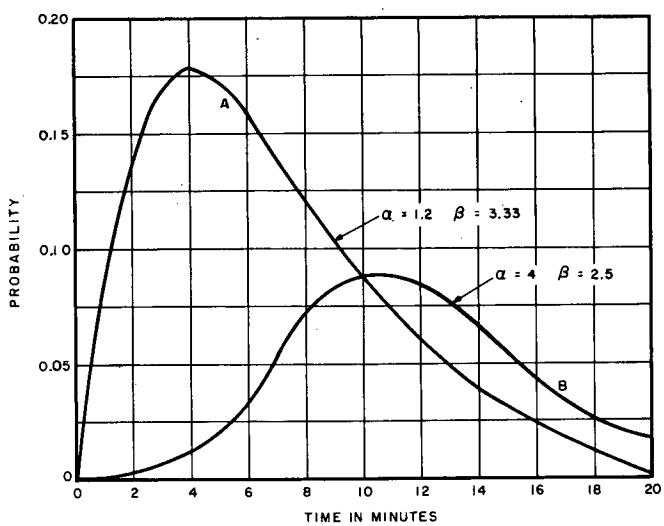


Figure A-1. Stop time density function for two stop types.

TABLE A-1

RICHMOND-PETERSBURG TURNPIKE SHOULDER STOPS

CAUSE	NO.	%	PROBABILITY OF DETECTION = 1/5 NO.	%
Directions	146	35.9	730	65.5
Flat tire				
Assistance	31	7.6	155	13.9
Sent help	39	9.6	39	3.5
AAA	3	0.7	3	0.2
Gas	35	8.6	35	3.1
Motor	131	32.2	131	11.7
Heat	21	5.1	21	1.8
Total	406		1114	

other roads. The percentages are somewhat lower because of the number of stops recorded for directions.

The results of the previous patrol analyses will now be applied to see what this does to the stop mixture. Assume that the probability of detection of short-term stops is about ⅕. This value would be typical for most patrol time constants as is shown in Figure A-2. Such categories as "directions" and "tires assisted" should be scaled up because they represent categories that were detected by chance. Other categories, such as gas, motor, heat, and "tires sent help" are considered to be of such a nature that they would remain until detected. The new totals for the number of stops in each category are now shown in Table A-1, column 3 and the associated percentages in column 4.

The total number of stopped vehicles on the side of the road is now 2.74 times as many as were recorded. Most of these stops are made to ask directions and the frequency is at least three times as high as the second most frequent cause.

The above shows that the distribution in types of stops and the apparent number of stops made on a facility should not be taken directly from patrol data without first taking into account the variations introduced by the data gathering technique.

A second and a more primary use of patrols, besides data acquisition, is an operating stopped vehicle detection system. The points of interest here are a bit more stringent than the above. We are not only interested in the probability that we will detect a vehicle at all, but also the time it takes, or the level of service. Returning to Eq. A-11, the values of α and β can be set for each of the above stop type distributions. The left side of the equation, the probability of detection, can be set as one of the defining qualities of the level of service. The remaining two parameters are the patrol frequency and the time response that is desired. This approach for analysis has been taken and the results are shown in Figure A-4.

Before interpretation of the curves in Figure A-4, some examples might be helpful. Assume that a facility desires to have a detection system that has a response time of 12 minutes and that the probability of detection of this situation should be 0.6. The assumed stop type distribution is that of curve B in Figure A-1. The question is, "How frequently should I patrol so that these objectives can be accomplished"? To find the answer use Figure A-4 which is for the stop type desired. Enter the abscissa at 12 minutes and proceed up the graph until the curve for probability of 0.6 is reached. The ordinate at this point is 10.6, or the required average time between successive patrols must be 10.6 minutes. Stated in words, this solution is "If you patrol with an average frequency of 10.6 minutes, then with a

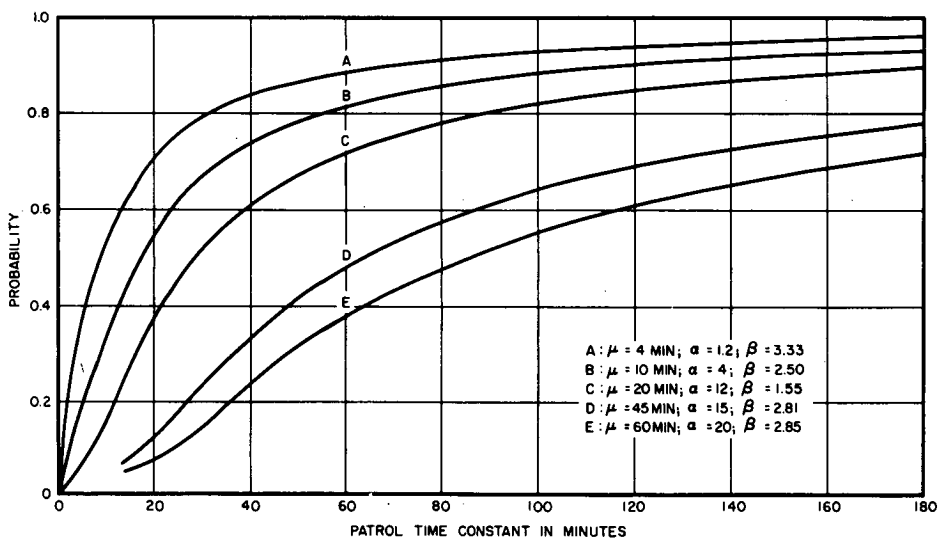


Figure A-2. Probability of not detecting stopped vehicles vs patrol time constant—for five stop times.

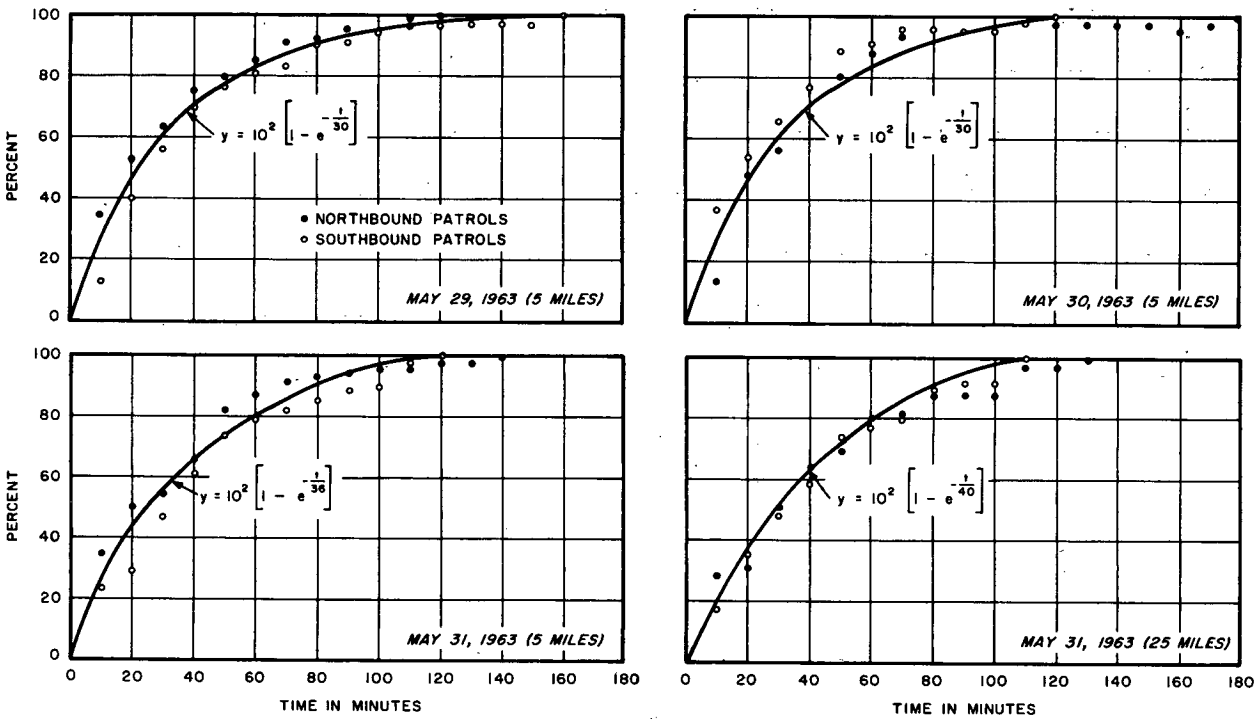


Figure A-3. Distribution in time between successive patrols.

probability of 0.6 you will detect a stopped vehicle in less than 12 minutes from the time it stops."

The question that is posed at this time is, "How can it be that the response time for the detection system is 12 minutes when I am patrolling on the average every 10.6 minutes?" This is because the patrol average is 10.6 minutes, it may likely be that it will be longer between successive patrols than 10.6 minutes. This is only part of the answer, the main portion lies in the fact that a vehicle may leave before it is detected and you have chosen a rather high probability of detection, namely 0.6. If you had chosen a probability of 0.4 for instance, then the required patrol time constant would have been 18.3 minutes which is more in keeping with the rather generally preconceived order of times.

The mean of the distribution of stops in Figure 20 is 12.5 minutes. In order to detect those people in the first half of the distribution with a reliability of 0.8, you have to have a patrol frequency of about 6 minutes. That is, in order to detect half of the stops with a reliability of 0.8 you have to patrol with a frequency of more than twice the expected stop time on the road. In order to sooth some of the pains that must be appearing at this point, let's see what happens if you patrol with a frequency equal to that of the average stop. This is somewhat of a happy paradox, if you patrol on the average as frequently as the time of the average stop; then you have a better than average probability of detecting the stopped vehicle.

There is still another interesting point of view of this analysis and that is from the data reduction from a patrol effort. Assume that a facility patrols with a frequency of 30 minutes. From Figure A-2 we see that the probability of detecting the above stop type is about 0.33. From Figure A-4 a probability of 0.3 and a patrol frequency of 30 minutes gives a response time of 15 minutes.

This would say that of 100 vehicles that stopped only 33 would be detected and if you asked these people how long they had been there, 30 of them would say less than 15 minutes. That is 91 percent of the reports would state less than 15 minutes whereas the actual distribution has a 9th decile of 20 minutes. It is very easy to deduce from the data that your patrol is getting stopped vehicles in a very satisfactory manner since you have gotten 90 percent of them in less than 15 minutes. In actuality you have detected only ⅓ of the stops. Thus patrol data can be quite misleading.

It is quite apparent that the stop time distribution plays an important part in the detection characteristics. To determine this effect the analysis was done for other stop distribution means while keeping the standard deviation constant at 5.6 minutes. Figures A-5, A-6, and A-7 show the corresponding curves for means of 8, 16.8 and 20.2 minutes, respectively.

It is difficult to visualize the problem from Figures A-4 through A-7 only. To aid this visualization, Figures A-8 through A-10 were constructed. Figure A-8 is a three-dimensional view of the surface for a probability of detection of 0.5. The surfaces for higher probabilities lie beneath this surface and those of lower probability above it. Figure A-9 is a plane cutting through the surfaces at $T = 10$ minutes. This shows the above stated order of the surfaces and their locations and shapes.

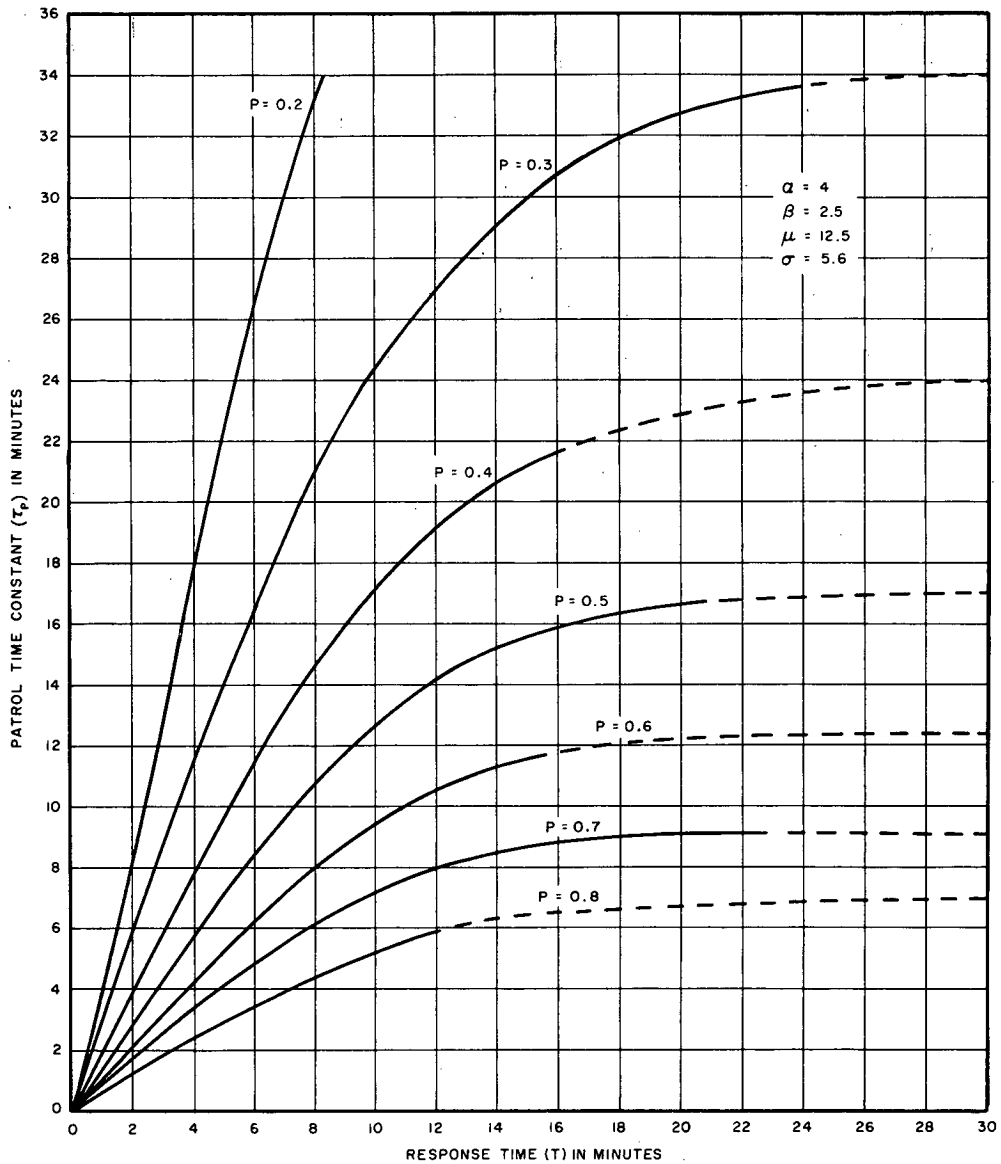


Figure A-4. Patrol time constant vs time to respond with probability of detection as a parameter for stop distribution parameters: $\alpha = 4, \beta = 2.5, \mu = 12.5$.

Figure A-10 is a projection of the lines of constant T onto the τ_p; μ plane for the surface $p = 0.5$.

From these figures we see that the surfaces are somewhat flat plates slanting upward and inward from the μ and T axes. A smooth bend occurs along the junction of these plates. The plates are not absolutely flat but bend over at the top.

Some interesting results can be obtained from Figure A-8. Suppose that a system is designed so that it operates at point A. Here the patrol time constant is about 10 minutes and the response time is about 25 minutes for a probability of detection of 0.5. If the patrol frequency increases to about 7 minutes, for the same probability of detection the response time decreases to about 7 minutes. Hence, by decreasing the patrol time constant by only 30 percent the response time is reduced 72 percent.

This advantage is maintained only until the slope of the line is greater than 45 degrees. In Figure A-5 line OM has been drawn to show the locus of these points. This line is asymptotic to the 0.6 curve for low values of T. For probabilities greater than 0.6 the above advantage is maintained for the entire practical range of T.

The entire picture of the patrol effort is not given only by the design points such as A and B in Figure A-8. There is some tradeoff relationship between probability of detection and response time for any given patrol frequency. Figure A-8 shows this tradeoff for a stop mean of 8 minutes. In Figure A-11 it is more apparent that specification of a

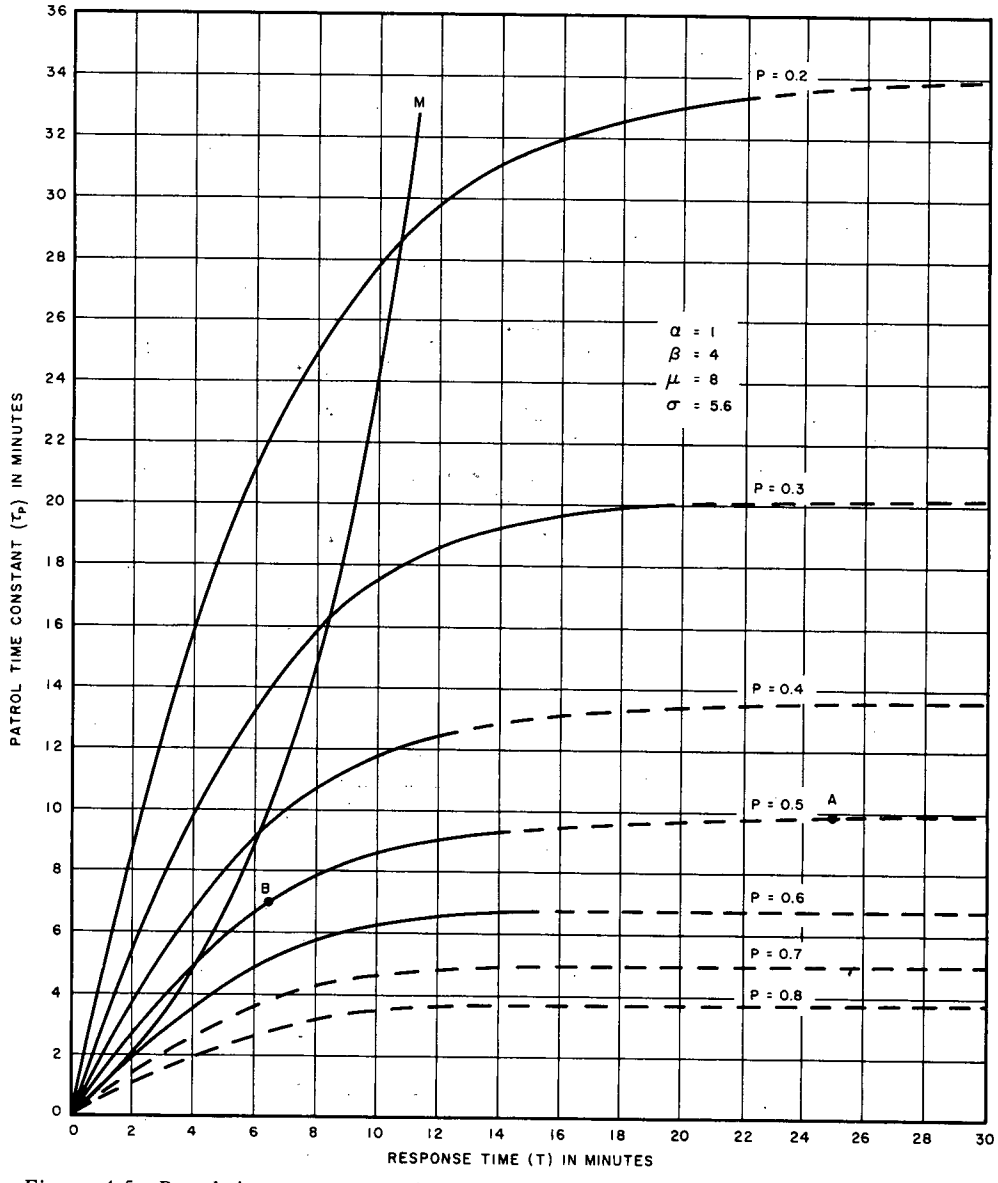


Figure A-5. Patrol time constant vs time to respond with probability of detection as a parameter for stop distribution parameters: $\alpha = 1$, $\beta = 4$, $\mu = 8$.

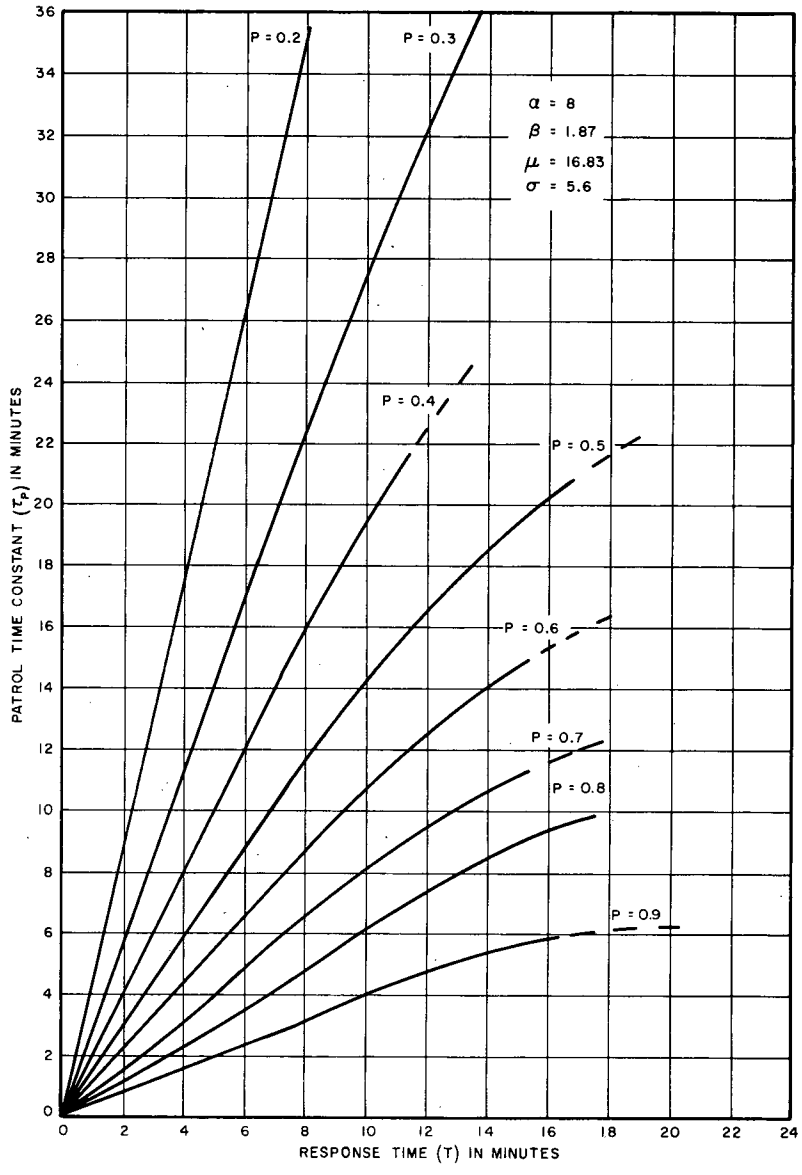


Figure A-6. Patrol time constant vs time to respond with probability of detection as a parameter for stop distribution parameters: $\alpha = 8$, $\beta = 1.87$, $\mu = 16.83$.

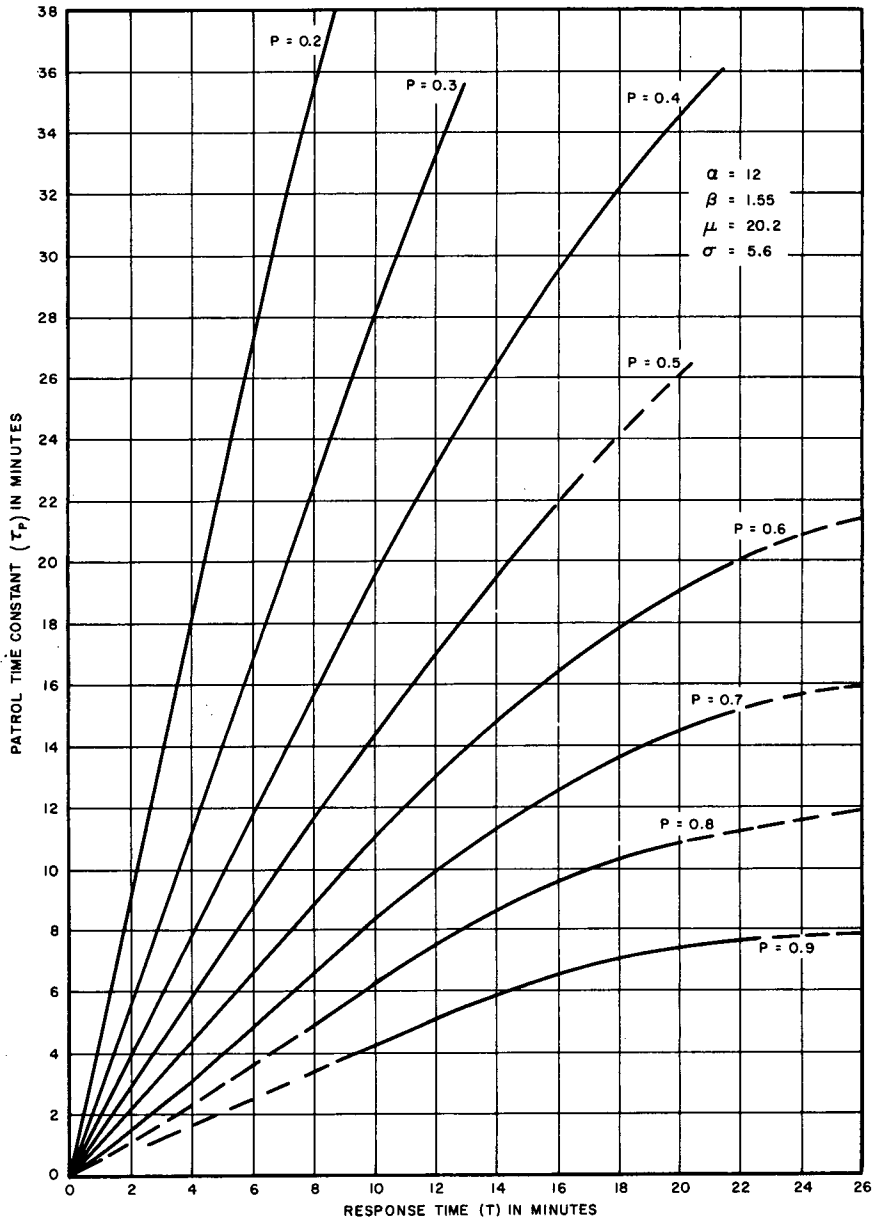


Figure A-7. Patrol time constant vs time to respond with probability of detection as a parameter for stop distribution parameters: $\alpha = 12$, $\beta = 1.55$, $\mu = 20.2$.

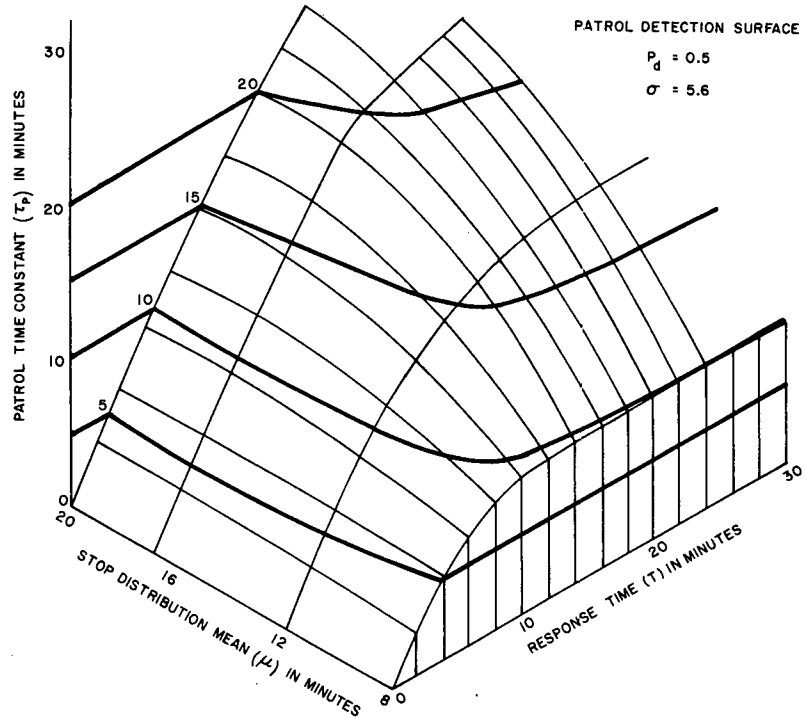


Figure A-8. Three dimensional view of probability $= 0.5$; surface in T, τ, μ space.

patrol time constant only determines a curve in the response time probability of detection plane. That is, specification of a system by point A determines a patrol effort. Once this effort is expanded, we have the same operating systems as though it had been defined as point A^1 on the image of line OM in Figure A-5. A system defined as $P_d = 0.5$, $T = 25$ may sound quite different from one specified as $P_d = 0.39$, $T = 6.5$ but as Figure A-11 shows, there is no difference.

Another result that comes from Figure A-8 is the insensitivity of response time to stop distribution mean for high performance systems. For a patrol time constant of 10 minutes the response time stops at about 6.5 minutes for stop means of about 11 to 20 minutes. Hence for low response time systems the required patrol frequency depends little upon the stop distribution mean.

At this point some form of warning as to the interpretation of the results should be inserted. It may be concluded by some persons that this analysis precludes the use of patrols as a means of detection of stopped vehicles. This is not true. The time response of the system as we have defined it here is not only the time response of detection but also the time response of service.

In some systems of detection it is possible to get a virtually instantaneous detection (in a central location) of a stopped vehicle. This detection is not service however. It is necessary at this time to dispatch some sort of patrol to the scene so that the above model state can be reached, that is, help at the point where it is needed. The time for this patrol to get to the scene should also be included in the over-all response time for such detection systems before a fair comparison can be made. Therefore, this section is not intended to compare any systems but merely gives an analysis of one type of system.

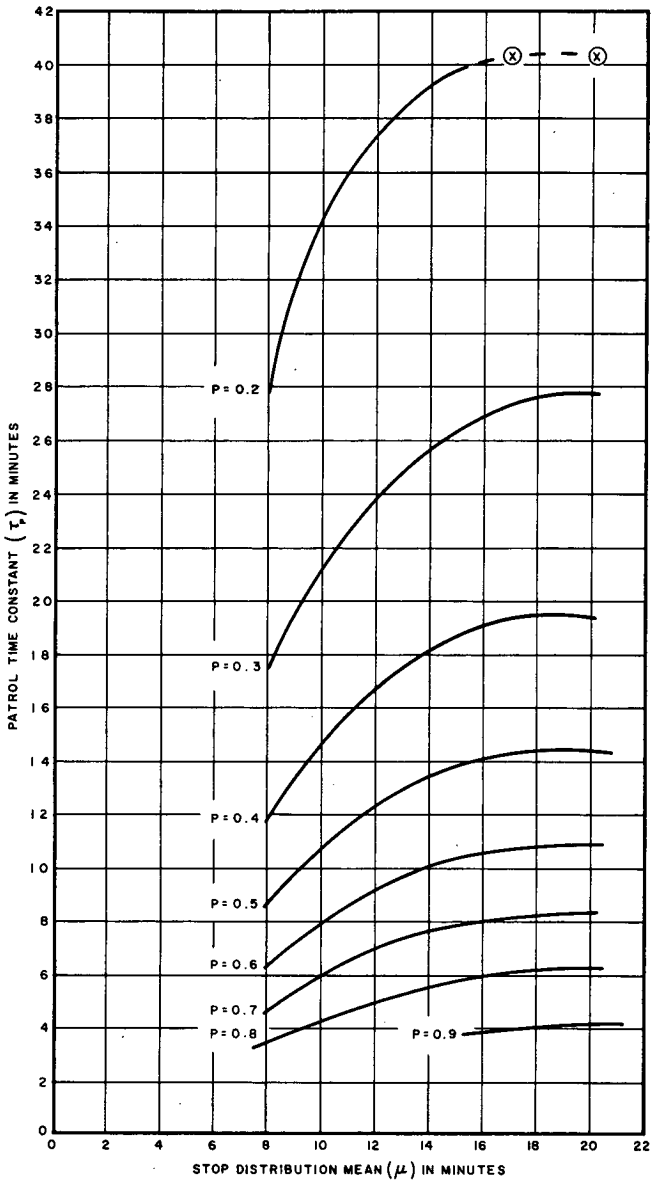


Figure A-9. Plane cutting through three-dimensional view at response time of 10 minutes.

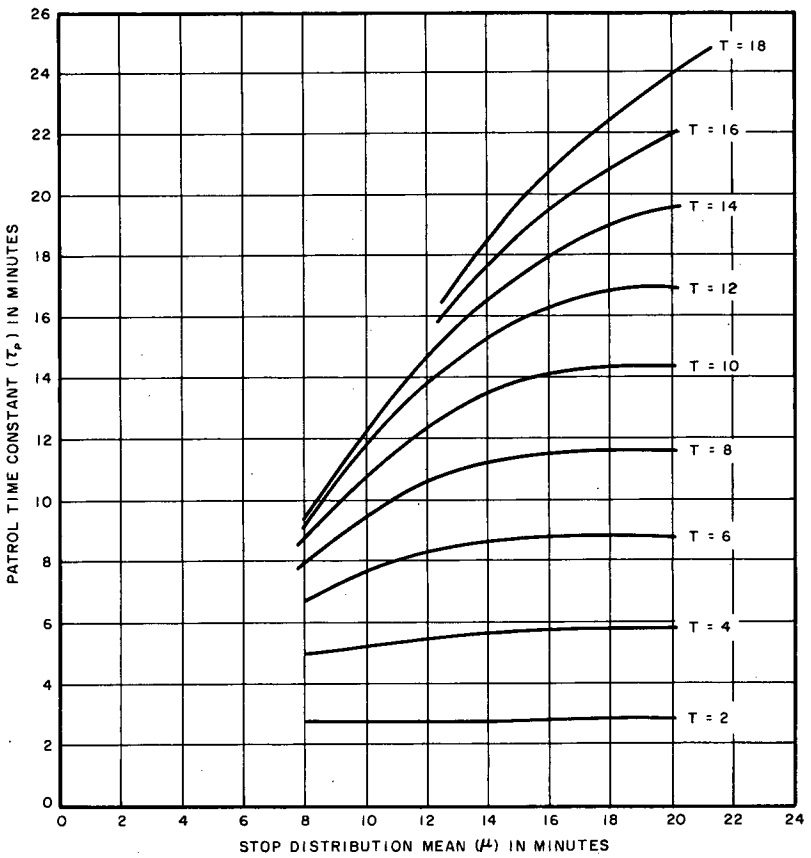


Figure A-10. Projection of lines of constant response time on μ, τ plane for probability of 0.5.

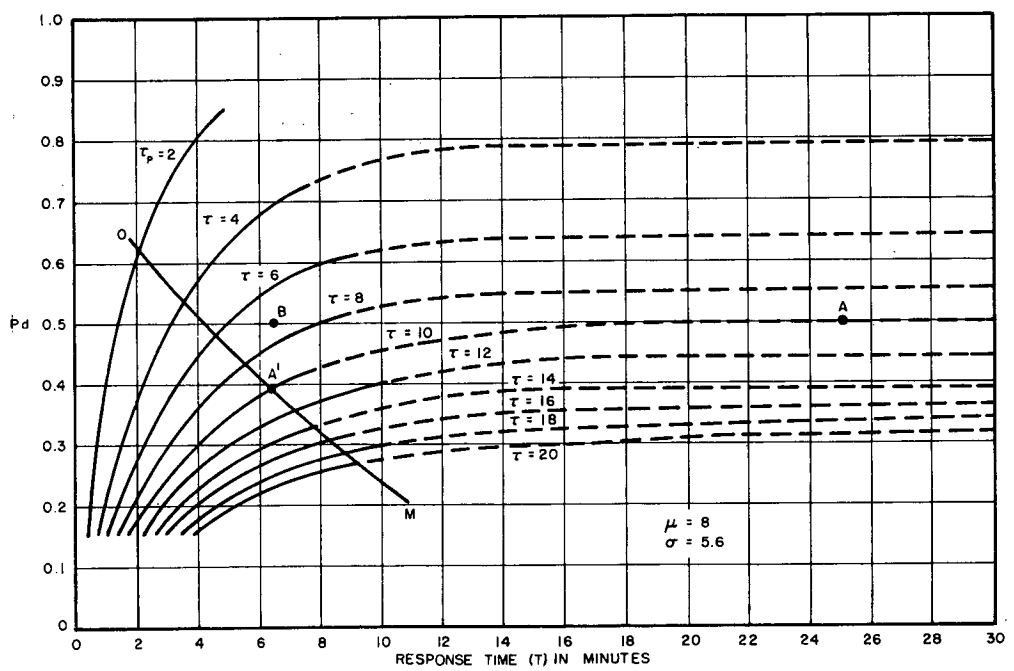


Figure A-11. Probability vs response time with patrol time constant as a parameter.

APPENDIX B

NATIONWIDE MOTORIST QUESTIONNAIRE

An important part of this project was a questionnaire survey of automobile owners throughout the country pertaining to some of their pertinent travel habits, likes, dislikes, and desires.

To ensure an unbiased sample, the originally anticipated sampling of the members of an auto club or travel association was discarded in favor of a completely random sampling of automobile owners. To get nationwide coverage, 7 states were chosen for sampling: California, Florida, Kansas, New York, North Dakota, Texas, and Washington. From all of the automobile owners in these states, a total of 95,923 were selected at random; the number selected from each state was proportional to that state's total registrants; the states themselves were chosen to sample various parts of the country, terrain, climate, and people. Table B-1 shows the states, the number mailed to each, the number received from each, and the corresponding percentage return, plus the over-all figures.

Each questionnaire upon receipt was opened, serially numbered, checked for format correctness, occupation code written in manually, and then all information was keypunched onto an IBM card. The program to reduce the information and tabulate the results was completed and "debugged" and a data run made.

The over-all return was about 14.5 percent, or significantly higher than an originally anticipated figure of 5 to

HELP TO IMPROVE YOUR HIGHWAYS!

Yes, they are YOUR highways – built with the tax dollars that YOU pay to the state and federal governments.

Therefore, it is reasonable to assume that you would like YOUR roads to be as good, safe, convenient, and attractive as possible, while satisfying your particular needs when traveling.

Not all of your tax dollars, however, go into concrete and blacktop. A small percentage of highway funds is used for fundamental research aimed at giving you the kind of highways that you need.

We, here at the Airborne Instruments Laboratory, under contract to The National Academy of Sciences, have been charged with performing a small part of the total research effort: that related to SERVICES along our major highways. Specifically, our task is to determine what services are actually available to the motoring public AND what the drivers themselves need in terms of such services.

However, we know of no better way to find out what motorists themselves feel they need than to ask them. Since we can hardly ask them all, we have retained the services of an electronic computer to select a representative sample of motorists from all over the United States. This is quite an undertaking since there are more than 75 million passenger cars registered in this country.

As one automobile owner thus selected, please consider this:

YOU REPRESENT ALMOST 1,000 OTHER AUTOMOBILE OWNERS
WHO WERE NOT SELECTED!

WE NEED YOUR HELP. We offer you no prizes, no stamps, no premiums. We do ask for about 10 minutes of your time to fill out the enclosed questionnaire. Your answers to these questions together with those of many others like you will not result in revolutionary and immediate changes along our highways. They will form a useful basis for eventual improvements that will make highway travel for all of us safer, more pleasant, and more convenient.

WOULD YOU PLEASE FILL OUT THE QUESTIONNAIRE TO THE BEST OF YOUR ABILITY? You need not identify yourself. When you finish, fold in accordance with instructions and drop in the mail box. PLEASE TRY TO FILL OUT AND RETURN TO US BEFORE 1 NOVEMBER 1966.

We sincerely thank you for your attention.
Transportation Research Section

Figure B-1.

TRAVEL QUESTIONNAIRE

1. Please indicate by number how many auto trips of 100 miles or more you have made within the last 12 months for business and pleasure.

   _____ Business; _____ Pleasure.

2. About how many miles total did you drive during this same period of time?

   _____ Miles.

3. Do you generally use the same brand(s) of gasoline?

   _____ Yes; _____ No.

4. Please state how many gasoline credit cards you have.

   _____ Credit Cards.

5. Please indicate your meal preferences by placing an R (restaurant), C (cafeteria), CS (counter service), or P (picnic) on each space below.

   ____ Breakfast; ____ Lunch; ____ Dinner.

6. How much, to the nearest dollar, do you spend daily, per adult, for each of your meals when traveling?

   ____ Breakfast; ____ Lunch; ____ Dinner.

7. How much do you expect to pay for overnight accommodations per room?

   _____ Dollars.

8. Do you usually make prior reservations?

   _____ Yes; _____ No.

9. The motorist on a freeway is usually alerted to the services available ahead by means of signs, billboards, and sometimes by actually sighting the service establishment such as a gasoline station or motel. Of the following types of information pertaining to the availability of services ahead, please check (✓) the one that most nearly satisfies YOUR informational needs.

   ____ Notification of: "SERVICES," or "SERVICES THIS EXIT," or "ROADSIDE BUSINESS."

   ____ Notification of Service Type: "GAS," "FOOD," "LODGINGS," "PHONE."

   ____ Services by Brand Name: "Texaco," "Mobil," "Howard Johnson's," etc.

   ____ Service Availability: "GAS 1 Mi," "OPEN 24 Hours," "NEXT SERVICES 15 Miles."

10. The list below consists of sources of aid when traveling. Please indicate by 1, 2, 3, 4 whom you would turn to first, second, third, fourth if you had a mechanical problem or were lost.

    ____ Gasoline station attendant
    ____ Local inhabitant
    ____ Police Officer
    ____ Yourself via maps, tools, ingenuity.

11. Similarly, please indicate by 1, 2, 3, . . . the order in which any or all of the list below annoy you when traveling.

    ____ Confusing or inadequate signs
    ____ Unclean restrooms
    ____ Billboards along highway
    ____ Traffic
    ____ Lack of services along freeway (gas, food, lodging, phone)
    ____ Inept or incompetent drivers

12. Check the conveniences that you feel should be provided at roadside parking or rest areas.

    ____ Telephone ____ Drinking water ____ Night lighting
    ____ Restrooms ____ Picnic tables ____ Information aids (maps, pamphlets, . . .)

13. What is your occupation? _____

14. Please state your age. _____ Years.

15. What state do you reside in? _____

Figure B-2.

10 percent. Thus, the following analysis is based on about 14,000 responses. First, distributions for each of the questions are summarized. The remainder contains correlations between the various questions which yielded significant relationships between the variables involved or indicated more or less distinct trends—or a lack thereof.

DISTRIBUTIONS

1. Please indicate by number how many auto trips of 100 miles or more you have made within the last 12 months for business and pleasure.

   _____ Business; _____ Pleasure.

TABLE B-1

QUESTIONNAIRE STATISTICS

STATE	NO. MAILED	%	NO. RETURNED	% RETURN	% OF OVER-ALL RETURN
California	30,506	31.2	3,874	12.6	27.8
Florida	11,092	11.4	1,391	12.5	10.0
Kansas	4,425	4.2	623	14.1	4.5
New York	24,300	25.2	4,296	17.7	30.8
North Dakota	1,200	1.3	205	17.0	1.5
Texas	18,700	19.5	2,422	13.0	17.4
Washington	5,700	6.0	1,096	19.2	7.9
Total	95,923		13,943		

This question was used to obtain a ratio indicating what percent of the motorists' total trips was made for business purposes. Figure B-3 indicates that about 48 percent of those answering make most (90 percent or more) of their trips for pleasure rather than for business. The average ratio for the total sample was 0.28.

2. About how many miles total did you drive during this same period of time?

   _____Miles.

The average for the total sample was 13,500 miles driven per year. In addition, 66 percent of the respondents answering travel at least 9,000 miles per year (Figure B-4).

3. Do you generally use the same brand(s) of gasoline?

   _____Yes; _____No.

4. Please state how many gasoline credit cards you have.

   _____Credit Cards.

More than 3 out of 4 motorists individually tend to use the same brand of gasoline and 68 percent have at least one credit card (Figure B-5).

5. Please indicate your meal preferences by placing an R (restaurant), C (cafeteria), CS (counter service), or P (picnic) on each space below.

   ____Breakfast; ____Lunch; ____Dinner.

Figure B-6 indicates that the respondents prefer to eat all of their meals in a restaurant, especially dinner. Note that percentages here were taken with respect to meal type, not meal preference. For example, about 85 percent of those eating dinner do so in restaurants. Cafeterias are used more by people eating lunch than by those eating breakfast or dinner. Likewise, picknicking is used almost exclusively for lunch, whereas breakfast is preferred at a counter slightly more than lunch.

6. How much, to the nearest dollar, do you spend daily, per adult, for each of your meals when traveling?

   ____Breakfast; ____Lunch; ____Dinner.

The average expenditures for our sample were $1.19 for breakfast, $1.47 for lunch, and $3.12 for dinner. Referring to the cumulative percentage (Figure B-7) we see that 98 percent of our respondents spend less than $2.00 for breakfast, the same percentage spend $2.80 or less for lunch, and up to $6.00 for dinner.

7. How much do you expect to pay for overnight accommodations per room?

   _____Dollars.

8. Do you usually make prior reservations?

   _____Yes; _____No.

The average expenditure for the respondents was $10.16. Referring to Figure B-8, almost 66 percent of the motorists answering spend $11.00 or less for lodgings and 95 percent spend $15.00 or less. However, 73 percent do not generally make prior reservations.

9. The motorist on a freeway is usually alerted to the services available ahead by means of signs, billboards, and sometimes by actually sighting the service establishment such as a gasoline station or motel. Of the following types of information pertaining to the availability of services ahead, please check (✓) the one that most nearly satisfies YOUR informational needs.

   ____Notification of: "SERVICES," or "SERVICES THIS EXIT," or "ROADSIDE BUSINESS."
   ____Notification of Service Type: "GAS," "FOOD," "LODGINGS," "PHONE."
   ____Services by Brand Name: "Texaco," "Mobil," "Howard Johnson's," etc.
   ____Service Availability: "GAS 1 Mi," "OPEN 24 Hours," "NEXT SERVICES 15 Miles."

On the basis of those persons who answered this question, 5.4 percent checked line 1, 30.8 percent checked line 2, 30.2 percent checked line 3, and 33.3 percent checked line 4. This would indicate that the motorist at least wants to know what type of service is being offered and a substantial number want information on brand names and availability.

The list below consists of sources of aid when traveling. Please indicate by 1, 2, 3, 4 whom you would turn to first, second, third, fourth if you had a mechanical problem or were lost.

____Gasoline station attendant
____Police Officer
____Local inhabitant
____Yourself via maps, tools, ingenuity.

Figure B-9 indicates that almost 50 percent of the re-

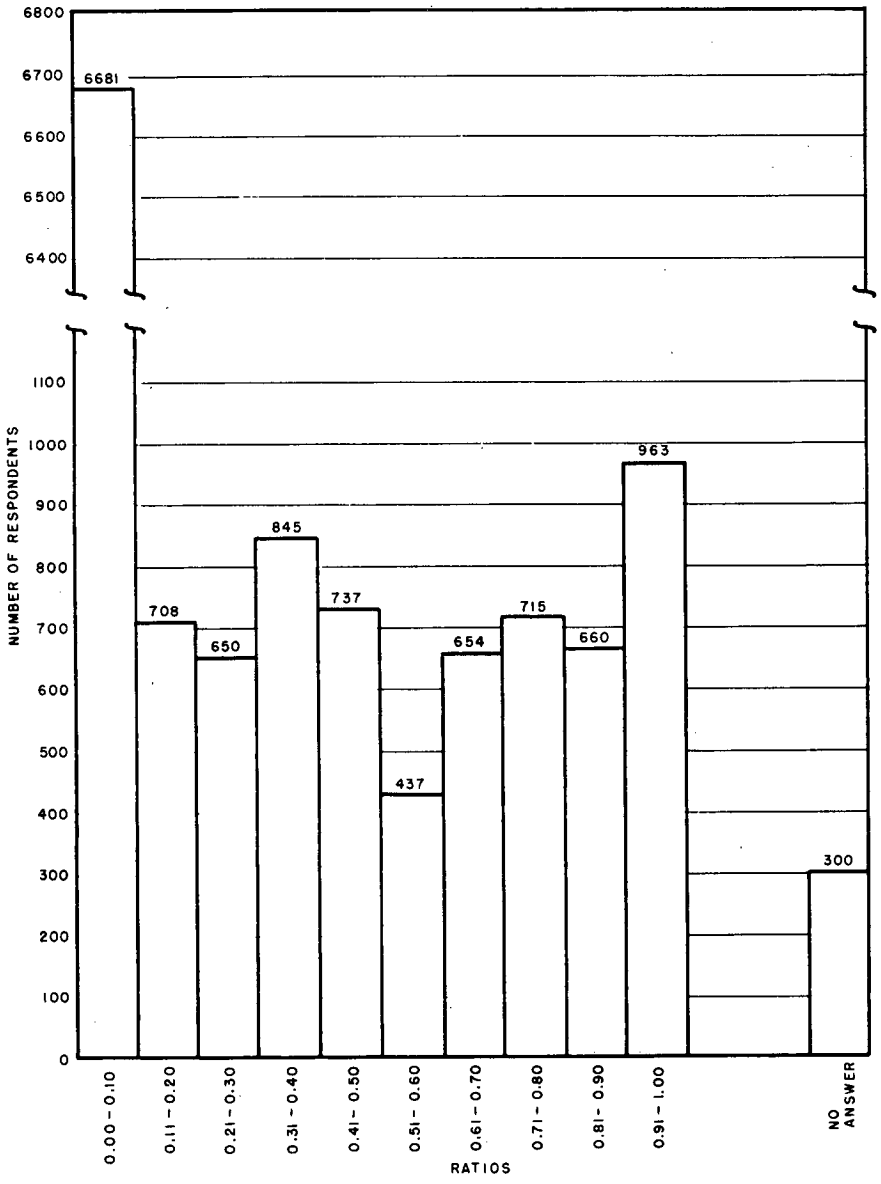


Figure B-3. Ratio distribution.

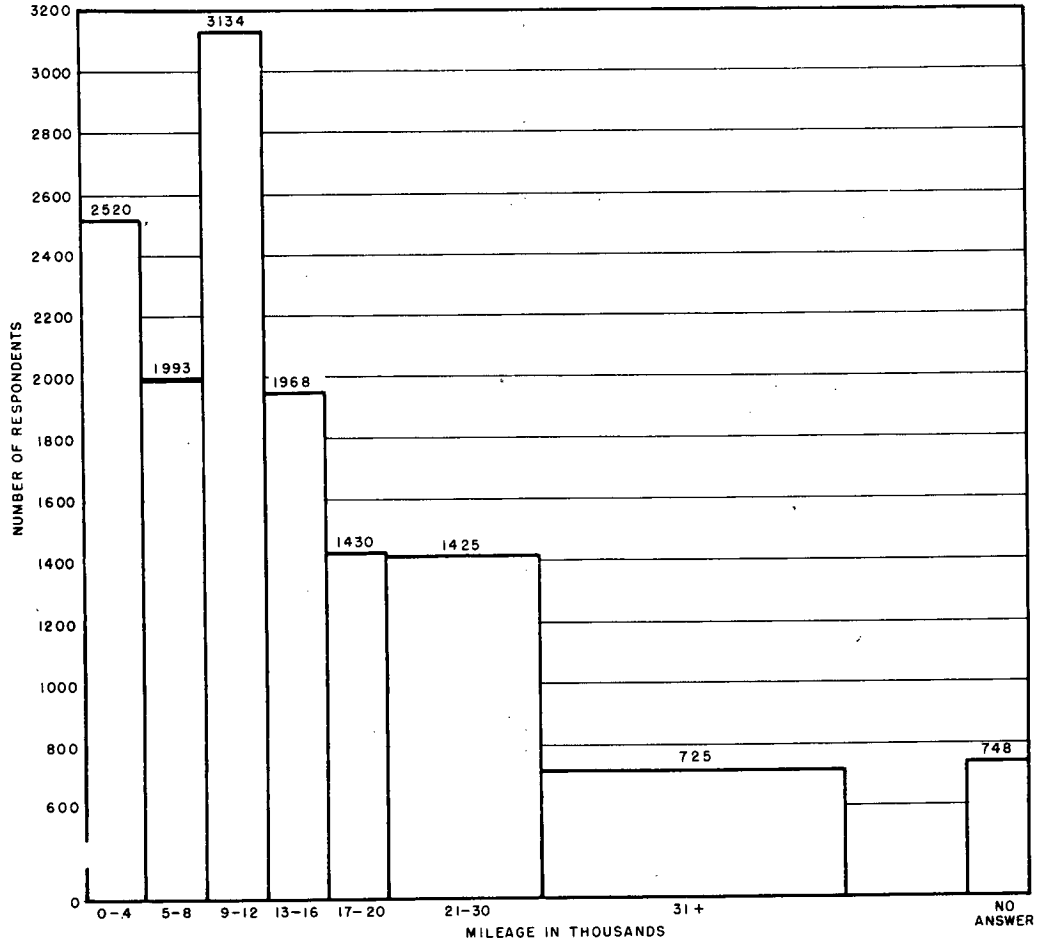


Figure B-4. Mileage distribution.

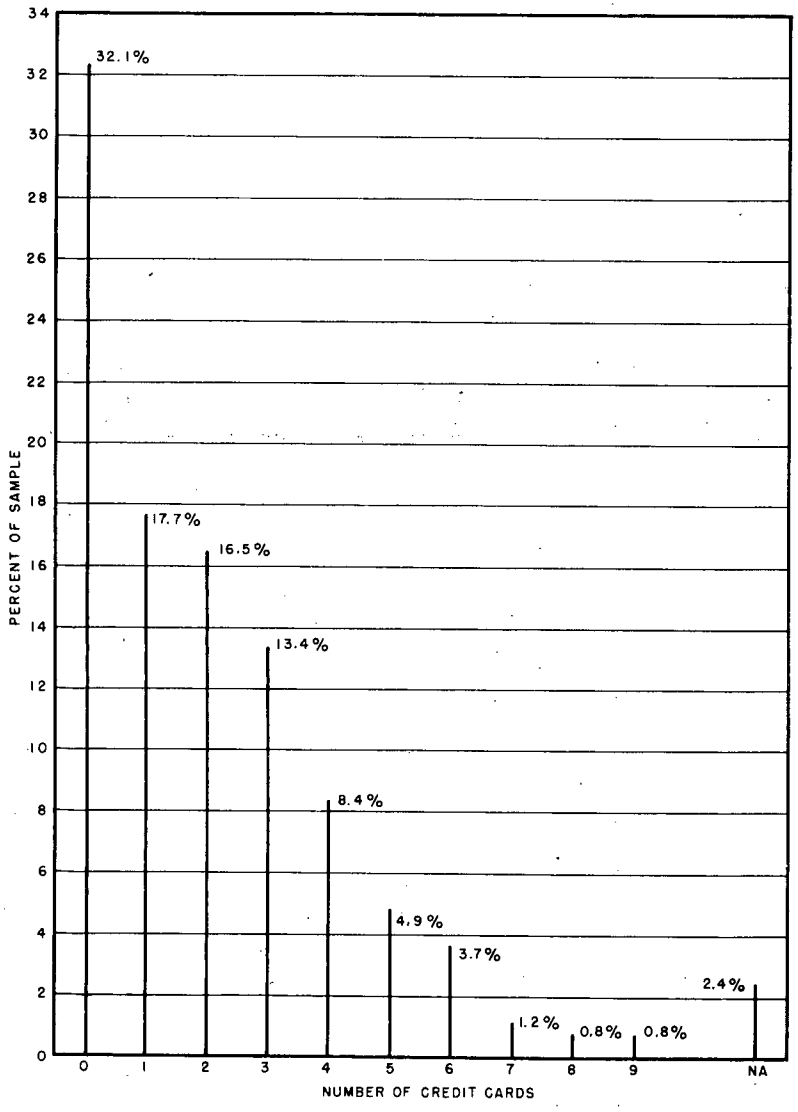


Figure B-5. Credit card distribution.

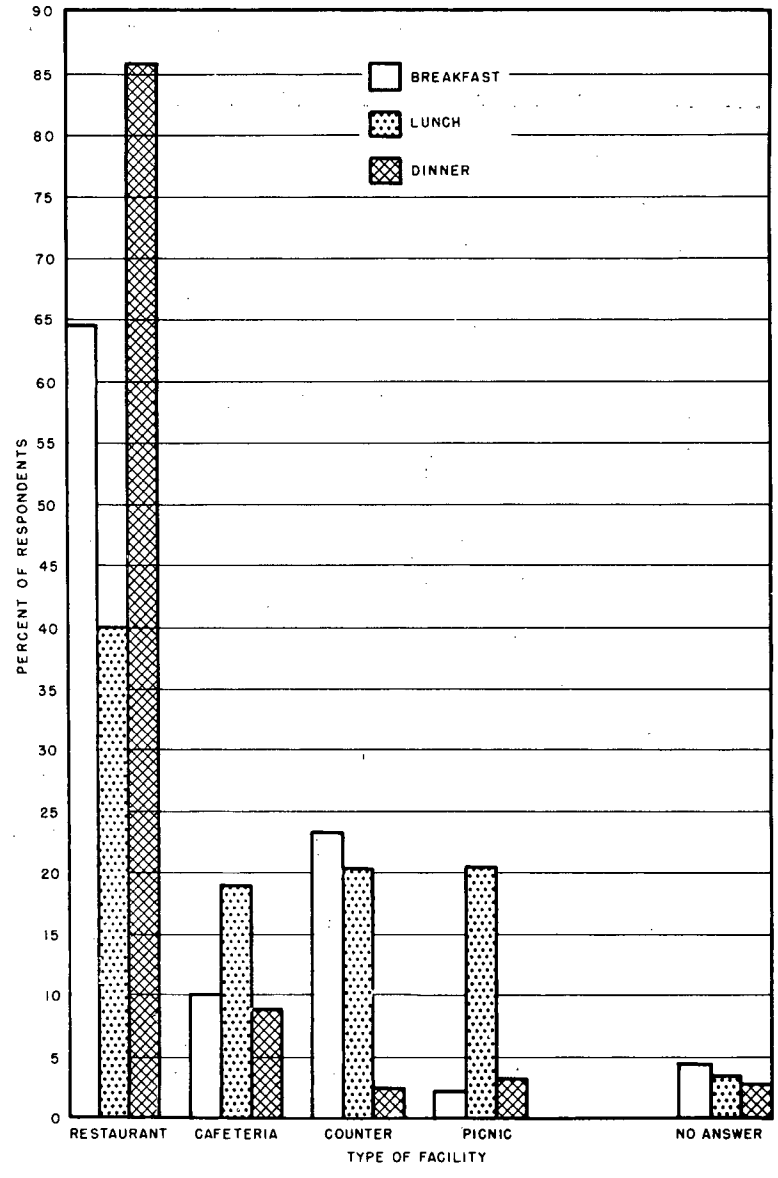


Figure B-6. Meal preference distribution.

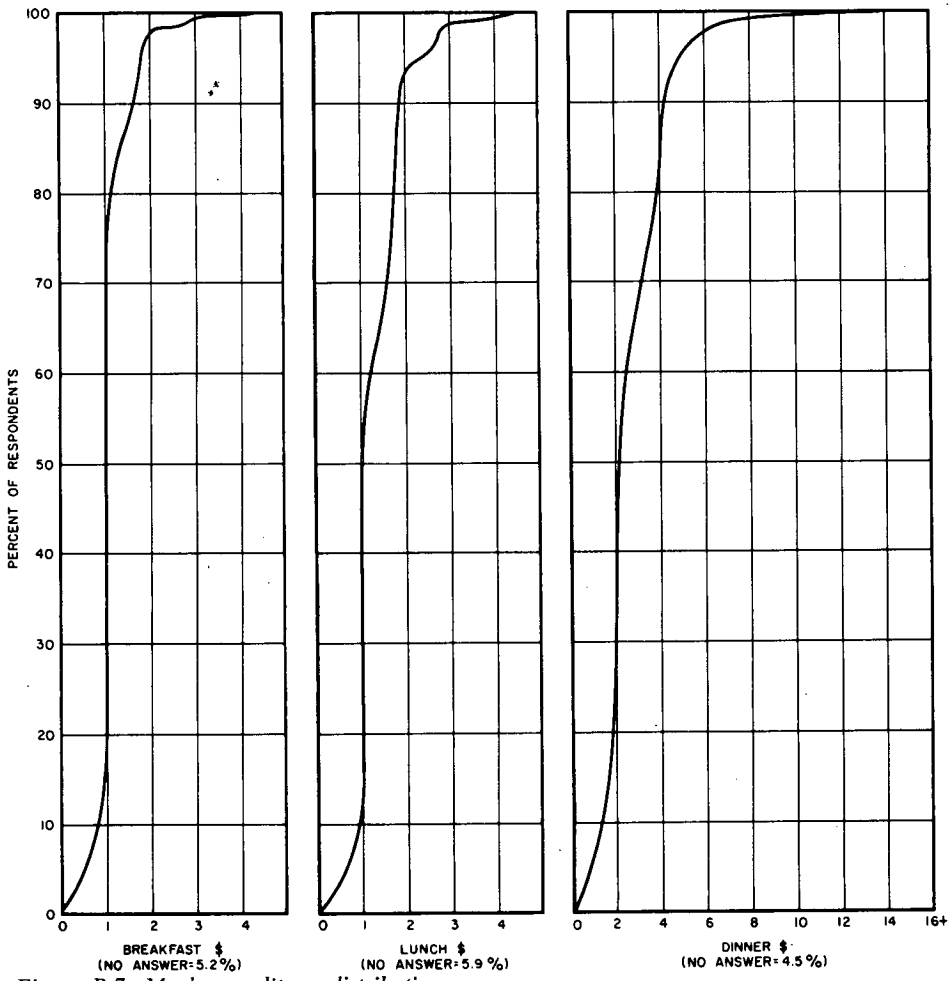


Figure B-7. Meal expenditures distribution.

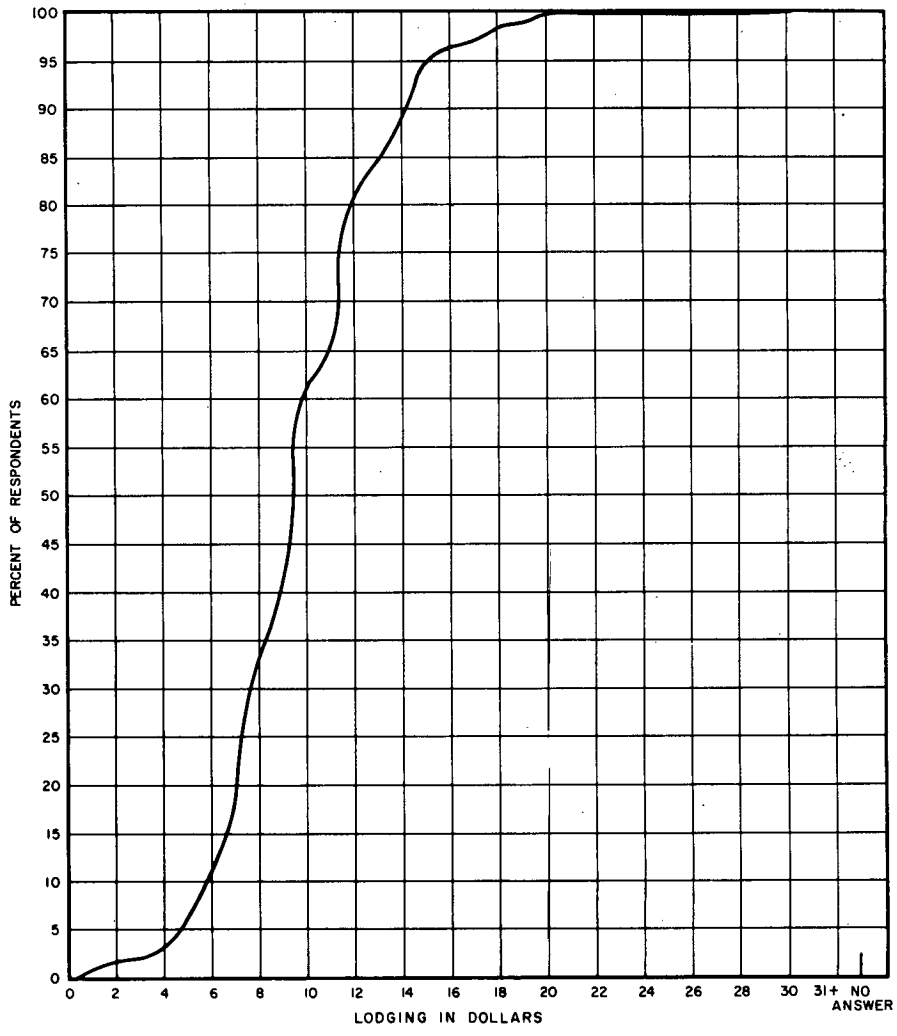


Figure B-8. Lodging expenditures distribution.

spondents chose a local inhabitant as the last person they would turn to for aid. Gasoline station attendant and self reliance are the primary sources of aid with police officer frequently rated second principally because "they're never around when you need them most." It is noteworthy that some of the respondents indicated that their choices are actually different when they are lost than when they have a mechanical problem.

11. Similarly, please indicate by 1, 2, 3, . . . the order in which any or all of the list below annoy you when traveling.

    _____Confusing or inadequate signs
    _____Billboards along highway
    _____Lack of services along freeway (gas, food, lodging, phone)
    _____Unclean restrooms
    _____Traffic
    _____Inept or incompetent drivers

Referring to Figure B-10, confusing or inadequate signs and bad drivers were definitely prime annoyances. Likewise, billboards were indicated as not being an annoyance with over 30 percent ranking it last and 35 percent not checking it at all. Unclean restrooms and traffic seem to be only moderate annoyances. The distribution for lack of services indicates that motorists tend to rank it as annoyance 1 or no annoyance at all.

12. Check the conveniences that you feel should be provided at roadside parking or rest areas.

    _____Telephone
    _____Restrooms
    _____Drinking water
    _____Picnic tables
    _____Night lighting
    _____Information aids (maps, pamphlets, . . .)

Table B-2 indicates that the respondents would like all the conveniences listed to be located at rest areas though restrooms and drinking water are in greatest demand and informational aids least in demand.

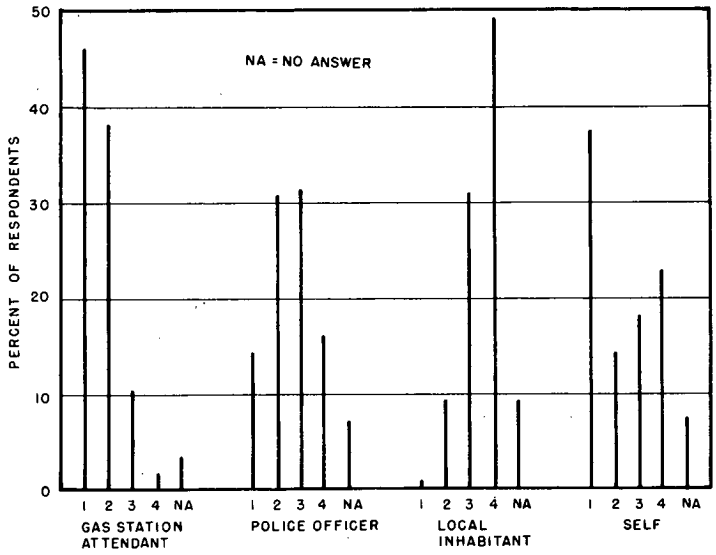


Figure B-9. Sources of aid distribution.

13. What is your occupation? _____

Table B-3 lists the occupation groups in which the respondents were placed and the percent of the total sample represented by each group.

14. Please state your age. _____ Years.

Figure B-11 indicates that the ages of the respondents follow a nearly normal distribution with a mean of about 41 years and a median of about 44 years.

CORRELATIONS

The motorists' trip purpose (ratio group) has a significant bearing on many of his traveling habits and desires. Those

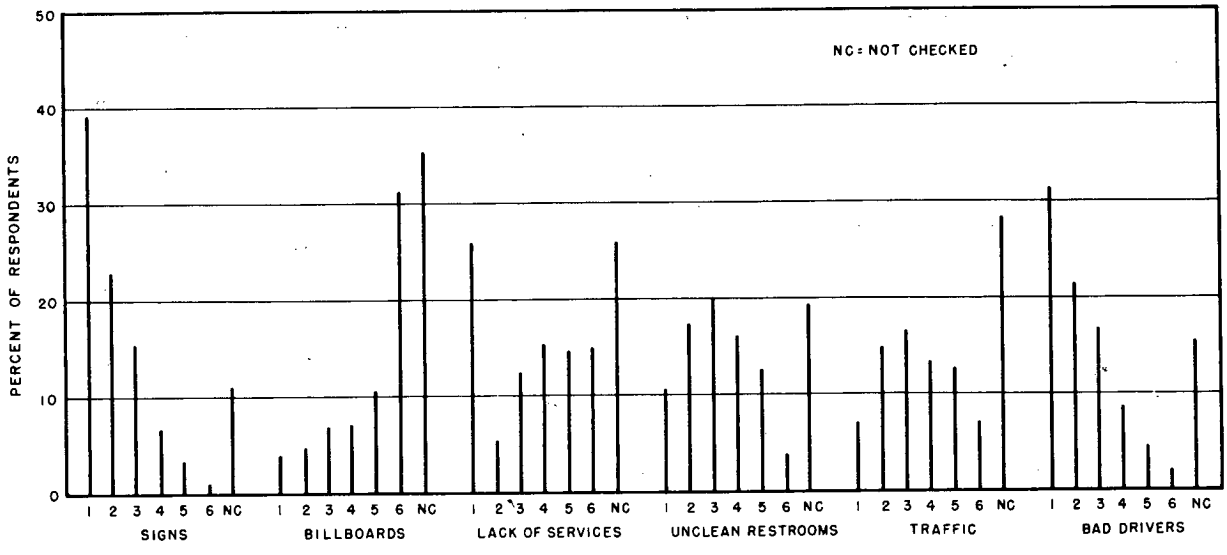


Figure B-10. Annoyances distribution.

TABLE B-2

CONVENIENCES DISTRIBUTION

FACILITY	%
Restrooms	93.6
Drinking Water	84.0
Telephones	65.9
Picnic Tables	55.6
Lighting	55.3
Informational Aids	36.1

TABLE B-3

OCCUPATION DISTRIBUTION

OCCUPATION	%
Professional, Technical and Managerial	33.8
Craftsmen and Labor	21.6
Clerical and Sales	21.4
Retired	8.7
Service	5.3
Housewife	3.9
Farm	2.8
Military	1.0
Student	1.0

who make auto trips of 100 miles or more mainly for business, drive a substantially greater number of miles per year than those traveling for pleasure (Figure B-12). There is little difference between the ratio groups when considering whether the motorists use the same gasoline; 78 percent of those making 50 percent or less of their trips for business use the same brand and 75.2 percent of those making more than 50 percent of their trips for business use the same brand. However, referring to Figure B-13, there is a direct relationship between the motorist's trip purpose and the number of credit cards he has. It should be noted that when average ratios are used in a correlation, they are valid for comparison purposes only since average ratios will always be low because the ratio distributions are heavily weighted in favor of those making 90 percent or more of their trips for pleasure.

The respondent's trip purpose seems to have no influence on his meal preferences and only a slight influence on his meal expenditures (Table B-4). This seems to indicate that the expense account society may be a myth. Since business travelers do spend slightly more for meals than pleasure-oriented motorists, one would expect the same tendency to hold for lodging expenditures. However, referring to Figure B-14, we observe that there is a distinct drop in the amount spent for overnight accommodations

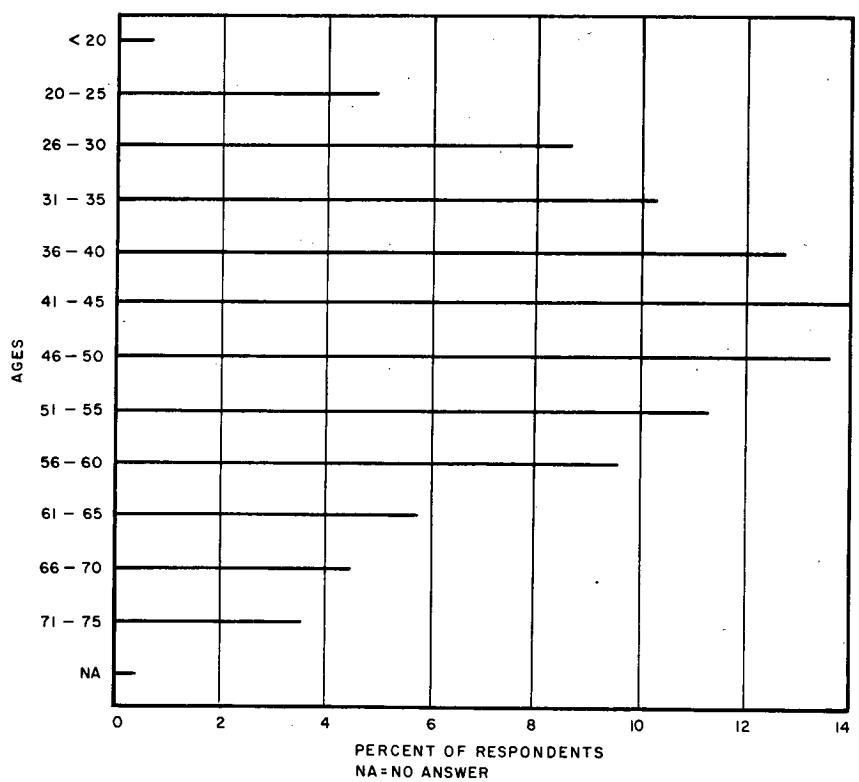


Figure B-11. Age distribution.

TABLE B-4

RATIO VERSUS MEAL EXPENDITURE

	RATIO 0.00 TO 0.50	RATIO 0.51 TO 1.00
Breakfast	$1.19	$1.19
Lunch	$1.44	$1.53
Dinner	$3.10	$3.20

for motorists making more than 70 percent of their trips for business purposes. Also, Figure B-15 indicates an inverse relationship between lodging expenditures and mileage driven per year. A possible reason for this unusual trend is related to the fact that the question dealing with lodging expenditures was asked in terms of how much the motorists spends per room. Those traveling primarily for pleasure would answer this question in terms of at least double occupancy rooms whereas those making more than 70 percent of their trips for business would presumably give a figure for a single occupancy room. It should be noted that certain expenditures were eliminated from Figure B-15 due to insignificant representation by the sample.

Figure B-16 indicates that a greater percentage of those motorists traveling mainly for business make reservations than those taking pleasure trips. In addition, those making reservations drive more miles per year (14,000) than those that do not (13,000) and spend more for lodgings ($11.50 versus $9.61).

Although trip purpose had no effect on sources of aid or annoyances, it did influence the motorists' desires for certain conveniences at rest areas. Table B-5 shows that telephones are desired more by motorists making mostly business trips whereas informational aids are desired more by those traveling primarily for pleasure. Table B-6 indicates that the only significant relationship between mileage and conveniences is that informational aids are desired primarily by infrequent drivers.

Table B-7 lists the average ratio for each occupation group. It is not surprising to see that the sales and professional groups show a high percent of business trips. However, it seems unusual to find farming with the highest ratio. This may be explained by the correlation we have already discussed in Figure B-12 between ratio and annual mileage. Farmers probably show a high percent of business trips due to the distances involved in their daily work routine rather than because they are making a trip to a person or company on business (as is the case with the professional and sales occupations). This hypothesis is substantiated in Table B-8 where we note that farmers travel more per year than any other occupation group (15,470 miles) and are followed closely by the sales and professional groups. In addition, retired people and housewives make the lowest percent of business trips and drive the least number of miles per year.

The percent of business trips made by a motorist is also related to the state in which he resides. Table B-9 shows

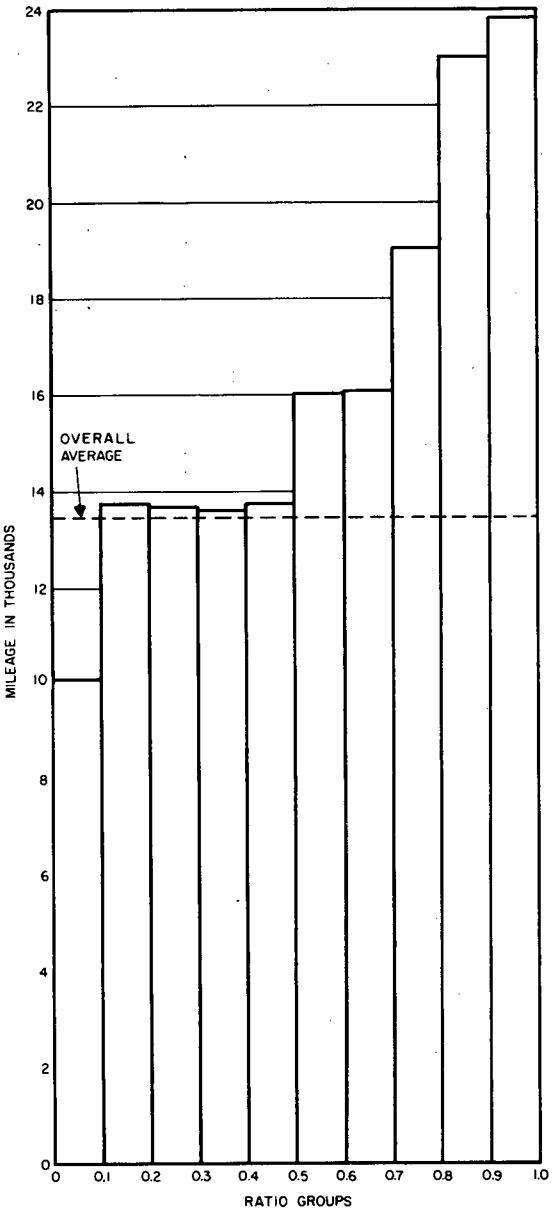


Figure B-12. Ratio vs average mileage.

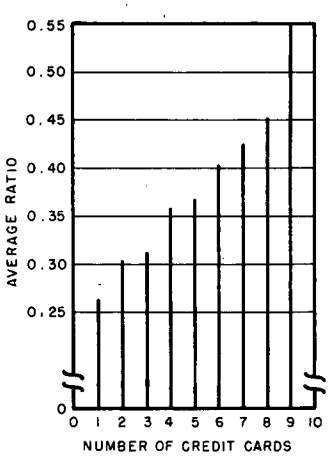


Figure B-13. Ratio vs credit cards.

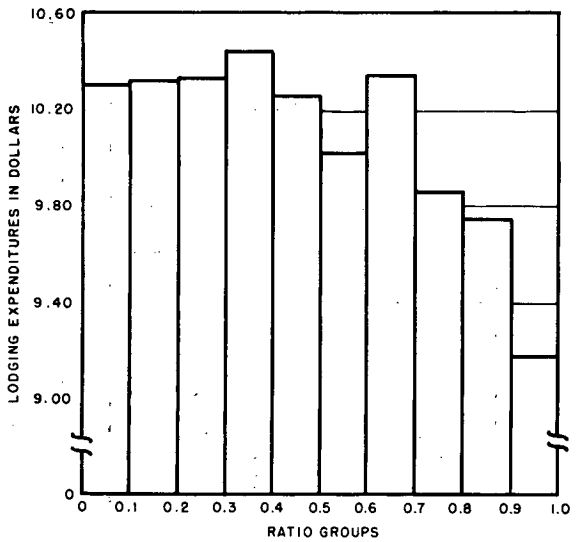


Figure B-14. Ratio vs lodging expenditures.

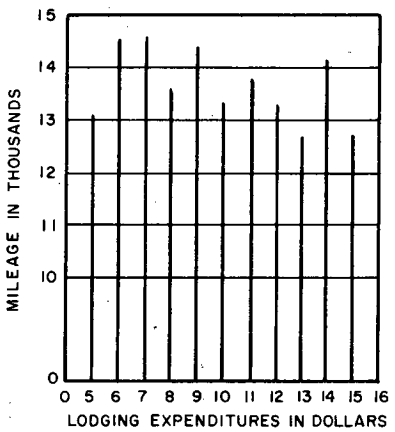


Figure B-15. Mileage vs lodging expenditures.

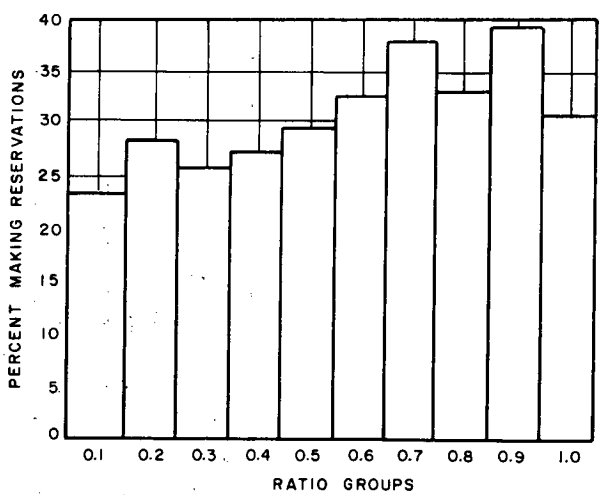


Figure B-16. Ratio vs reservations.

TABLE B-5

RATIO VS CONVENIENCES

FACILITY	RATIO GROUP 0.00 TO 0.50 (%)	RATIO GROUP 0.51 TO 1.0 (%)
Telephone	64.5	68.8
Restrooms	94.1	92.7
Drinking Water	84.8	82.0
Picnic Tables	56.8	54.2
Night Lighting	54.9	55.4
Information Aids	36.6	32.9

TABLE B-6

AVERAGE MILEAGE VS CONVENIENCES

FACILITY	CHECKED	NOT CHECKED
Telephone	13,600	13,200
Restrooms	13,500	13,400
Drinking Water	13,500	13,200
Picnic Tables	13,800	13,100
Night Lighting	13,600	13,400
Information Aids	12,600	14,000

TABLE B-7

RATIO VS OCCUPATION

OCCUPATION	AVG. RATIO
Farming	0.490
Sales and Clerical	0.362
Professional, Technical, and Managerial	0.321
Service	0.272
Craftsmen and Laborer	0.269
Student	0.233
Military	0.199
Housewife	0.171
Retired	0.159

TABLE B-8

MILEAGE VS OCCUPATION

OCCUPATION	MILEAGE IN THOUSANDS
Farm	15.47
Sales and Clerical	15.35
Professional, Technical, and Managerial	14.23
Craftsman and Laborer	13.68
Military	13.48
Service	12.94
Student	11.41
Retired	8.40
Housewife	7.78

the average ratio for the motorists in each state sampled. We feel that the ratio differences appearing here are due to heavy distributions of particular occupations within that state. Referring to Table B-10, we see that almost one third of the motorists from North Dakota are farmers, whereas the percent of motorists from Kansas who are farmers (13.4 percent) is almost four times greater than any of the remaining states. This may account for the high ratio for those two states. In addition, New York has the lowest percent of farmers and the highest percent of housewives, which may account for the low ratio of this state.

TABLE B-9

RATIO VS STATES

STATE	AVG. RATIO
North Dakota	0.46
Kansas	0.39
Texas	0.36
Florida	0.31
California	0.30
Washington	0.27
New York	0.25

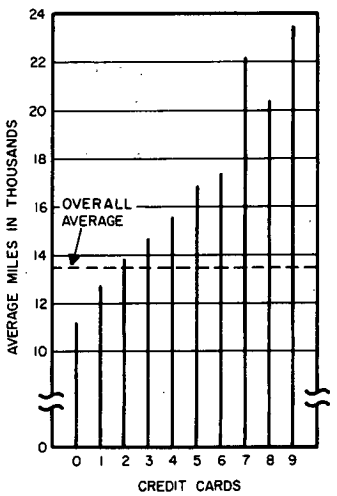


Figure B-17. Mileage vs credit cards.

TABLE B-10

STATES VS OCCUPATIONS (PERCENTAGES)

OCCUPATION	N.Y.	FLA.	CALIF.	TEX.	WASH.	KAN.	N.D.
Professional	36.7	27.3	35.9	33.7	30.8	27.1	23.6
Service	6.9	5.4	4.6	5.1	3.8	3.9	3.0
Sales and Clerical	22.1	20.1	22.0	23.1	18.2	18.4	15.8
Craftsmen and Laborer	21.3	17.9	21.2	22.4	28.4	22.9	18.2
Farm	0.8	1.2	1.8	3.6	3.4	13.4	32.0
Student	0.8	0.9	1.0	1.7	1.5	1.1	0.9
Military	0.3	2.0	1.1	1.7	0.6	0.8	0.5
Housewife	5.7	4.2	2.9	2.9	3.6	3.9	2.0
Retired	5.3	21.1	9.6	6.3	9.7	8.4	3.9

TABLE B-11

MILEAGE VS STATE

STATE	MILEAGE IN THOUSANDS
Texas	15.5
Kansas	15.5
North Dakota	14.4
California	14.2
Washington	13.3
Florida	12.6
New York	11.8

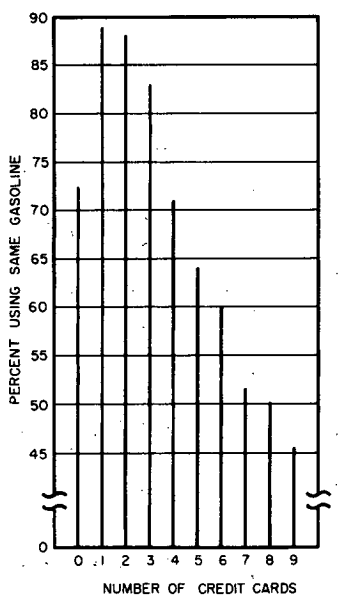


Figure B-18. Credit cards vs same gasoline.

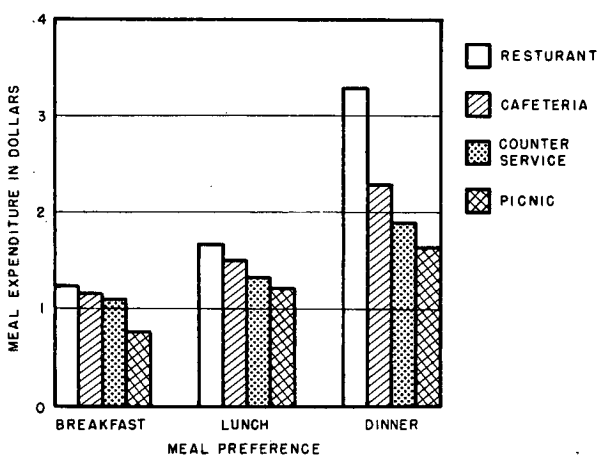


Figure B-19. Meal preference vs meal expenditure.

A relationship between ratio and average mileage again appears when comparing Tables B-9 and B-11. The same three states (North Dakota, Kansas, and Texas) show high ratios and high annual mileage figures whereas New York is last on both tables.

There is a slight relationship between the annual mileage driven by the motorist and whether he uses the same brand of gasoline. Those using the same brand average 14,600 miles and those not using the same brand average 13,200 miles. Figure B-17 indicates a direct relation between mileage driven and the number of credit cards owned by the motorist; as the mileage increases so does the number of credit cards. Figure B-18 shows the relation between the number of credit cards a respondent has and whether he uses the same brand of gasoline. Persons having no credit cards or more than three cards apparently do not use the same brand of gasoline as much as those having one, two, or three credit cards. It should be noted that a motorist having three credit cards may interpret same brand as one of the three brands designated by his cards. However, as the number of cards exceeds three, this misuse of the word "same" by the motorist becomes less likely.

Concerning meal preferences, motorists who eat in restaurants drive more miles per year than those eating in cafeterias, at a counter, or who picnic. In addition, those who eat lunch or dinner in a cafeteria drive slightly more miles annually than those eating breakfast there, but even these motorists average less than the 13,500 mile average of the sample. Figure B-19 shows that a restaurant is the most expensive place to eat followed by cafeteria, counter service, and picnicking. It is therefore logical to assume that since high mileage drivers eat primarily at restaurants, these same motorists would be spending more than the average amounts ($1.19 for breakfast, $1.47 for lunch, $3.12 for dinner) for each meal. This assumption is substantiated by Figure B-20. It should be noted that certain expenditure categories were eliminated from this figure due to insignificant representation of the sample.

Motorists traveling more than the sample average of 13,500 miles per year feel that self-reliance is the best source of aid and that a police officer is the worst (Figure B-21). Gas station attendant is used next to last by these motorists. The low-mileage drivers turn to police officers first and self-reliance last.

There are no significant relationships between annual mileage and the annoyance of unclean restrooms, traffic, or poor drivers. However, Figure B-22 indicates that poor signs, billboards, and lack of services annoy low-mileage drivers more than high-mileage drivers. Veteran drivers are usually more familiar with the areas they drive in and the types of signing available along highways and would not be confused by signs as easily as the occasional driver. In addition, being primarily business trip drivers, they would tend to be more oblivious to billboards and less concerned with services offered along the route than those motorists making mostly pleasure trips.

The motorist's age has a definite effect on his driving habits, likes, and dislikes. Figures B-23 and B-24 indicate that approximately the same age groups travel primarily for business and drive the greatest number of miles per year. Motorists between the ages of 31 and 45 make the greatest number of business trips, whereas motorists between the ages of 26 and 40 drive the most miles per year.

Figure B-25 indicates an inverse relationship between the motorist's age and his use of the same brand gasoline. This relationship may be due to a general decrease in interest in car maintenance as one gets beyond his thirties. However, referring to Figure B-26 we see that motorists in their thirties have the most credit cards.

The four age groupings designated in Figure B-27 influence meal preferences for breakfast and dinner very little, but are definitely determining factors for lunch. Restaurants are always preferred for lunch but after 45 years of age, picnicking drops from second choice to last choice whereas the reverse is true for cafeterias. The lunch preference of counter service over picnicking for those motorists under thirty may be due to many members of this group having no children or very young children and therefore not

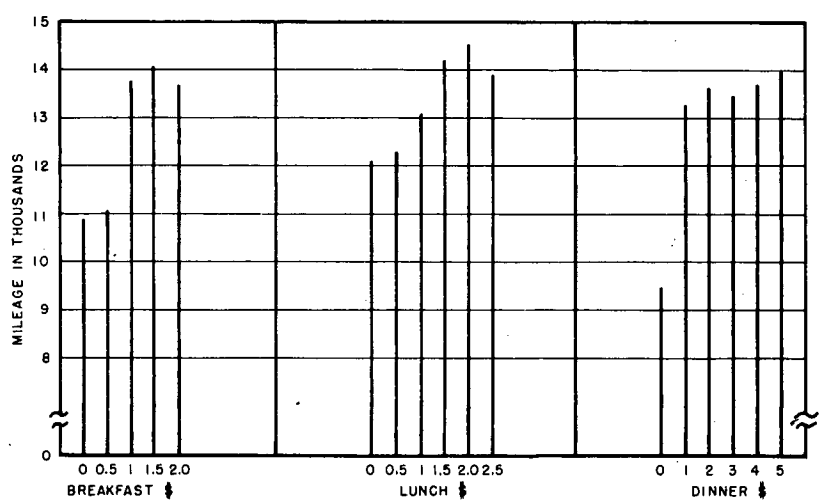


Figure B-20. Mileage vs meal expenditure.

as yet encountering the high cost of feeding a family while traveling. This hypothesis appears feasible when we look at Figure B-28, which indicates that motorists under thirty spend the most for breakfast and lunch followed by a distinct decrease in expenditures per person as age increases (as family expenses increase). The nearly normal distribution of dinner expenditures for the age groups is interesting. Motorists between the ages of 36 and 60 seem to save money on breakfast and lunch and spend more on dinner.

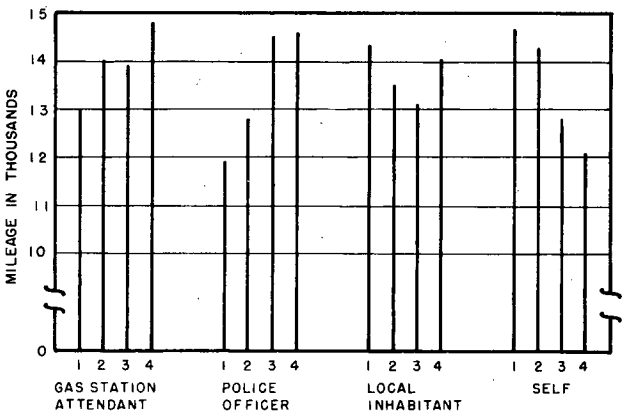


Figure B-21. Mileage vs sources of aid.

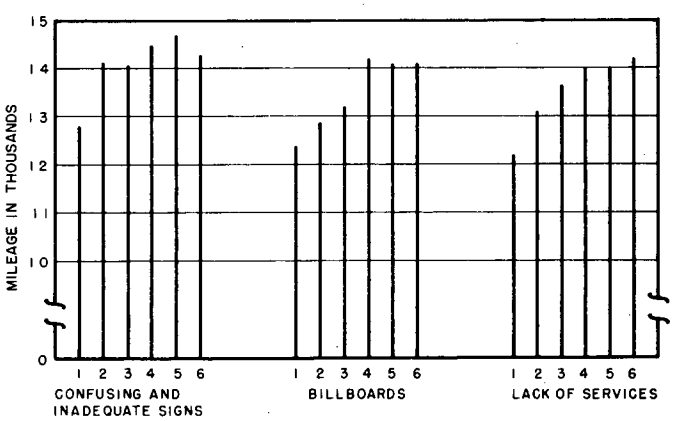


Figure B-22. Mileage vs annoyances.

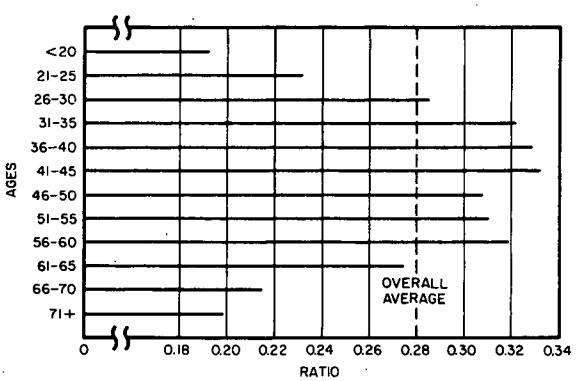


Figure B-23. Ratio vs age.

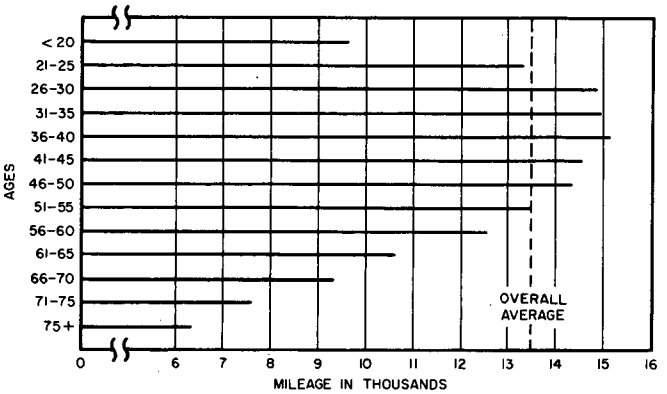


Figure B-24. Age vs mileage.

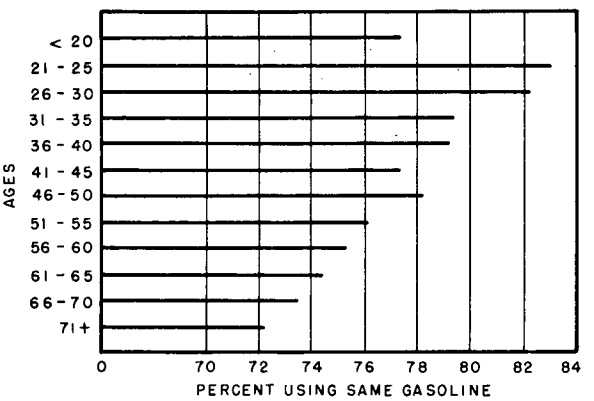


Figure B-25. Age vs same gasoline.

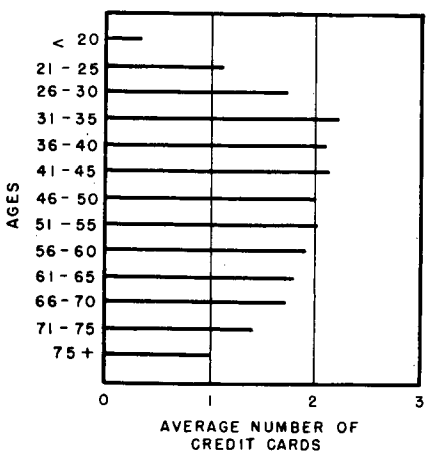


Figure B-26. Age vs credit cards.

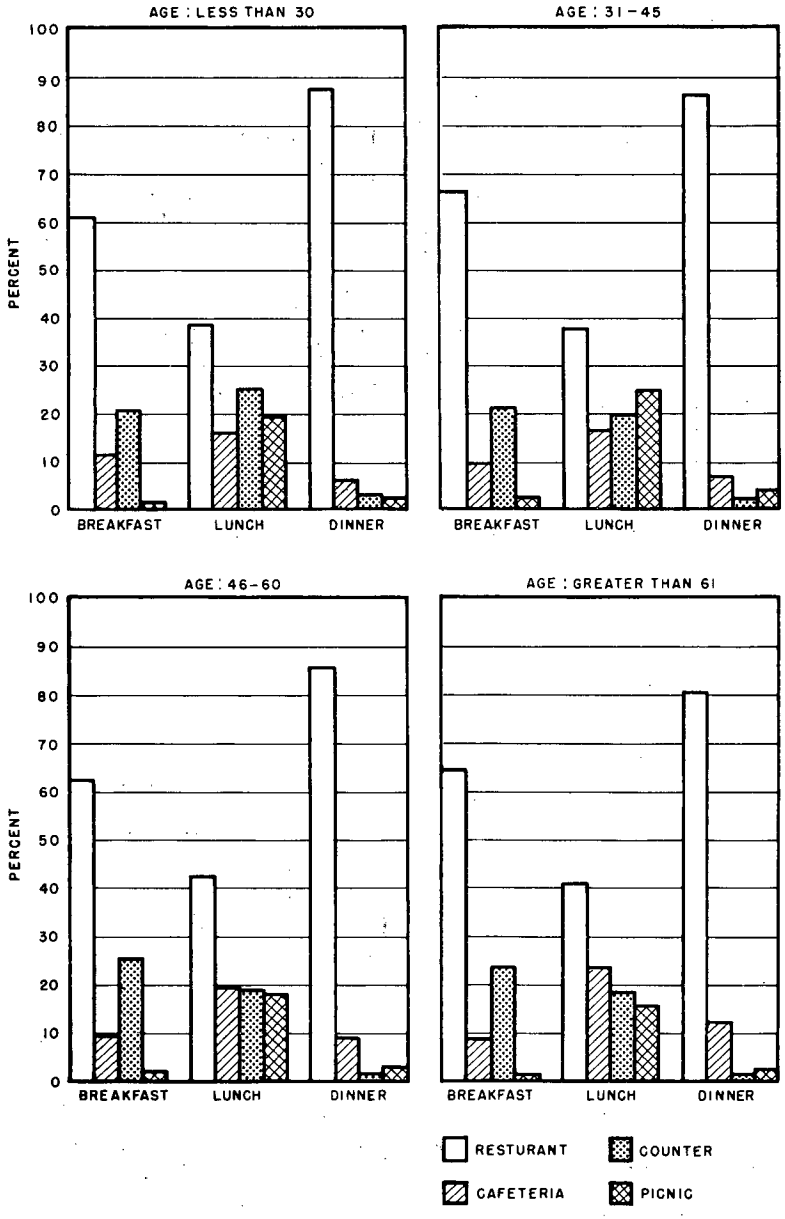


Figure B-27. Age vs meal preference.

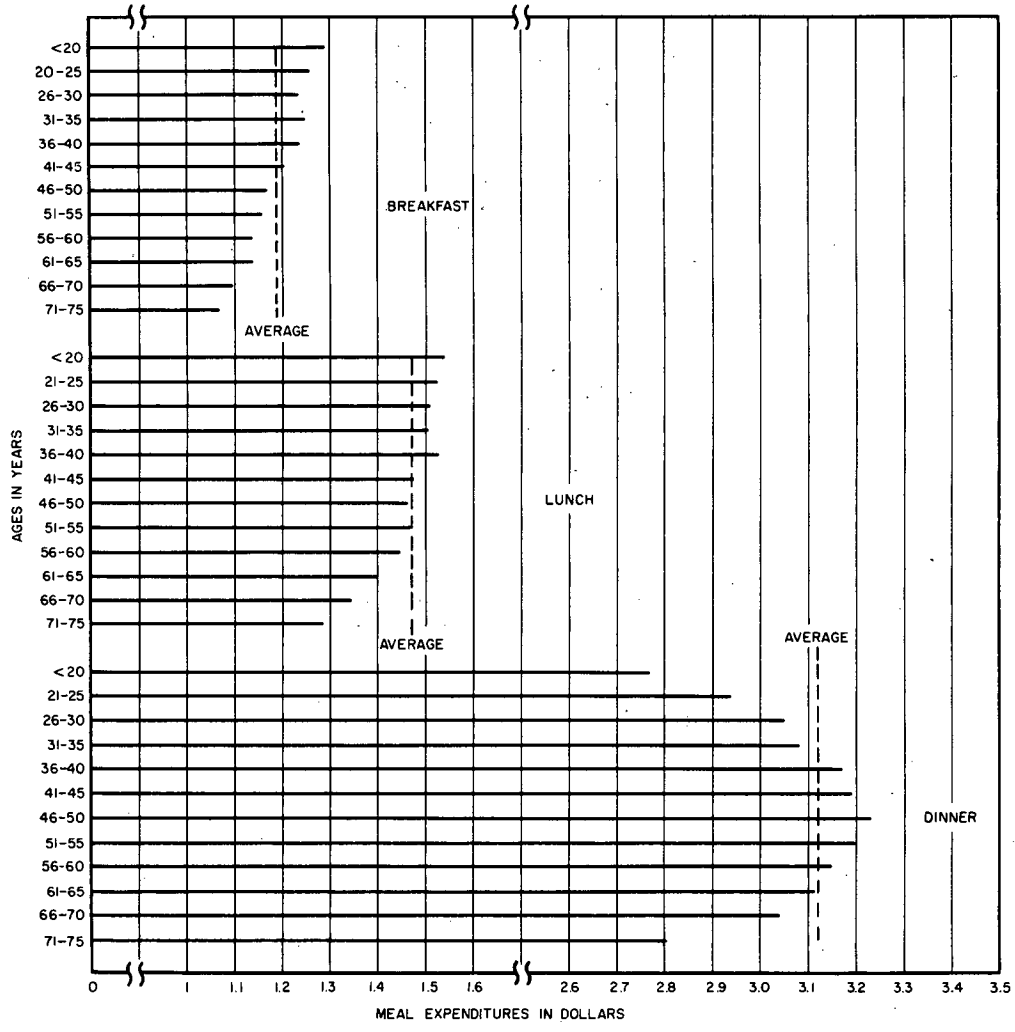


Figure B-28. Age vs meal expenditure.

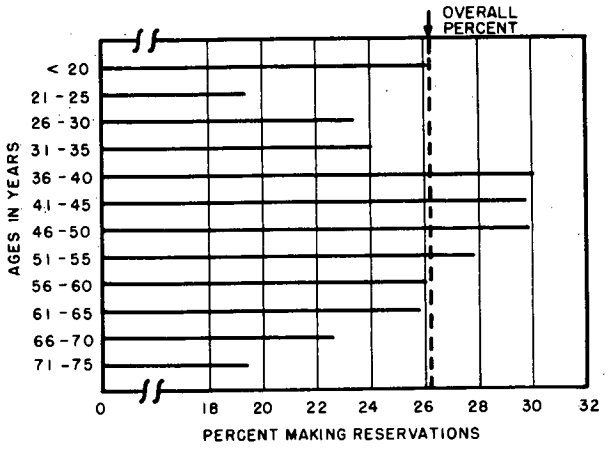


Figure B-29. Age vs reservations.

These motorists presumably use dinner as a form of entertainment, possibly including an alcoholic beverage as part of the dinner. A similar middle age group indicates that they make the most reservations (Figure B-29) and spend the most for overnight accommodations (Figure B-30).

All of the age groups designated that a local inhabitant would be the last person to whom they would turn for aid when lost or when faced with a mechanical problem. Figurge B-31 compares each age group with the average ranks given to the other sources of aid. Remembering that a rank of one means that the motorist would use that source of aid first, as the average rank gets larger the source of aid becomes less valuable to that age group. For example, a gasoline station attendant is used as a source of aid more by a motorist 55 years old (average rank 1.60) than by one 21 years old (average rank 1.85). As a motorist gets older, he is more likely to go to either a gas station attendant or a police officer for aid and less likely to be self-reliant.

The same method of average rank was used for Figure B-32, where age is compared with annoyances. Neither restrooms nor billboards appear on the graph because they were ranked relatively the same by all age groups with billboards being very definitely last (average rank between 5.4 and 5.7); unclean restrooms ranged in average rank

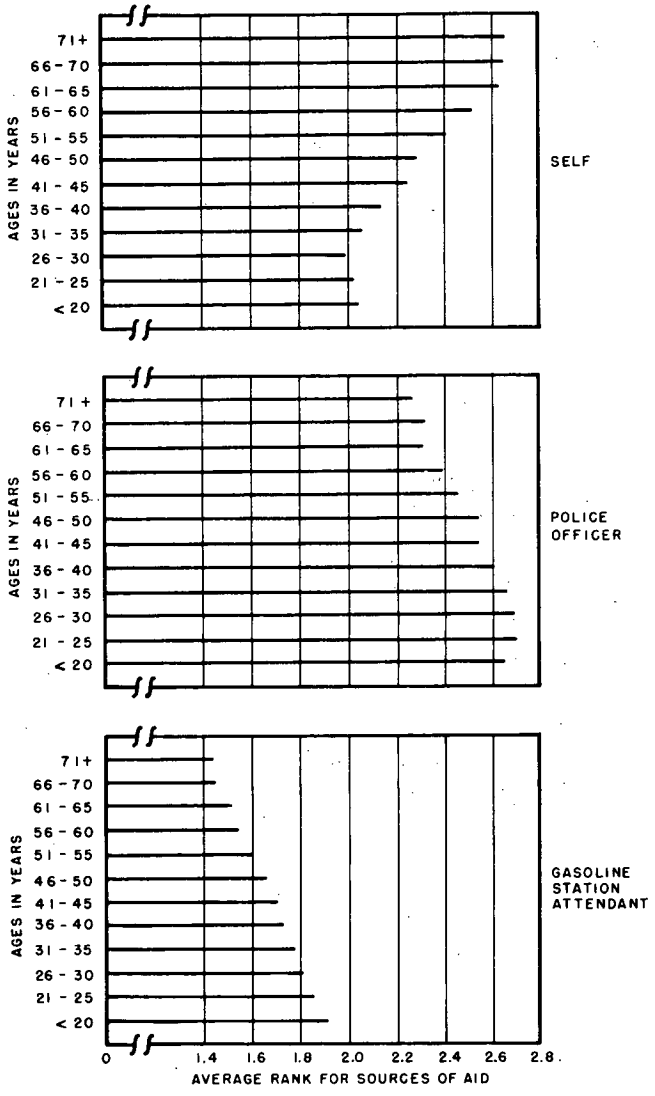


Figure B-31. Age vs sources of aid.

from 3.9 to 4.3. Poor signing seems to annoy the middle-aged motorists the most whereas lack of services, traffic, and poor drivers annoy the youngest motorist the most,

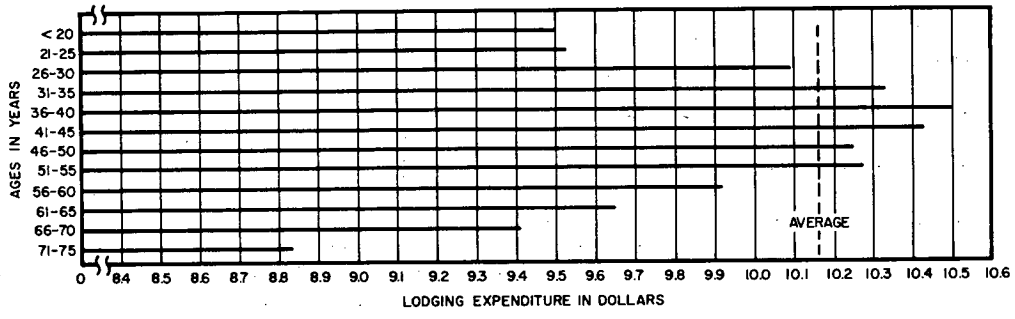


Figure B-30. Age vs lodging expenditure.

becoming less annoying as the age of the motorist increases.

Figure B-33 shows the age distributions for each state. Florida has more motorists over age 60 than any of the other states giving that state a high average age of 49. (This occurs because of the high percentage of retired people there.)

The state in which a motorist resides influences many of his habits, likes, and dislikes. Table B-12 indicates that a significantly fewer number of motorists from Kansas individually use the same brand of gasoline than motorists from the other states. This may be due to a lack of availability of gas stations in the state thus not enabling the motorist to use the same brand of gasoline even if he wanted to. Table B-13 indicates that motorists from Texas average the most number of credit cards (2.6) while New Yorkers average the least (1.1).

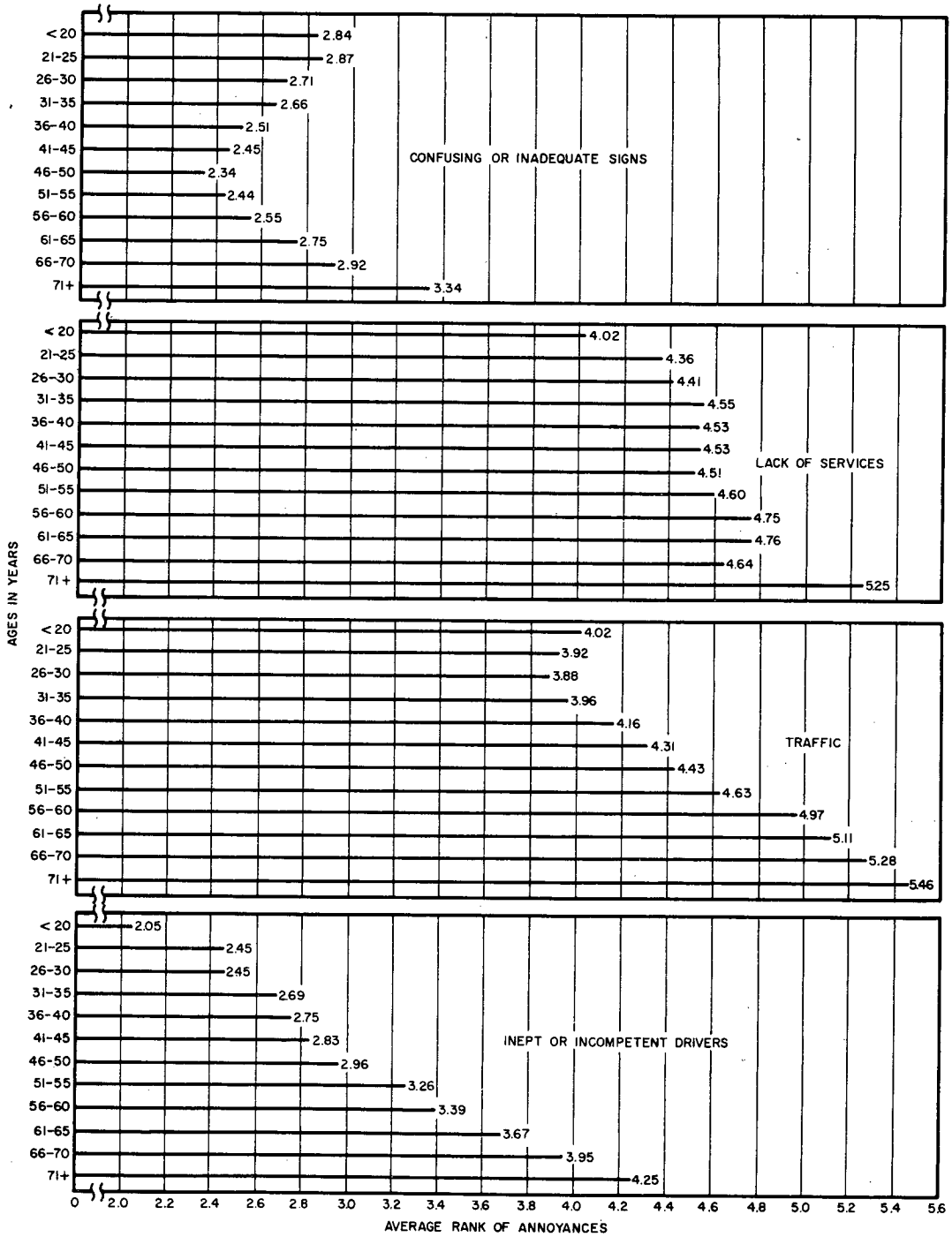


Figure B-32. Age vs annoyances.

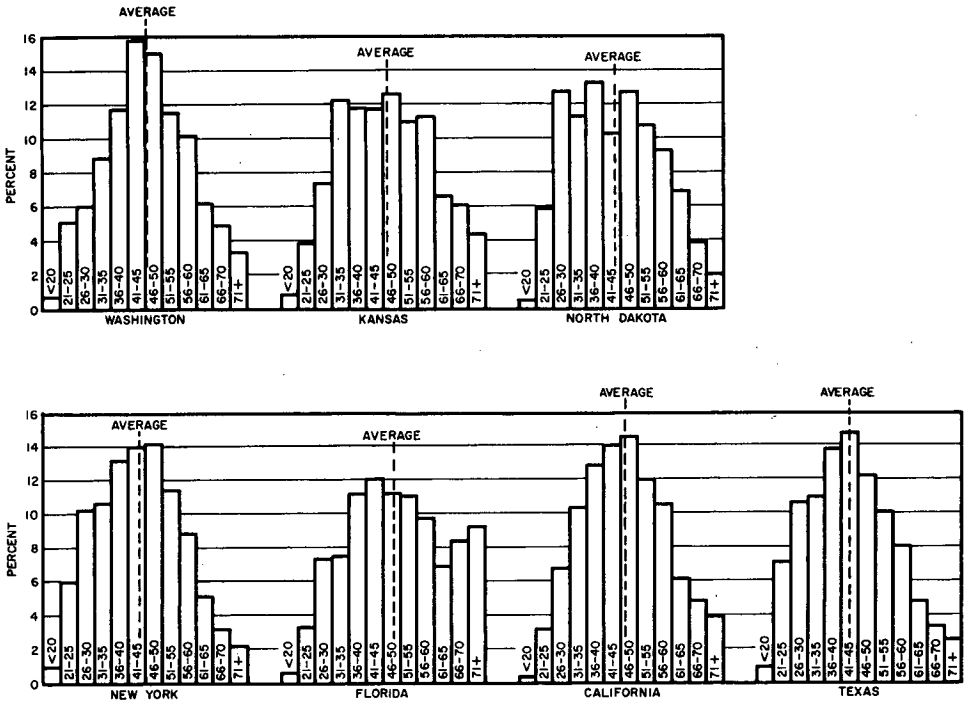


Figure B-33. Age vs States.

Meal preferences and meal expenditures vary according to the state in which a motorist resides (Figures B-34 and B-35). Restaurants are preferred for all meals by each of the states but the "New York pace" seems to influence many New Yorkers in abandoning the leisurely breakfast and lunch in a restaurant for quick service at a counter. However, New Yorkers eat dinner in restaurants more than motorists from the other states and spend the most money for it. Picnicking predominates for lunch in California and Washington, whereas the cafeteria is a favorite for lunch in Texas. Motorists from Florida and Texas eat dinner at a cafeteria far more than those from other states, but still consider restaurants a better choice.

Figure B-35 indicates that motorists from California spend more for breakfast than those from other states and are second to New Yorkers for lunch and dinner. These two states also lead in expenditures for overnight accommodations (Figure B-36). Kansas and North Dakota motorists spend less for their meals and lodgings than any of the other motorists. Table B-14 lists the percent of motorists in each state making reservations.

Comparing Table B-14 and Figure B-36, we see that the states with the largest percent of motorists making reservations spend the most for their lodgings.

Referring to Figure B-37, which gives the average rank of sources of aid for each state, we see that motorists from all states would go to a local inhabitant last for aid. Although all motorists use a gasoline station attendant first for aid, New Yorkers would not use the attendant quite as much as the other motorists. In addition, New Yorkers and Floridians are the only motorists who use a police officer for aid before being self-reliant.

TABLE B-12

STATES VS SAME GASOLINE

STATE	% USING SAME GASOLINE
Washington	80.2
California	79.3
New York	79.2
Texas	76.0
North Dakota	75.4
Florida	74.2
Kansas	68.5

TABLE B-13

STATES VS CREDIT CARDS

STATE	AVG. NO. OF CREDIT CARDS
Texas	2.6
California	2.3
Kansas	2.3
Washington	2.0
Florida	1.9
North Dakota	1.8
New York	1.1

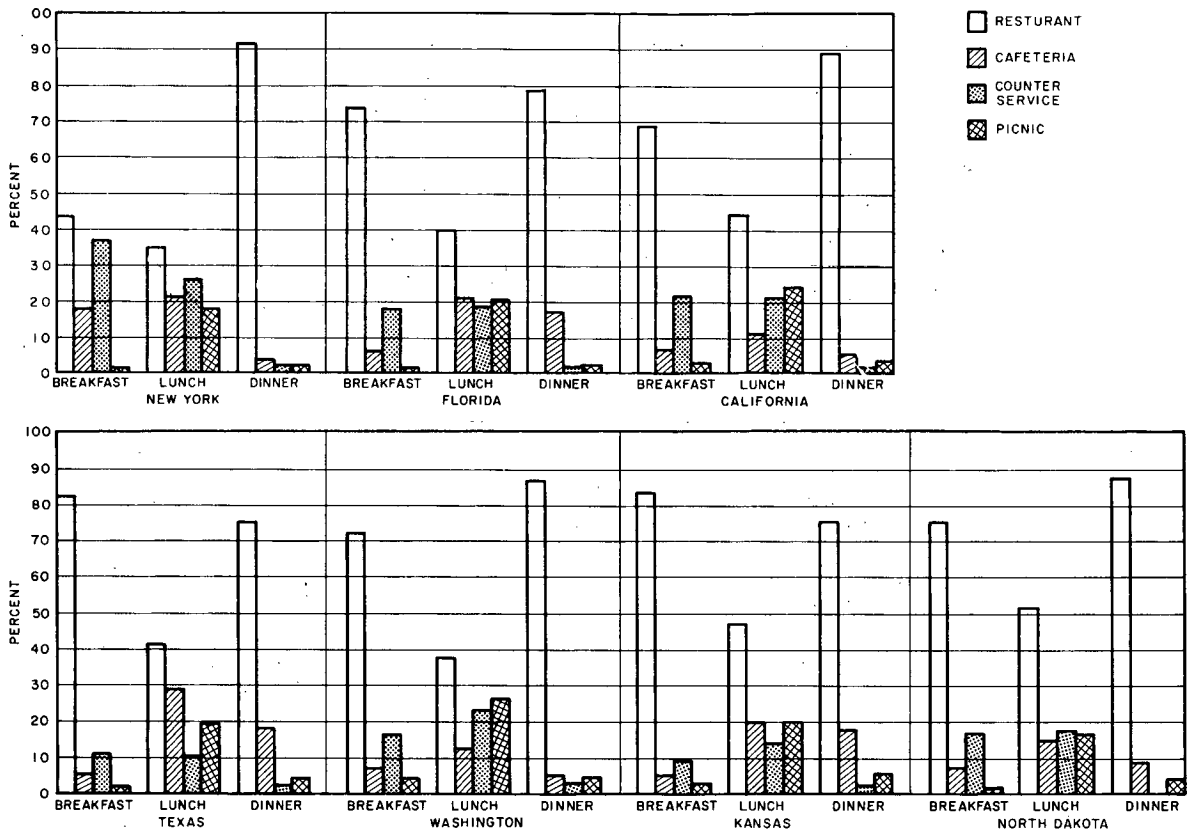


Figure B-34. States vs meal preference.

Figure B-38 indicates that though motorists from the various states agree on the order of their three main annoyances (the three lowest average ranks), it is obvious that New Yorkers are most annoyed with poor signs and least annoyed with unclean restrooms; Floridians are least annoyed with bad drivers. Since restrooms in gasoline stations are usually the worst in terms of cleanliness and New Yorkers use station attendants for aid least, it seems reasonable that New Yorkers would be least annoyed with unclean restrooms. Billboards are considered to offer the least annoyance in all states.

In addition to the motorists' age and the state in which he resides, his occupation is significant in determining his behavior. Table B-15 lists the percent of motorists in each occupation group individually using the same brand of gasoline; Table B-16 gives the average number of credit cards owned by these motorists.

Figure B-39 indicates that all occupation groups prefer a restaurant for each meal. However, farmers and military men prefer a restaurant for breakfast more than other occupation groups. Picnicking is preferred for lunch by service persons, craftsmen, laborers, military men, and housewives. Retired persons, farmers, craftsmen and laborers eat dinner in a cafeteria more often than motorists from the other occupation groups. Figure B-40 indicates that though there are differences in meal expenditures for each occupation group, major differences appear for dinner only. Farmers spend little for all meals. This would account for the low meal expenditures of motorists from Kansas and North Dakota (Figure B-35), since these two states have the largest proportion of farmers. Farmers spend little for lodgings as well (Figure B-41), which would account for Kansas and North Dakota also showing low lodging expenditures in Figure B-36.

Table B-17 lists the percent of motorists from each occupation group making reservations. Comparing this table to Figure B-41, we see that the occupation groups that spend the most for lodgings also have the greatest percent of motorists making reservations and vice versa. The occupa-

TABLE B-14

STATES VERSUS RESERVATIONS

STATE	% MAKING RESERVATIONS
New York	32.9
California	26.3
Texas	26.1
Washington	20.0
Florida	19.7
Kansas	19.3
North Dakota	14.4

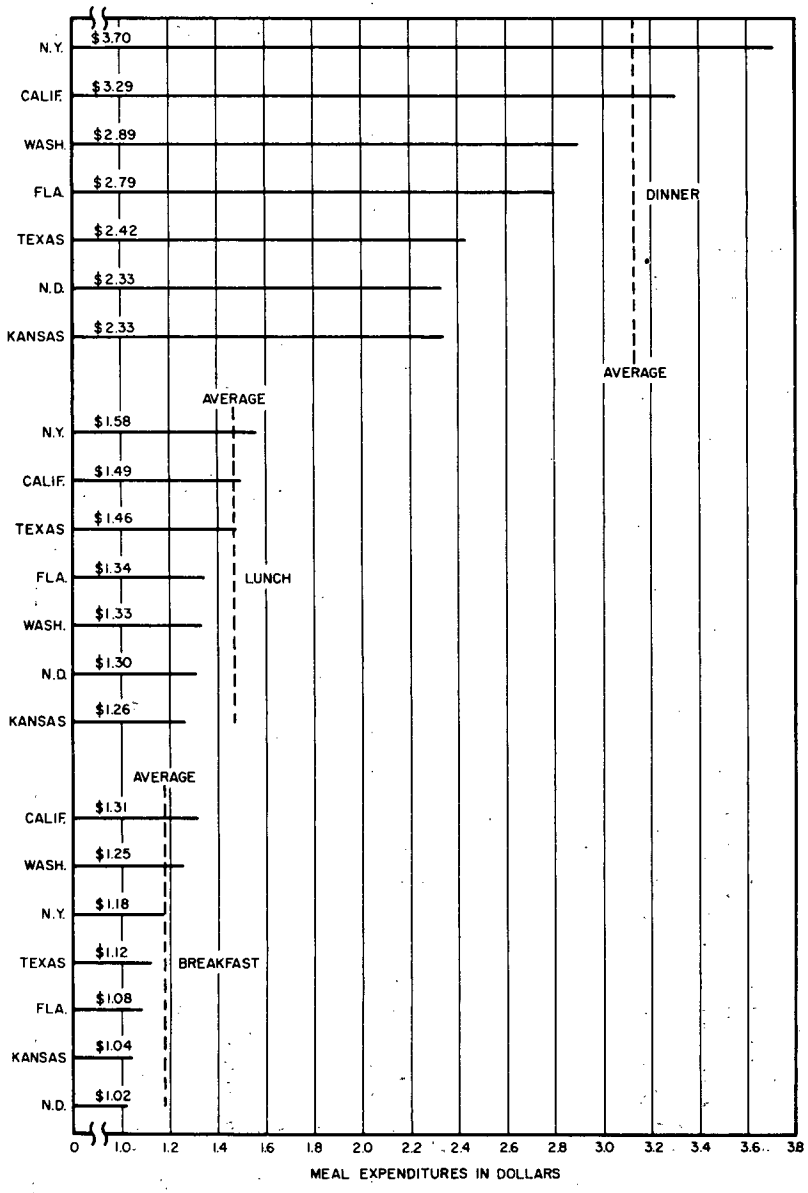


Figure B-35. States vs meal expenditure.

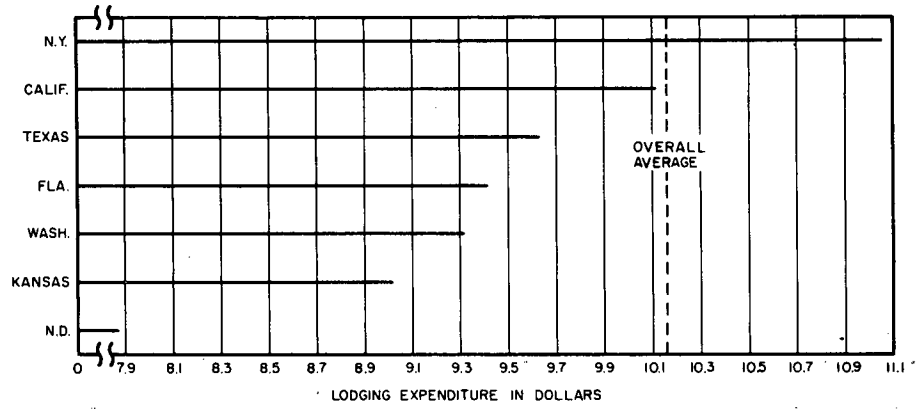


Figure B-36. States vs lodging expenditure.

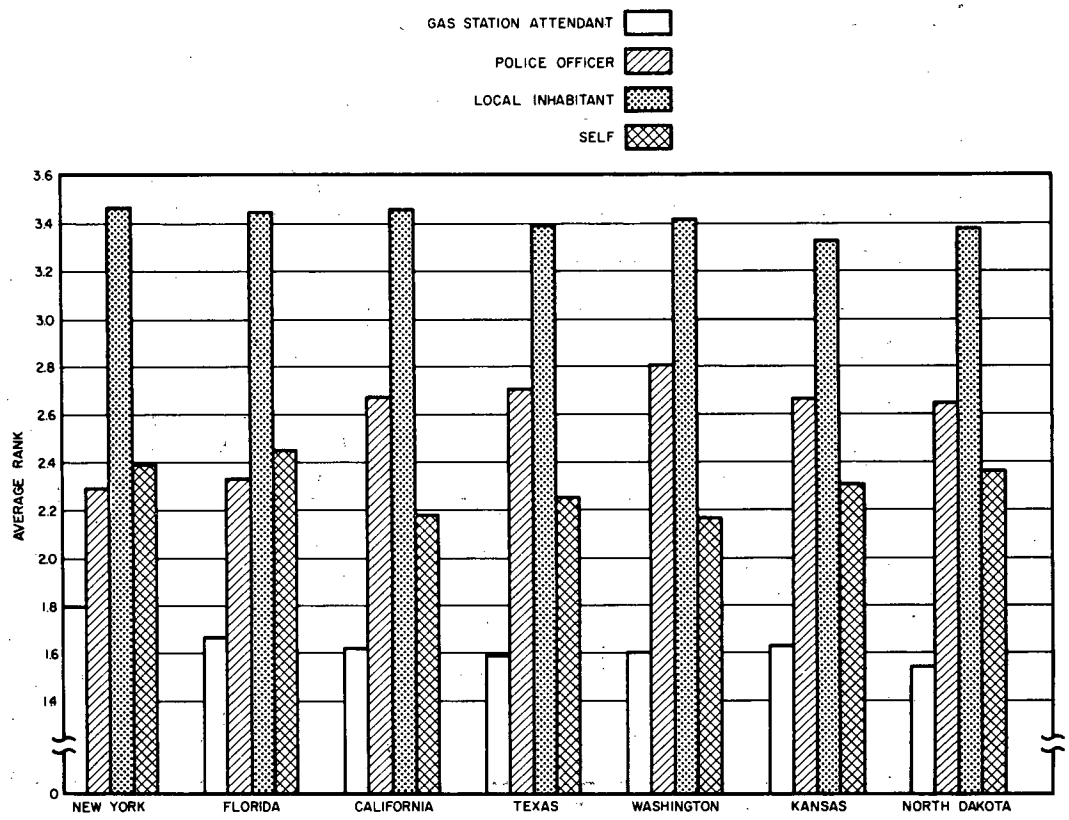


Figure B-37. States vs sources of aid.

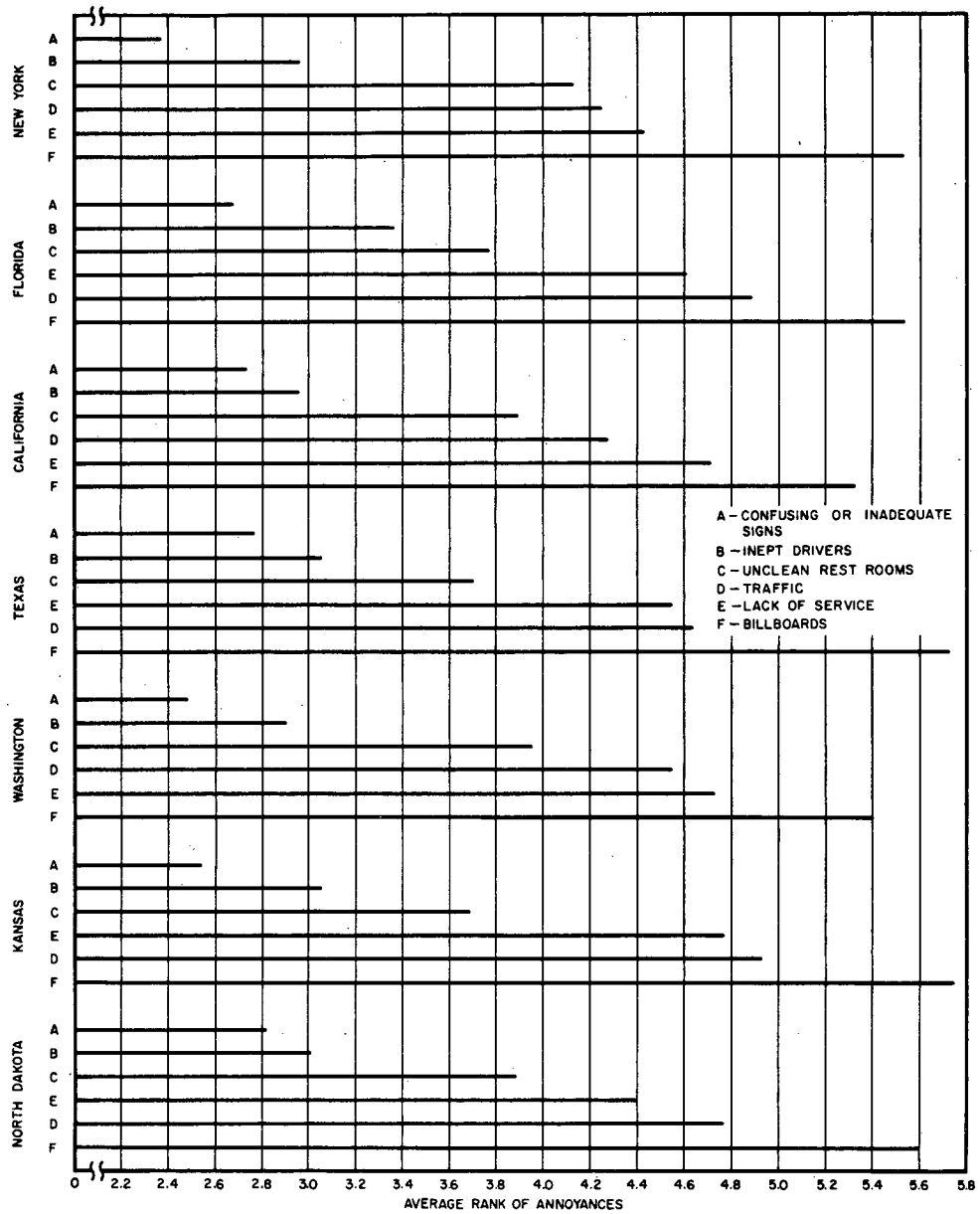


Figure B-38. States vs annoyances.

TABLE B-15

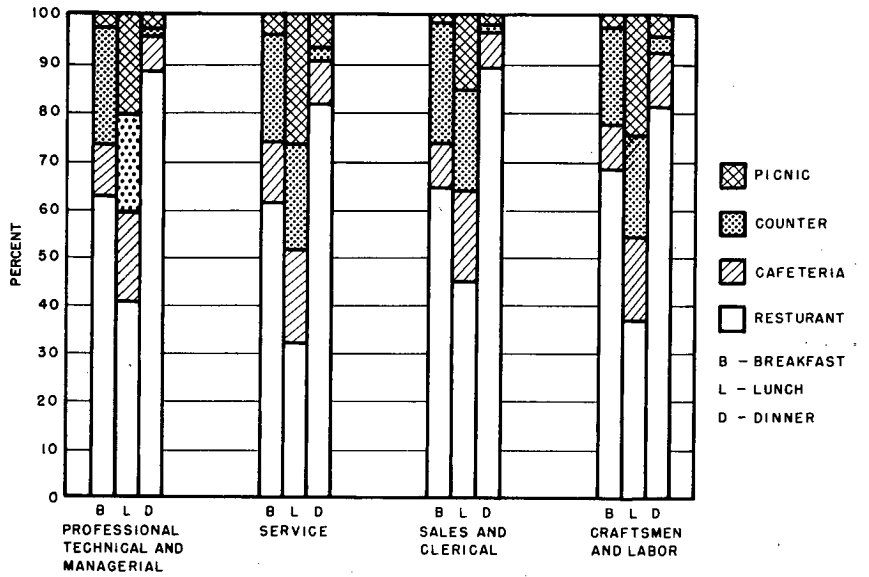
OCCUPATIONS VS SAME GASOLINE

OCCUPATION	% USING SAME GASOLINE
Housewife	83.9
Professional, Technical, and Managerial	79.2
Service	78.4
Craftsmen and Laborer	77.9
Military	77.0
Sales and Clerical	76.4
Farm	75.7
Student	72.7
Retired	72.7

TABLE B-16

OCCUPATIONS VS CREDIT CARDS

OCCUPATION	AVG. NO. OF CREDIT CARDS
Professional, Technical, and Managerial	2.3
Sales and Clerical	2.2
Military	1.7
Farm	1.7
Retired	1.6
Service	1.5
Craftsmen and Laborer	1.4
Housewife	1.1
Student	0.9



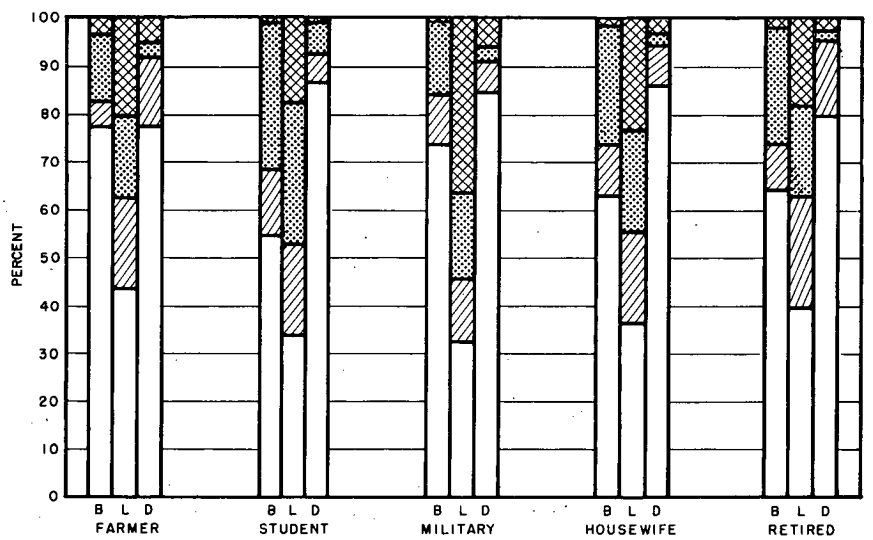
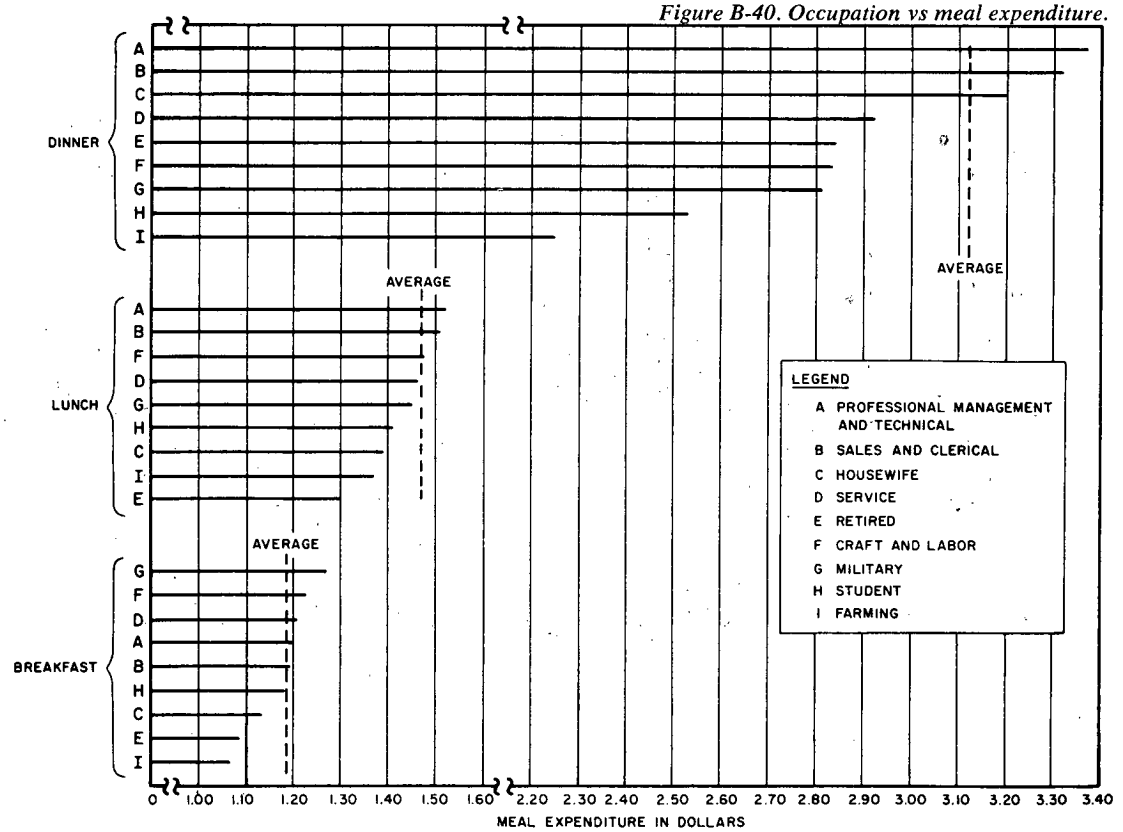


Figure B-39. Occupation vs meal preference.

Figure B-40. Occupation vs meal expenditure.



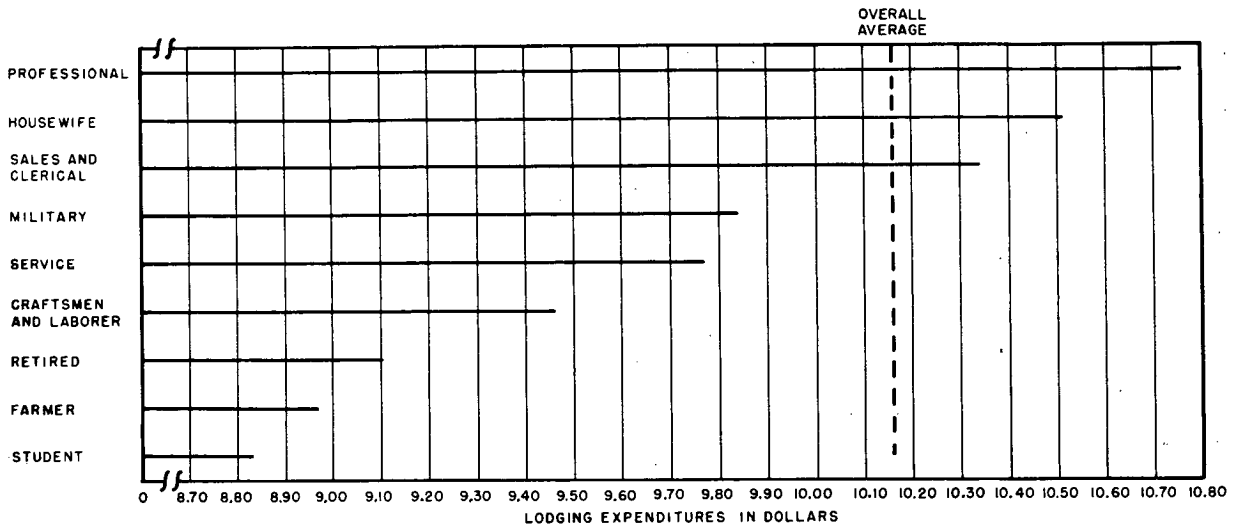


Figure B-41. Occupation vs lodging expenditure.

TABLE B-17
OCCUPATIONS VS RESERVATIONS

OCCUPATION	% MAKING RESERVATIONS
Professional, Technical, and Managerial	34.9
Sales and Clerical	32.4
Housewife	30.9
Student	20.0
Service	19.2
Retired	17.9
Craftsmen and Laborer	15.4
Farmer	13.6
Military	10.8

tion group that does not seem to fit this pattern is the military. This may occur because military men do not have to make reservations when visiting other bases. Thus, in terms of making reservations, military men are unique. This is substantiated further by the fact that when farmers are eliminated, motorists from the professional and sales occupations make the highest percent of business trips and make the most reservations. Farmers actually make the highest percent of business trips but these trips are probably not of the overnight variety.

Each occupation ranks local inhabitant last as a source of aid in Figure B-42 and ranks gasoline station attendant first. However, housewives and retired persons are the only

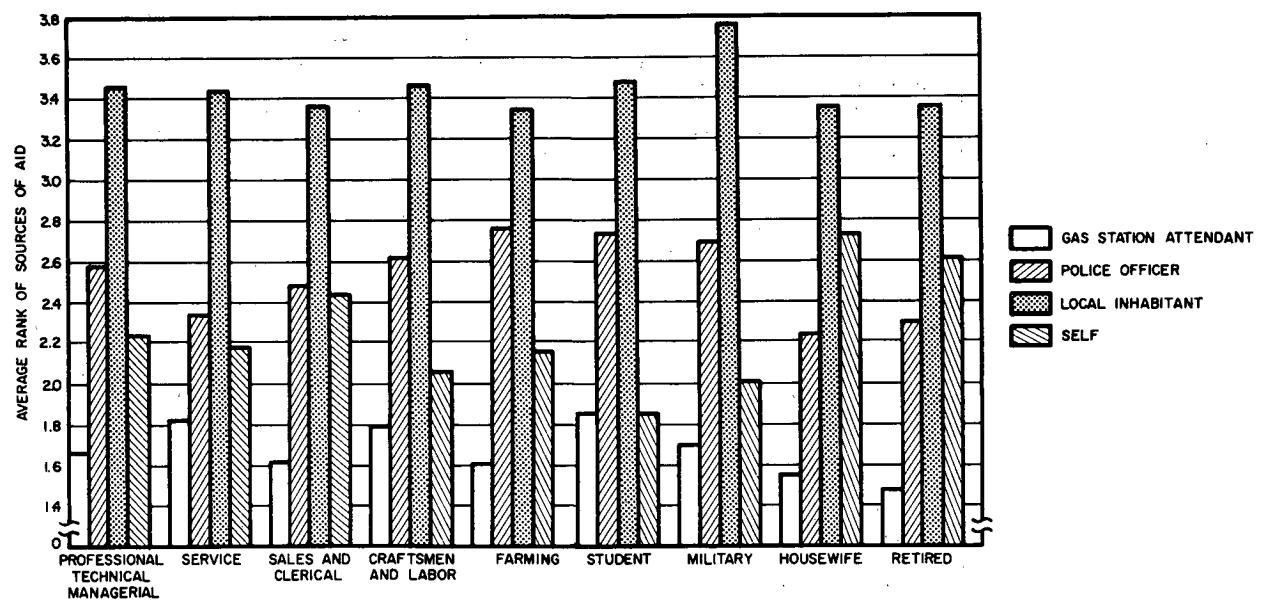


Figure B-42. Occupation vs sources of aid.

motorists who have to turn to a police officer for aid before trying to help themselves.

Table B-18 shows the average rank that the motorists from each occupation group gave to the various annoyances. Remembering that a low rank means a major annoyance, we can see that nearly all occupation groups list poor signs as the first annoyance, bad drivers as the second, and billboards last. Unclean restrooms are ranked third by all occupations except students who think traffic is more annoying.

Figure B-43 indicates the correlation between the motorists' occupations and the conveniences desired at rest areas. Restrooms, drinking water, and telephones (in that order) are considered to be the most important conveniences, and informational aids the least important convenience by all occupation groups except farmers and military men. These two groups consider picnic tables more important than telephones. This is reasonable since we have already noted in Figure B-39 that these motorists consider picnicking their meal preference for lunch.

The motorist's informational needs do not seem related to many of his other habits, likes, or dislikes due primarily to the misunderstanding of the question dealing with informational needs. As service signing on the highway stands today, service availability appears only on billboards that also carry the brand name of the service being offered. Considering the types of responses received on the question, we feel that the respondents did not realize that service availability included brand name.

Motorists checking service brand as their informational need use the same brand of gasoline more (85 percent) and have more gasoline credit cards (2.4 average) than motorists checking any of the other informational need choices. These same motorists are more annoyed with unclean restrooms than any of the others.

Students, professional people, salesmen, military men generally prefer more information on services than the other occupation groups. Retired persons are the least concerned with service availability probably because they tend to travel during regular hours, thus avoiding the problem of encountering closed service facilities.

Age has only a slight bearing on informational needs. Older motorists desire notification of service availability less and are more satisfied with only notification of services. This may occur because older motorists are more experienced as to the availability of services and are more inclined to travel during hours when most service facilities are open.

The final correlation, Figure B-44, indicates how the motorists in the various states differ as to their informational needs. It is felt that these differences are to a great extent due to the type of official signs and billboards found in each state rather than to what the motorists feel satisfy their informational needs.

SUMMARY OF QUESTIONNAIRE COMMENTS

A considerable number of respondents added their own unsolicited comments, complaints, and suggestions, indicating a lively interest and concern in the project. The following paragraphs summarize the views expressed.

Meal Expenditures and Food Service

Most comments were in reference to the high cost of food in roadside establishments. ". . . usually prepare meals at home to take on trips, . . . would pay $2.00 for dinner but can't in cities like New York, Los Angeles, Chicago, . . . most roadside restaurants overcharging for breakfast—$1.00 to $1.35, coffee extra, . . . lunch and dinner are more reasonable. . . ."

Comments relative to the service type were price motivated as well. ". . . eat in restaurants because can never find cafeteria, . . . counter service faster and more reasonably priced, would use cafeteria if available, . . . need more big diners along Route 301 and upstate New York. . . ."

Motels and Reservations

Again, cost was mentioned repeatedly. ". . . Y membership gives me good overnight quarters for far less money, . . . big '6' motels in California are excellent, . . . would

TABLE B-18

OCCUPATIONS VS ANNOYANCES (AVG. RANK)

OCCUPATION	CONFUSING INADEQUATE SIGNS	BILLBOARDS	LACK OF SERVICES	UNCLEAN RESTROOMS	TRAFFIC	INEPT OR INCOMPETENT DRIVERS
Professional	2.51	5.24	4.58	3.82	4.09	2.83
Service	2.52	5.58	4.49	4.02	4.64	3.02
Sales and Clerical	2.60	5.61	4.56	3.94	4.35	2.94
Craftsmen and Laborer	2.58	5.74	4.52	4.03	4.66	3.06
Farmer	2.76	5.61	4.77	3.93	4.80	3.03
Student	2.80	5.23	4.32	4.27	3.62	1.97
Military	2.40	5.42	4.35	3.51	4.11	2.53
Housewife	2.55	5.56	4.40	3.57	4.77	3.11
Retired	2.91	5.63	4.91	4.08	5.22	3.93

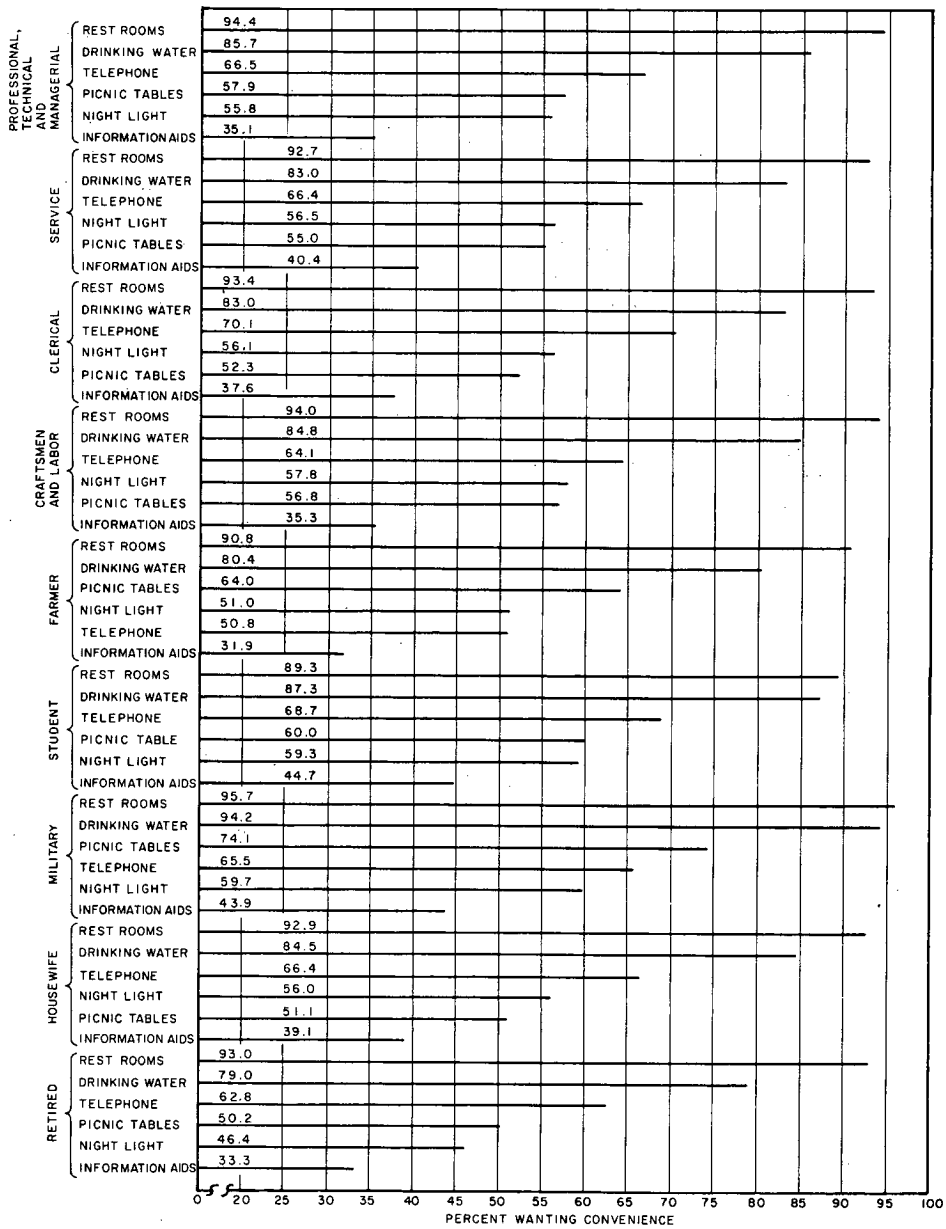


Figure B-43. Occupation vs conveniences at rest areas.

like costs to be less, . . . would like nice, clean, comfortable accommodations instead of all the frills . . .". Repeated comments praised the oil company-motel corporation. ". . . boon to travelers, . . . just great!! . . . motels should advertise whether they honor oil company credit cards. . . ."

Though the question pertaining to reservation allowed only a "yes" or "no" answer, many felt compelled to qualify their answers. For example, they made reservations, ". . . staying more than a week, . . . when traveling for business, but not on pleasure trips, . . . depending on where traveling. . . ."

Trailers and Campers

Though no questions pertaining to this item were asked, many comments were received reflecting a considerable number of motorists who travel with trailers. These comments were related to the lodging question (prices), rest areas (provisions for parking conveniences), and simply added on. For example, ". . . more camp sites, . . . overnight parking areas, . . . dumping stations, . . . are needed, . . . often can't make it from one camp to another in one day, . . . parking at rest areas for campers (should be permitted), . . . make another questionnaire and adjust to travel trailers. . . ."

Billboards

Verbal comments were quite diverse, with slight preponderance of pro-billboard statements. Objectors' statements, in part: ". . . Billboards must be stopped, beer, cigarettes, or alcohol should not be part of highway travel, . . . cluttering the scenery, . . . cause driving hazards, . . . distraction. . . ." Proponents most frequently mentioned the informative value of the billboards: ". . . Use billboards as helps or aids, . . . need some billboards for information, . . . enjoy reading billboards, . . . leave billboards so traveler can know what to expect ahead, . . . keep me alert and awake. . . ." A slightly different comment suggested ". . . remove all billboards, . . . encourage private money to build and maintain rest areas, . . . place all advertising at the rest areas. . . ."

Signing for Services

Generally, comments tended to complain about inadequate (official) signing for services. Specifically, information pertaining to the kinds of services and the distance they may be removed from the freeway was considered lacking. Some samples: ". . . signs do not tell you if services one or ten miles away, or what they will be like, . . . there should be distinct notices of services, with second at the exit, . . . should include truckers welcome, . . . Freeways and Turnpikes have too few accommodations for truck drivers, . . . allow proper commercial signs giving directions to repair, lodgings, etc., . . . they should be financed by merchants adjacent or near freeways. . . ." Illinois was praised by one motorist as having very good service signs.

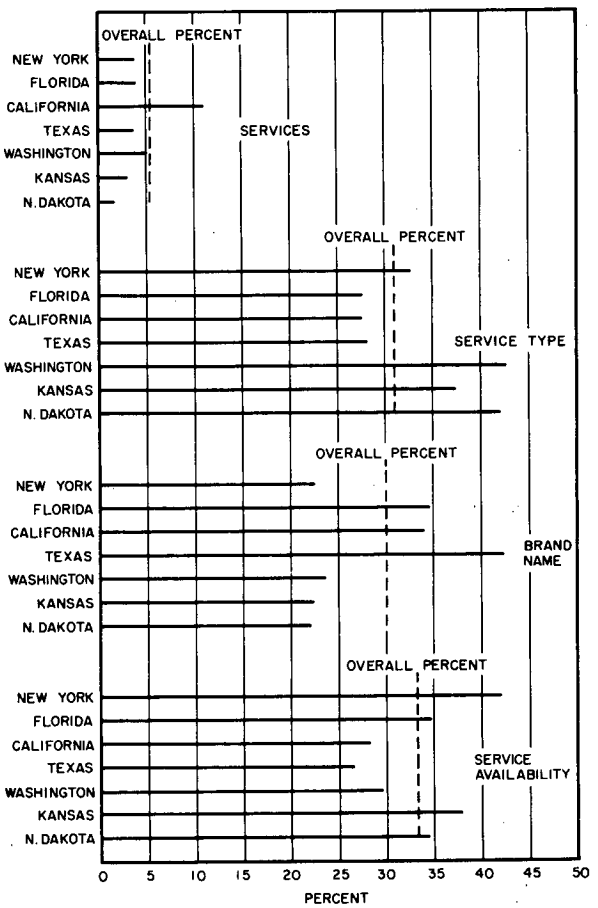


Figure B-44. Informational needs vs States.

Signing for Directions

A large number of comments dealt with bad placement, inadequacy, and confusing messages of directional signs. For example: ". . . most valuable information is lane directions and exit directions sufficiently in advance, . . . need better signs or directions ½ to 1 mile ahead, . . . signs placed too near intersections, . . . when approaching Freeway, give adequate notice whether on-ramp nearest right or left lane, . . . confusing or inadequate signs near intersections of multiple roads and highways particularly in multilane traffic circles. Freeway signs are too hard to read, . . . confusing, especially to one not accustomed to driving on Freeways, . . . names of towns should be under street signs, . . . out-of-towner doesn't know where streets lead to, . . . too few Interstate signs through cities . . ." other comments voiced similar dissatisfaction with Interstate sections alternating with US routes through cities and the motorist frequently getting lost as a result. Desire for more signs indicating distance to approaching towns or cities was mentioned, as well as that signs were inadequate for prevailing speed.

Uniformity of Signing and Regulations

A number of comments were received, of which the following is representative: ". . . Why aren't traffic signs made uniform in all 50 States? . . ." Lack of uniformity in traffic regulations, speed limits, and signal lights was also mentioned repeatedly.

Sources of Aid

A substantial number of comments were received stating the necessity for an emergency communications system—telephones, radio, etc. Most comments reflected the attitude that they would seek the nearest or most readily available source of aid. A large number stated that they would prefer to turn to the police first, but that they are never around when needed. The local inhabitant was commented on as usually unable to furnish highway information beyond 10 miles of their immediate locality.

Travel Annoyances

The most frequent comments were directed at poor and discourteous drivers. Some samples: ". . . Inept or incompetent drivers don't last long but impolite, thoughtless, and greedy drivers last forever, . . . selfish pedestrians in California, . . . road hogs, . . . tailgating, . . . take impolite, selfish drivers off highways. If caught drinking while driving, should be put in pen for one year and $1,000 fine, . . . should ticket drivers in left lane who . . . drive

alongside slower right lane driver . . . half mile or more causing bottleneck behind them, . . . should be arrested for driving with one hand. . . ."

Some suggested remedies: ". . . driver education needed to teach inept drivers how to use acceleration lanes, . . . everyone should have complete examination every 4-5 years —physical, mental, and driving. Drivers who cannot keep up to speed limit should not be allowed, . . . give drivers over 55 a yearly health examination, . . . all Freeway entrances and exits should be from right lane. . . ."

Some other annoyances which were written in follow: ". . . Big trucks and buses drive over their speed limits, . . . high beams from on-coming traffic and excessive lighting of roadside facilities, . . . ill-kept, ill-lighted facilities with ill-mannered service attendants, . . . litter and garbage along the highways—especially in Florida, . . . gas not always available. . . ." Finally, one motorist suggested a solution to all of the problems: ". . . Let's automate the Freeways. . . ."

Rest Areas

A substantial number of remarks were written in pertaining to rest areas in specific states. The largest number by far praised rest areas in Kansas as being the best in the country: well equipped, clean, nicely located, etc. Rest areas in Nebraska and Oregon were also praised. Californians felt that many more rest areas were needed.

Facilities (in addition to those enumerated on the questionnaire) which some respondents felt worth writing in were: ". . . a list of the nearest mechanical help next to the phone, . . . heated, lit, soundproof phone booths, with a place to write, . . . shade, . . . big state maps, . . . restaurants, . . . adequate litter/refuse cans. Canned gasoline dispensers in remote areas, . . . larger parking areas, electric outlets, . . . areas set aside for overnight campers. . . ."

Restrooms at rest areas were indicated as desirable only if kept clean: ". . . clean restroom requires an attendant. . . ." Some fears were voiced: ". . . with all the attacks on women, an unguarded restroom is invitation to trouble. . . ." One motorist wants showers. Another's annoyance was, . . . increase of pay toilets in restaurants and gas stations for customers after they spend their money. . . ."

Further suggestions: ". . . rest areas between lanes on Freeways in open country—only half the cost. . . ." And finally: ". . . rest areas should be indicated on road maps. . . ."

Road Construction, Traffic Conditions, Cars

Though no questions pertaining to this subject were asked on the questionnaire, many comments were contributed: ". . . Not enough shoulders in some states (North Carolina and Virginia) to pull off in emergency, . . . arterial highways should be wider, . . . stop signs are obscured through small towns—example is Lindsburg Kansas Highway—US 81, . . . curb stone pavement in rural areas terrible, . . . suggest that California Division of Highways install the new style illuminating reflectors along the broken white lines and shoulders of all the older Freeways in California, . . . have lights at exit of expressways, . . . provide more dual highways, . . . night speed limits should be cut, . . . to 50 mph on thruways, . . . dangerous cobble stones on the West Side Drive in N.Y.C., . . . bad judgment by state workers in marking passing or double lines on highway, . . . like the buttons separating the lanes instead of lines. Four feet on each side of center strip should be of a rougher surface to warn driver when he starts to drift off, . . . lighted signs, flashing red or yellow lights from roadside facilities can be mistaken for distress or traffic signals, . . . why are trucks allowed to overload with gravel, etc.?, . . . many one-car accidents are caused by power steering, . . . auto tires need attention . . . can never buy round ones, . . . too much speed in cars . . . put governors on them. . . ."

Services Generally

Spacing of services was commented on as being frequently too large. Some complained of having to exit from the facility, and that services were often too far off the highway. Service availability was specifically mentioned as poor on California Freeways, South Carolina Highways, and the Pennsylvania Turnpike. Some people objected to seeing the same brand of gasoline on some highways, and would like to see more of the "cheaper" gasoline companies represented.

APPENDIX C

INCREASED PROBABILITY OF SURVIVAL

This hypothesis is difficult to substantiate since no conclusive studies have been made that will show the probability of survival as a function of time. It cannot be stated, therefore, that improved detection time will increase the probability of survival by a certain percentage. Here again, the most important aspect is not the detection time, but the time required to get aid to the victims. If a graph depicting the probability of survival (assuming that aid is received in

time τ) could be determined, then some measure of the system effectiveness could be obtained. Such a curve would be similar to Figure C-1A.

The initial and final points of the curve indicate those that will not survive independent of the level of aid and those that will survive independent of aid. From such a curve, we can determine the value obtained by installing a detection system.

Figure C-1B is the negative of the derivative of the curve in C-1A. This figure shows the need for aid at time τ. There is some delay followed by a peak, after which the need for aid returns to zero. Thus, the time range over which aid is required can be derived from this figure.

The time τ is the time before aid is received. This time includes not only detection time but the transit time required to get the aid to the person needing it. In some cases, this is the time required to get to the scene; in other cases, it is the time required to get the victim to a hospital. It can be seen that as these travel times become excessively long, the need for a rapid detection system diminishes because we are moving to the right of Figure C-1B. If the travel time is short, then there is little need for instantaneous detection because the victims will live another few minutes.

Nothing definite can be said from this discussion because of the lack of data; however, a framework is established wherein the problem can be evaluated and in many cases given a qualitative value. Here, probably more so than in any other situation, the detection aspect plays a subordinate role to travel time.

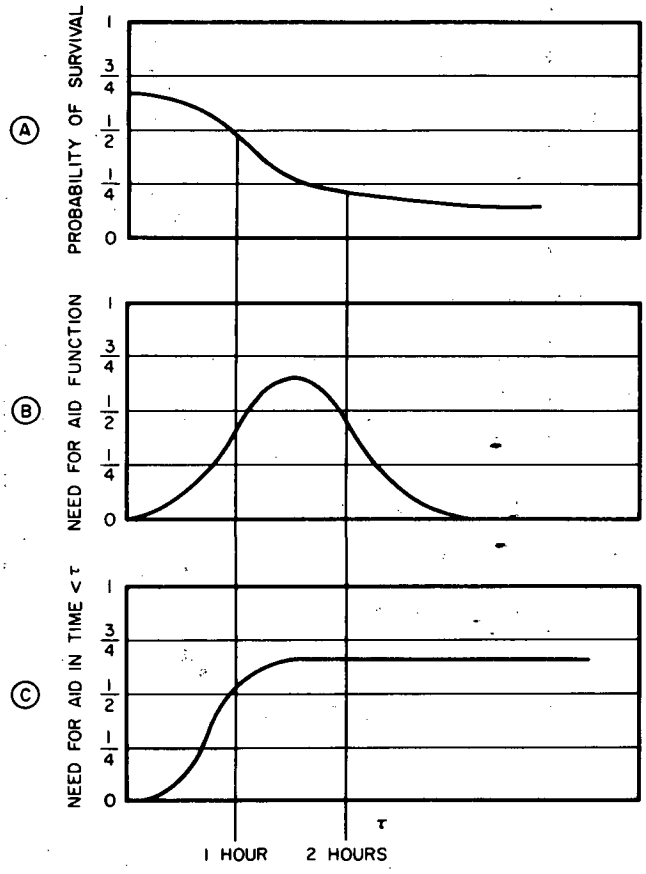


Figure C-1. Emergency aid functions.

APPENDIX D

THE GROWTH OF THE MOTEL INDUSTRY

The figures and tables of this section show the growth of motels in the United States. From humble beginnings as roadside cabins, the motel has evolved into elegant, multi-storied, luxurious, modern establishment, with swimming pools, restaurants, etc. In the process, it has quickly caught up to and passed the downtown hotel business. In 1960, it was estimated by the American Automobile Club that Americans spend $2.5 billion annually for lodgings; of this, $2 billion is spent in motels (*52*). Figure D-1 shows the number of motel establishments by region and Figure D-2 shows the sales receipts of these motels (*53*).

The business has capitalized on the affluence, mobility, and wanderlust of the American citizen, but it also grew at the expense of the downtown hotels. Table D-1 illustrates this growth.

Note that the growth of the lodging industry as a whole in terms of the GNP is nonexistent, and in terms of the GPS it is negative; at the same time, the motels as a percentage of GNP as well as GPS have nearly quadrupled, whereas motels command an ever greater percentage of the lodgings business.

The figures are of interest primarily to the economist. Of interest to the motorist is the combination of features that made the motel of today a success—features which the motorist obviously wanted. Some of these are ease of access, no parking problems, little (if any) tipping, modern facilities, and more informal surroundings.

The Interstate System promises motorists rapid, convenient travel over great distances. Therefore, the motel industry has capitalized on locations adjacent to the Inter-

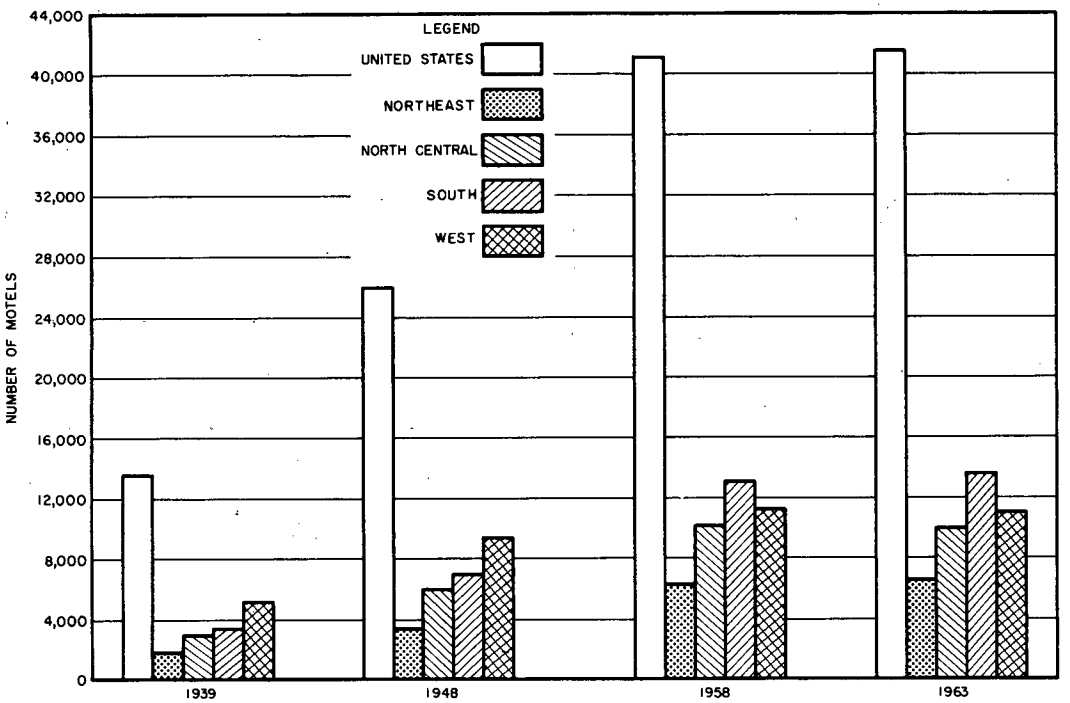


Figure D-1. Number of motel establishments by region.

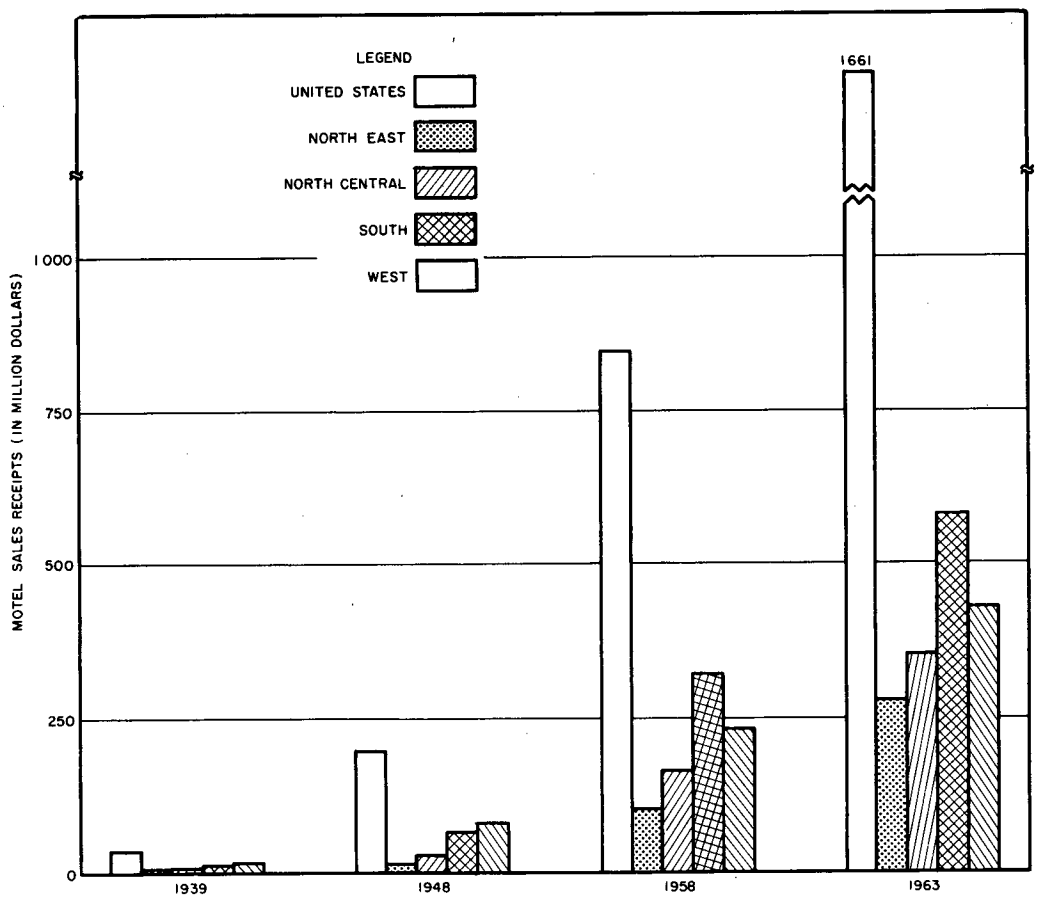


Figure D-2. Sales receipts of motels by region.

TABLE D-1

TREND IN LODGING AND MOTEL SALES RELATED TO GROSS NATIONAL PRODUCT AND GROSS PRODUCT OF SERVICE INDUSTRY (IN BILLIONS OF DOLLARS)

			SALES RECEIPTS		LODGING AS % OF		MOTELS AS % OF		MOTELS AS % OF
YEAR	GNP	GPS	LODGINGS	MOTELS	GNP	GPS	GNP	GPS	LODGINGS
1948	259.4	22.9	2.37	0.194	0.9	10.3	0.07	0.80	8.2
1954	363.1	33.9	3.03	0.457	0.8	8.9	0.13	1.35	15.0
1958	444.5	46.5	3.89	0.850	0.9	9.4	0.19	1.82	21.8
1963	589.2	66.0	5.05	1.661	0.9	7.7	0.28	2.52	32.9

state System. For example, a chain of 22 to 30 motels is being built along I 75 from the Kentucky-Tennessee state line to Tampa, and along I 95 from the Virginia-North Carolina border to Riviera Beach, Florida by the Hilton chain (55). The building schedule is intended to be such that the inns open about 6 months after the respective sections of the Interstate are completed.

The most successful chain operation, Holiday Inns of America, has about 750 motels in operation throughout the country and Howard Johnson's is second with about 250.

It is interesting to note (Table D-2) the increase in per capita motel expenditures in various parts of the United States.

The per capita expenditures are greatest in the South and West. During 1939, annual per capita expenditures in the West were much higher ($1.17) compared to other regions ($0.10 to $0.28). The relative growths expressed in percentages show that the growth rate was lowest in the West and yet maintained highest per capita expenditures during 1963. Northeast and North Central regions had much higher percentage of growth during 1939 to 1958 and 1958 to 1963.

TABLE D-2 *

ANNUAL PER CAPITA EXPENDITURES AT MOTELS

REGION	1939	1958	% OF INCREASE FROM 1939 TO 1958	1963	% OF INCREASE FROM 1958 TO 1963
United States	0.28	4.90	1650	8.90	82
Northeast	0.10	0.10	2790	6.07	126
North Central	0.12	3.34	2683	6.77	103
South	0.28	6.10	2086	10.05	65
West	1.17	8.97	666	14.15	58

* Source: Census of Business 1939, 1958, 1963 Tourist Courts and Tourist Camps, Statistical Abstract of U.S. 1940, 1959, 1964.

APPENDIX E

STATES' LEGAL STATUS RELATIVE TO ROADSIDE ADVERTISING AND PROVIDING INFORMATION IN REST AREAS

TABLE E-1

SUMMARY OF LEGAL RESTRICTIONS

a. *States With Possible Restrictions on Informational Aids Within Rest Areas* (*56* and legal search)

Georgia	(New, date not given)—Advertising signs must be within 12 miles of service. Signs in specific interest of traveling public must not be more than 50 feet from the activity.
Iowa	(1965)—Advertising must be within 12 air miles of activity. Also have a $350,000 "interstate outdoor advertising fund."
Kansas	(No date, status 68-422)—State highway commission is authorized to remove any and all billboards or signs located within the limits of the right-of-way of state highways which bear advertising of any kind or character.
Maine	(1965)—Prohibits the erection, within 500 feet of nearest right-of-way boundary line of any state turnpike, any advertising sign. To guide the users of the turnpike system to recreational sites, there shall be erected and maintained on right-of-way near approaching exits descriptive and directional signs readable when traveling at the maximum lawful speed. State highway commission shall erect and maintain these on the Interstate System. Also may erect signs at exits for motels, hotels, and restaurant areas.
Michigan	(1958)—Prohibits the erection and maintenance on or along any highway or within 200 feet of the center line thereof any signs, etc., except official signs, which contain reflector buttons, reflex reflectors, or any similar devices.
Mississippi	(1964)—Prohibits erection of any billboards or advertising sign of any kind or description closer than 50 feet to the center line of any state highway.
Nevada	(1925)—No advertising of any kind within department of highways right-of-way of any state highway.
New Mexico	(1953)—Advertising on or over public highway right-of-way outside incorporated cities is prohibited.
North Carolina	(1965)—Roadside rests, parks, picnic areas, etc., may not be used for commercial purposes.
North Dakota	(1960, revised in 1965 but no changes)—Prohibits placing of any sign, billboard, or advertisement within the limits of a public highway.
Oregon	(1965)—Definition: Advertising structure within 5 miles travel distance from roadside service. Not more than two structures in each direction from roadside service are permitted.
Pennsylvania	(1961)—No commercial signs or other advertising media shall be erected within 1200 feet of rest area. (1965)—Informational sites may be established and may have signs advertising activities being conducted within 12 air miles of area. These must be on a panel not exceeding 13 feet in height or 25 feet in length. Sign must NOT be legible from any place on highway or turning roadway. Not more than one sign concerning a single activity.
Washington	[Revised 1962, 1965 (Pocket Part)]—Prohibits signs, signboards, signals, or guideposts on right-of-way of state highway.
Wisconsin	(1966)—Signs in public interest: natural phenomena, scenic areas, or historical sites. Signs providing essential information: lodging, food, outdoor recreational, or automotive service facilities located adjacent to and readily accessible from interstate highway are permitted if signs are within 12 miles of facilities advertised. Directional signs which aid travelers in locating gasoline, food, lodging, or recreational services not adjacent to or visible from interstates permitted provided that facilities are located within 12 miles of sign.

b. *States in Full Agreement With New U.S. Standards* (*57* and legal search)

Kentucky	New York	New Hampshire

TABLE E-1 (*Continued*)

c. *States With Contradictions With New U.S. Standards* (*57* and legal search)

Minnesota	(1965)—Permits no signs over 400 square feet in area (federal law says maximum of 300 square feet).
New Mexico	(No date)—Signs not permitted within 300 feet of intersections (federal laws say 500 foot limit).
New Jersey	(Statute 54:40–30)—Sign shall not exceed 25 feet high, 60 feet wide, 1000 square feet in area (federal law says 20 feet high, 40 feet long, and 400 square feet in area).
Vermont	(1965 revision of 1959 law)—600 square foot limit on area vs federal limit of 400 square feet.

d. *States With Nothing on Advertising Control as of 1965*

Montana Wyoming

e. *States With Little on Highway Advertising* (*57*)

District of Columbia Hawaii Idaho South Carolina Texas Utah

f. *States With Varying Amounts of Legal Advertising Control But Not Completely Conforming to Federal Standards* (*57*)

Alabama	California	Florida	Maryland	Ohio	South Dakota
Alaska	Colorado	Illinois	Massachusetts	Oklahoma	Tennessee
Arizona	Connecticut	Indiana	Missouri	Puerto Rico	Virginia
Arkansas	Delaware	Louisiana	Nebraska	Rhode Island	West Virginia

g. *States Which Explicitly Provide for Informational Sites on Interstates as of 1965* (*58*)

Delaware New Hampshire Pennsylvania New Jersey

APPENDIX F

AVAILABILITY OF SERVICES AS A FUNCTION OF THE INTERSERVICE INTERVAL

The following technique is presented because it is believed to give a good indication of the expected availability of services, assuming that the need for such services arises at an arbitrary point along a facility. It is predicated on the assumption that the need is equally likely to occur on any point along the highway. Of course, this is not strictly true, as shown by the variation in the apparent demand for the various services as a function of the ADT, ATL, proximity to a major trip generator, and the type of service.

Plots of such availability are shown for several highways which were surveyed in some detail. Since the availability of gasoline is the one most nearly applicable (a motorist may run out at any point) the plot for gasoline-to-gasoline interval distributions shall be discussed in some detail. The figure showing comparable plots for the food-to-food interval distributions is also shown for comparison.

The plot in Figure F-1 will answer the following: On a facility, what is the probability that the distance to gasoline is less than X miles? What is the probability that it is greater than Y miles? Thus, consider the plot for I 70: the probability that the interval is 20 miles or less is about 0.56. By the same token, it can be said that the probability that this interval is greater than 20 miles is $1 - 0.56 = 0.44$. Thus, a motorist completely ignorant of the location of the services is assured that it is slightly more likely that gasoline is available within 20 miles; thus, if he started walking, he could reasonably expect to walk 10 miles.

For comparison, consider the plot of US 17: on the sector surveyed, he is reassured that the distance is 5 miles or less with a probability of 1.0 and 4 miles or less with a probability of about 0.64—or 2 in 3 chances that the nearest gasoline available is 4/2 miles distant. Comparable plots are shown in Figure F-2 for food and lodgings.

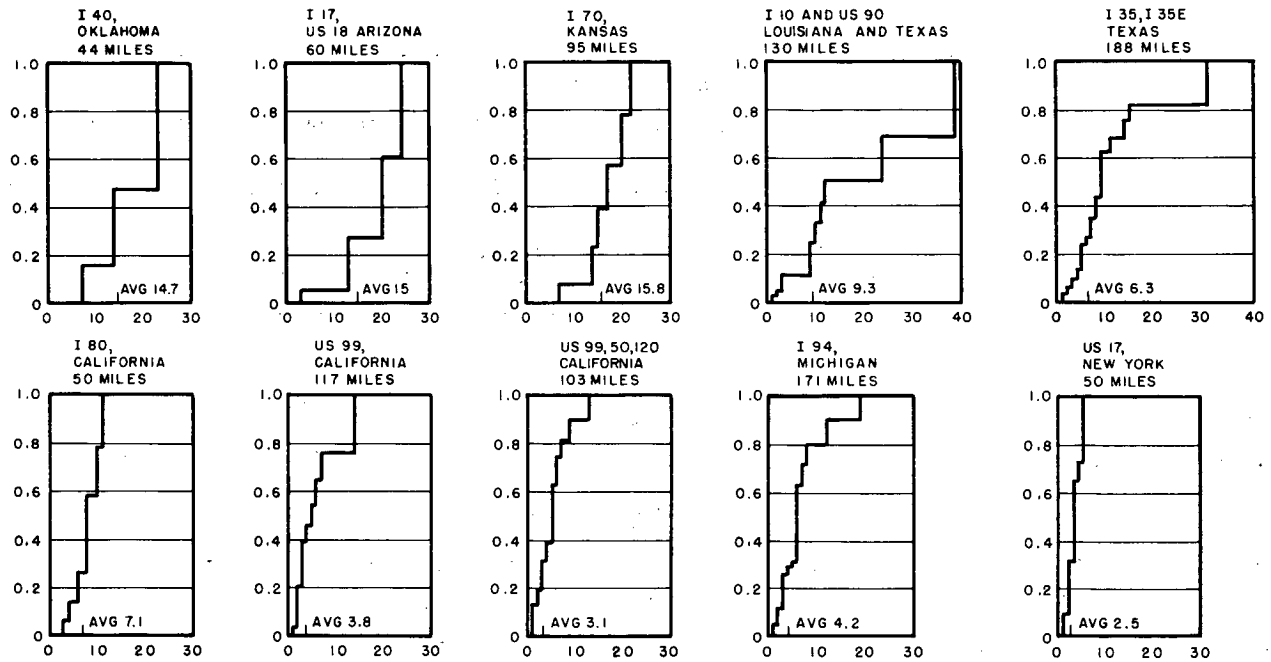


Figure F-1. Availability of gas as a function of interservice interval.

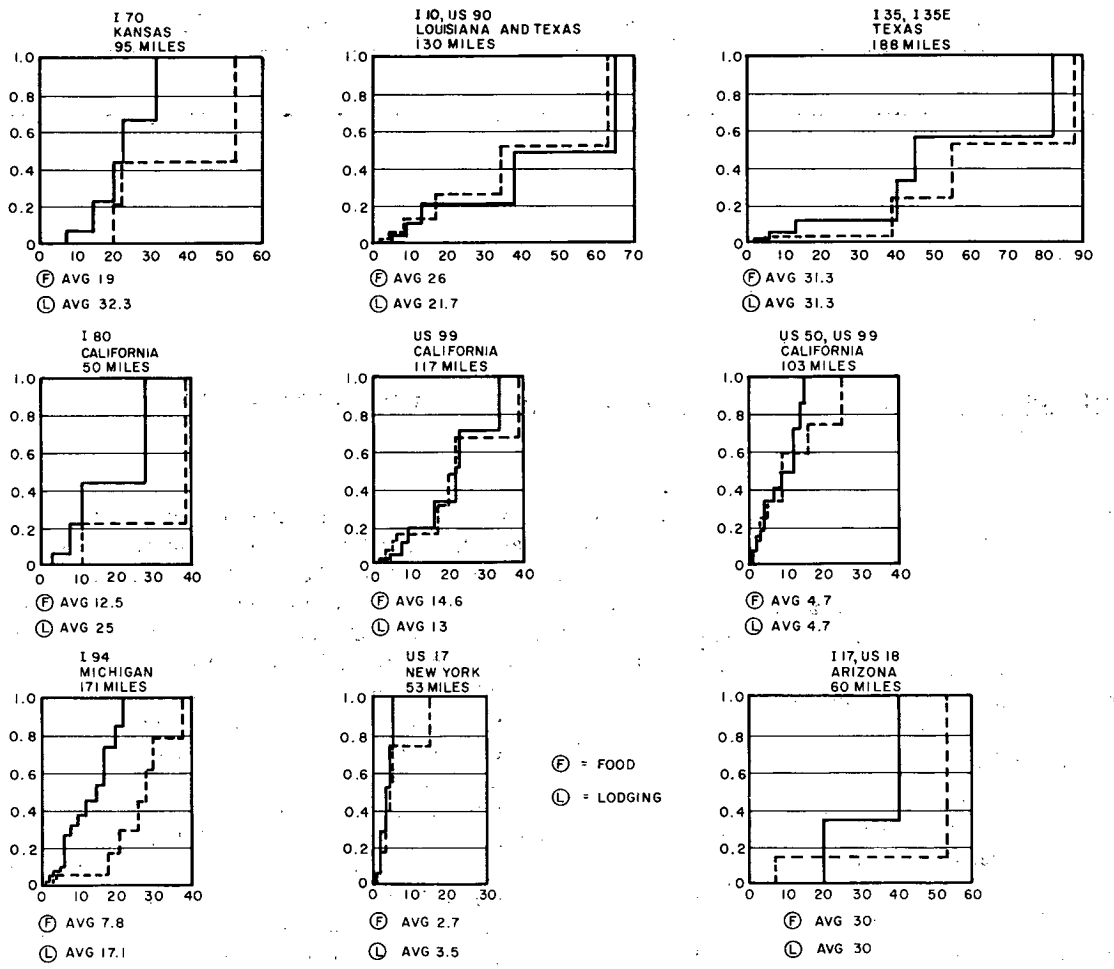


Figure F-2. Availability of food and lodging as a function of interservice interval.

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