ENGINEERING IN TRAFFIC SAFETY IN UTAH

by

Donald T. Hunter

A thesis submitted in partial fulfillment of the requirements
for the degree of
Master of Science
in the
School of Engineering

Utah State Agricultural College

1940
ENGINEERING IN TRAFFIC SAFETY IN UTAH

by

Donald T. Hunter

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the School of Engineering

Utah State Agricultural College

1940

Approved:

______________________________
Major Professor

______________________________
For English Department

______________________________
Dean of the School

______________________________
Chairman of Committee on Graduate Work
ACKNOWLEDGMENT

I wish to express appreciation to Foster Kunz, Utah State Traffic Safety Engineer of the Utah State Road Commission and to C. G. Wooley of the Salt Lake City Engineering Department for their efforts in acquainting me with the work of their respective agencies and supplying me with information, some of which is incorporated in this thesis. I acknowledge, also, the material given me by the National Safety Council.

Donald T. Hunter
PREFACE

Traffic safety involves accident-free movement of physical entities. It includes all means of transportation and is a function of mobility, an important variable affecting directly the mortality rate and increase of accidents. All transportation groups have coincidentally with or without increase of mobility been attempting to reduce accidents. Those notably succeeding are the shipping, railroad, and airline interests. The operating motor vehicle and pedestrian groups have failed conspicuously.

The early means of attaining a better degree of traffic safety in the motor vehicle and pedestrian groups were based on opinions, and though rational, were incomplete because the dynamic and static factors involved were not considered as a whole. The real solution lay in coordination and more effective legislation, motor vehicle administration, enforcement, engineering, personnel training, education, and research (6).

The extensive scope of the field of traffic safety engineering could not be completely covered in this thesis; therefore, an attempt has been made to present the traffic safety situation in Utah and to venture a limited account of traffic safety engineering procedures for solution of a few accident situations.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>History</td>
<td>2</td>
</tr>
<tr>
<td>Organizations for traffic safety in Utah</td>
<td>9</td>
</tr>
<tr>
<td>Department of Highway Safety</td>
<td>9</td>
</tr>
<tr>
<td>Utah Traffic Safety Council</td>
<td>10</td>
</tr>
<tr>
<td>Salt Lake City Traffic Commission</td>
<td>13</td>
</tr>
<tr>
<td>General traffic safety situation</td>
<td>13</td>
</tr>
<tr>
<td>Causes of accidents</td>
<td>15</td>
</tr>
<tr>
<td>Engineering</td>
<td>20</td>
</tr>
<tr>
<td>Utah's place in accidents</td>
<td>37</td>
</tr>
<tr>
<td>Accident analysis</td>
<td>37</td>
</tr>
<tr>
<td>Appendix I</td>
<td>41</td>
</tr>
<tr>
<td>Appendix II</td>
<td>48</td>
</tr>
<tr>
<td>Bibliography</td>
<td>56</td>
</tr>
</tbody>
</table>
ILLUSTRATIONS

Figure 1. Standard highway safety program for states. ............. 11
Figure 2. Critical speeding diagram .............................. 26
Figure 1a. Comparison of auto deaths in Nation, ten western states and Utah ............................... 49
Figure 2a. Registration and auto deaths of Utah ....................... 50
Figure 3a. Comparison of auto deaths in Nation, ten western states and Utah ............................... 51
Figure 4a. Collision diagram at 27th So. and State Streets, Salt Lake City, Utah ............................... 52
Figure 5a. Condition diagram of 27th So and State Streets, Salt Lake City, Utah ............................... 53
Figure 6a. Collision diagram of 2nd cross-street so. of Clearfield on U. 8. 91 ............................... 54
Figure 7a. Collision diagram of 35rd So. and State Streets, Salt Lake City, Utah ............................... 55

Table 1. Types of accidents resulting in deaths for the Nation and the State of Utah in 1939 ............................... 42
Table 2. Types of accidents resulting in injuries for the Nation and the State of Utah in 1939 ............................... 42
Table 3. Action of drivers resulting in deaths for the Nation and State of Utah in 1939 ............................... 43
Table 4. Action of drivers resulting in injuries for Nation and State of Utah in 1939 ............................... 43
Table 5. Actions of pedestrians and bicyclists resulting in deaths for the Nation and the State of Utah in 1939 ............................... 44
Table 6. Actions of pedestrians and bicyclists resulting in injuries for the Nation and the State of Utah in 1939 ............................... 45
Table 7. Condition of vehicles involved in fatal accidents in the Nation and the State of Utah ............................... 46
Table 8. Condition of vehicles involved in injury accidents in the Nation and the State of Utah ............................... 46
Table 9. Utah State data on age of drivers in total accidents and fatal accidents in 1939 ............................... 46
Table 10. Experience of drivers involved in fatal accidents in the Nation and the State of Utah for 1939 47

Table 11. Weather conditions prevailing at fatal accidents in the Nation and the State of Utah for 1939 47

Table 12. Road conditions prevailing at fatal accidents in the Nation and the State of Utah for 1939 47

Table 13. Sex of drivers in fatal accidents in the Nation and the State of Utah for 1939 47
INTRODUCTION

Death and property damage have been remarkably prevalent on Utah's highways and streets since 1928. Social disturbance and economic loss have been the direct result. Too often one reads of highway massacres and their precipitated costly lawsuits and expresses the need for their elimination. A real civic problem, traffic safety has been properly designated a function of the government. What has Utah done and what should it do to curb the mounting menace of automobile and pedestrian traffic accidents?

The historical part of this question is answered in brief by the fact that Utah has constantly put forth effort to reduce its traffic toll; but until 1939, it did so in only a haphazard and unscientific way. The seven-point program of the Utah Traffic Safety Council, now operating in the State, is the ultimate in the proper direction. The need of extension of this program to every part of the State is evident with recommendation that the following phases of traffic safety, covered to a greater or lesser extent in the body of this thesis, to be given emphasis: intersectional traffic protection and accident-prone location studies by means of the critical speed and condition-collision diagrams and pin maps; driver training in the public schools; statewide education by press releases from competent traffic engineers and educators in the State; use of channelization and freeways to eliminate the basic traffic frictions; speed surveys; commercial and traffic signals and signs studies for determination of their aggravation leading to lawbreaking and accidents; more complete statistical information regarding moving traffic, accident reports, and traffic blockades; more trained traffic analysts; and traffic safety coordination in the local units of government.
HISTORY

Traffic safety has been existent in the form of the individual instinct for self-preservation ever since man began to move about. Early travel, first by foot and later by animal, needed few if any rules to facilitate orderly traffic because individuals were entirely capable of averting accidents under such relatively low speed conditions. Accidents as did occur were not of a serious nature and caused little public concern. Traffic congestion, however, did exist to a considerable extent in the larger cities, but again, the factor of death resulting from traffic accidents was insignificant. It remained for the wide-spread use of the automobile with its high-speed and death-dealing characteristics to complicate the problem and bring about the present-day concern over traffic accidents and the ills causing them.

Local units of government began safety programs in earnest about 1910 in signing of the streets for speed limitation and in making rules for general use of the streets by vehicles. These road rules and street and highway speed signs were generally instituted without proper consideration of their effect. They were someone's idea of a proper move. Some guesses were right, but most of them were wrong. There was a noted lack of uniformity between the states as well as within the states. Enforcement was practically the only weapon with which the state and early municipal safety organizations attacked the problem. A balanced program was lacking in that engineering and especially education for traffic safety were not widely practiced. However, The Utah State Road Commission began early to include such safety engineering as super-elevation on curves, improved alignment, and longer sight distances in its roads.

The State of Utah entered the field of enforcement for traffic safety
and regulation in 1925, at which time the State Road Commission installed
the State Highway Patrol as a department under its jurisdiction for the
purpose of protecting its engineering works from undue use, advising
motorists against unsafe highway practices, fostering safety by arrest
of traffic law violators, and fulfilling of other general police duties
of a state character. From an agency of three members in 1925, it has
expanded, partly because of increase of police powers of the Commission
and the need for its function, to a personnel of about fifty in 1939.

Important legislation was made in 1933, when the legislature
adopted the Uniform Motor Vehicle Operator's License Act (Chapter 45,
Laws of Utah, 1933). This act took effect January 1, 1934 and provided
that operators and chauffeurs obtain licenses to drive on public highways.
Licenses were to be given after the aspirant had successfully shown his
ability to drive in traffic. With the making of this law, it was seen
that the task of immediate testing all of the drivers of the State would
be insurmountable, especially under the conditions that financing of the
examination cost should come from receipts of the driver license fees,
which were 25 cents. Thus it was agreed that licenses would be given
on request without examination until April 1, 1934. As a result, 137,287
drivers were permitted on the highways, many of them actually incapable
under present qualifications. These licenses can be voided and owners
re-examined as a possible safety measure. The legislature delegated this
function to the Utah State Tax Commission; and by arrangement of the
latter with the Road Commission, Patrol members conducted the examinations.
On November 13, 1939, the Tax Commission took over the function completely,
establishing a permanent record file of each driver holding a license
and creating its own driver examination personnel, schooling them in the
best examination method, and providing better equipment for mental and physical tests. Under these laws, which are still functioning, operators and chauffeurs are examined and given licenses for a fee of 25 cents and 2 dollars respectively. Operators' licenses are good for 5 years or until revoked, and chauffeurs' licenses expire on December 31 of each year. Provision is made that drivers may learn by practical driving experience before obtaining their licenses by issuance of instruction permits, under which condition they are accompanied at all times by only a licensed driver. The Tax Commission provides roving examiners to examine drivers at the county seats of the various counties of the State.

Under the Laws of Utah, 1935, Section 57-7-64X, Chapter 48, the Road Commission required yearly vehicle inspection, and now requires biennial commercial and resident vehicle inspection for all vehicles operating in the State by State Police Officers or by official inspection stations, designated by the Commission for the purpose of detecting and eliminating hazards to traffic safety incident to below-average mechanical condition of vehicles.

These acts have been made to effect traffic safety, but it remained for the 1937 legislature to usher in a definite safety program. Chapter 39 of the Laws of Utah 1937, authorized a Department of Highway Safety under the State Road Commission by giving the Commission the following power:

To set up a Department of Highway Safety in charge of a qualified Highway Safety Engineer whose duty it shall be:

(a) To conduct a highway safety survey and locate, designate, and recommend the removal by the State Road Commission of highway hazards to safety.

(b) To conduct, in conjunction with the Department of Education in and through all state schools, a definite education campaign in highway safety and to work in conjunction with civic organizations,
churches, local units of government, and other agencies which may function in accomplishing the purposes of reducing highway accidents.

(c) The State Road Commission is hereby authorized to expend sufficient of the funds allocated to it to accomplish the purposes of the Act.

In fulfillment of this statute the Department was installed and headed by a safety engineer. A preliminary survey was made and consisted of the collection of all available accident reports, including information relative to the location, time, manner of occurrence, road conditions, and persons involved. Most of this information was obtained from the accident files of the State Tax Commission, which requires reporting of all accidents of 50 dollars property damage or over and those involving injury or death.

To get a wider coverage, since a great number of injury and especially property damage accidents were not reported, the Road Commission required the reporting by its field forces, all accidents coming to their attention.

Report forms used were those approved by the National Safety Council as giving complete information leading to accurate analysis of accidents.

Traffic accident spot maps of the populous counties and of the State as a whole were made, a pin showing the location of each accident. A study of these maps showed accident locations by a bunching of the pins at a certain point. These points were then studied in the office by means of accident collision and condition diagrams, and actual field investigation.

Owing to poor accident reports and the scarcity of good ones, only a few of such analytical diagrams were possible in 1937 and 1938. A definite program is now under way to obtain more usable accident reports for condition and collision diagrams.

The studies made in 1937 and 1938 resulted in some road relocations to eliminate dangerous curves and improve sight distances and lighting installations, notably those between Salt Lake and Murray. Efforts were
made through correspondence with other states to effect uniform motor
vehicle laws, rules, signing, inspection of motor vehicles, and examination
of operators. Education in traffic safety in the schools was begun by
establishment of brief safety courses in high schools, junior patrols for
grade schools, lectures by peace officers, and motion pictures for safety
education. A booklet, Creating Safer Communities in Utah, was published
in 1938 for the benefit of municipal and community leaders to form a good
traffic safety program.

In the summer of 1939 a traffic violation and speed survey accomplished
by the Road Commission gave valuable information as to how the public
obeyed speed laws. Most of the points investigated showed a great percentage
of the drivers were driving in excess of speed laws, and doing so justly
from a standpoint of safety as determined by an accompanying set of speed
tests.*

A step toward safety was made by uniform signing on October 19, 1939,
when district engineers of the Road Commission were relieved of the duty
of installation of traffic signs. The traffic engineer now effects their
installation, and maintenance of them is the remaining signing function
of the district engineers.

Traffic blockades, in which all the drivers passing a certain location
on the highway are stopped by police and they and their cars inspected in
behalf of safety, have been held in the State at unannounced times and

*The speed of the cars was determined by an observers hidden from
view of autoists and observing the time by stopwatch taken for autoists
to pass through the line of vision of two mirrors placed so that the ob-
server could see the automobiles pass two set locations of predetermined
separating distance. Simple calculation then gave the speed of each car.
The speed taken as the appropriate speed was that below which 90 percent
of the autos were driven.

These speed tests were made by having a number of drivers selected
at random to negotiate the locations under study at the maximum safe
speed in their estimation.
locations under the direction of the Road Commission. This affords a check-up; and with an effective threat of prosecution for violation of the provisions of the State requiring that a vehicle meet specified safety conditions, a better compliance is obtained.

The need of state statistical information is evidenced in the lack of obtaining and distributing information relative to the observance of the vehicle mechanical provisions. The percent of the mechanically unsafe cars stopped for each blockade would tell an interesting story. Effective selective enforcement and education could be utilized and the use of the blockade justified.

The State has instituted a program in which offenders of the lesser traffic violations not involving accidents are given warning tickets that are filed against their driving records. The effect of this program in bringing about better compliance with the law and accident reduction is yet to be seen in Utah. The use of this device has the effect of inexpensive and effective enforcement up to the point where the number of warnings given bring contempt for the law.

One of the most effective measures undertaken in the state to bring about traffic safety has been the education movement which has had its foundation in the Utah State Agricultural College. Present and future high school and college teachers have been instructed there in the art of teaching driving. No small part of the accidents on the highways are due to ignorance of the safe driving principles. The time to teach the driver properly is before and while he is learning to drive. The high school and the college offer the best opportunities for the inculcation of the safe driving habit. Evidencing the need of such education, the Utah State Department of Public
Instruction has authorized such driver training in the State. The institutions effectively doing this work in Utah are, besides the Agricultural College, the South Cache, Ogden, Provo, and Weber High Schools, and Weber College.
The Department of Highway Safety of the Road Commission is mainly a coordinating agency of the Commission to effect the insertion of all factors of highway safety into the highway work of all the departments of the Commission. Through a program of research problems incident to safety defects on Utah's present and proposed highways are solved, the solutions being tempered where necessary by the experience and advice of other highway safety agencies, both civic and governmental. As stated, the duties of the Department, as of previous years, continue in the present organization, but a more intensive work is in effect. Its functions are in agreement with the program outlined by the Utah Traffic Safety Council. Its organization chart as of 1940 is shown below*.

*Tentative organization of the year
The Utah Traffic Safety Council

The present state traffic safety program and organization had its inception in 1938 when Governor Blood called a meeting of State officials for the purpose of outlining a safety program. The various functions of the government were all considered for the part which they might be properly fitted to play. The functions represented at the meeting were the Executive, the Attorney General, the Superintendent of Public Instruction, the State Road Commission, and the State Tax Commission. The Utah Traffic Safety Council was formed and the various officials and committee members of it were installed late in 1939 as a result of the meeting.

The program approved by the Council was that outlined by the Automotive Safety Foundation, which is shown in Figure 1, following. The diagram illustrates the organization and functions of the Council. Its widespread approval is shown by the great number of organizations recommending its use, such as the following:

American Assn. of Motor Vehicle Administrators
American Automobile Association
American Institute of Steel Construction
American Legion
American Road Builders' Association
American Transit Association
American Trucking Associations, Inc.
Associated Business Papers, Inc.
Associated Farm Papers
Associated General Contractors of America, Inc.
Association of American Railroads
Automobile Manufacturers Association
Automotive Parts and Equipment Manufacturers
Benevolent and Protective Order of Elks
Better Vision Institute
Boy Scouts of America
C. I. T. Safety Foundation
Cycle Trades of America, Inc.
Electric Institute
General Federation of Women's Clubs
Highway Education Board
Independent Petroleum Assn. of America
International Association of Chiefs of Police
STATE SAFETY ORGANIZATION

An agency to facilitate the cooperation of all state-wide traffic safety activities in accordance with the program outlined below and to assist county and community groups. Details to be adapted to conditions in the State.

<table>
<thead>
<tr>
<th>GOVERNOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATE OFFICIALS,</td>
</tr>
<tr>
<td>AND LEGISLATURE</td>
</tr>
<tr>
<td>to sponsor safety program</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PUBLIC SUPPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>for safety program</td>
</tr>
</tbody>
</table>

| CIVIC AND |
| BUSINESS |
| GROUPS |
| represented in the organization |

**PROGRAM**

<table>
<thead>
<tr>
<th>LEGISLATION:</th>
<th>MOTOR VEHICLE:</th>
<th>ENFORCEMENT:</th>
<th>ENGINEERING:</th>
<th>EDUCATION:</th>
<th>TRAINING:</th>
<th>RESEARCH:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADMINISTRATION:</td>
<td>PERSONNEL:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1. Standard highway safety program for states**
Kiwanis International
National Association of Manufacturers
National Automobile Dealers Association
National Congress of Parents and Teachers
National Conservation Bureau
Nat'l Council of Private Motor Truck Owners
National Electrical Manufacturers Association
National Grange
National Industrial Traffic League
National Institute of Manufacturers and Distributors
National Paving Brick Association
National Petroleum Association
National Safety Council
National Slag Association
National Standard Parts Association
Northeastern Retail Lumbermen's Association
Northwestern University
Portland Cement Association
Rubber Manufacturers Association
U. S. Conference of Mayors
Yale Bureau for Street Traffic Research

The Utah Traffic Safety Council has the following standing committees, each meeting at times convenient to its members and performing its specific function: the executive committee, the enforcement committee, the education committee, the engineering committee, the research committee, and the motor vehicle administration committee. Sub-committees existing as of November 24, 1939, were the school education committee and the press committee. Since that time other sub-committees have been formed in the main committees. The Council has the full cooperation of all the services of the state in that advice and actual work is forthcoming from the various State departments in carrying out the program. The Council is, in the main, a policy-forming body, coordinating the traffic safety problems of the various localities of the state through means of representation, and making suggestions to be acted upon by the proper state agencies for fulfillment or rejection. The organization is purely philanthropic and the committee members are not paid for their services and incidentals.
The Salt Lake City Traffic Commission

This commission serves in a capacity similar to the Utah Traffic Safety Council, but it is much smaller and does not participate in such extensive functions. It was created by ordinance. Salt Lake City does not boast of a traffic engineer in its employ as approved by the National Safety Council or the Yale Traffic School, but the function of engineering is included in the traffic safety plan of the Commission in that the engineering department of the city serves in traffic planning and the designing of safety engineering structures in conjunction with the police department.

The General Traffic Safety Situation

Weber, Cache, and Utah Counties and Salt Lake City are the only units of government, other than the state, in which a safety body exists. These units are of the citizen-council type. None of the counties or cities of the state have traffic engineers and are not expected, with the possible exception of Salt Lake City, to have them for at least 3 years. Generally, enforcement is poor throughout the municipalities and counties in the state, as these units do not have more than a few, if any, specifically and properly trained traffic enforcement officers. Three-day police schools and a traffic safety school of short session have been held in the state, the latter being conducted by the International Association of Chiefs of Police at Pinecrest, Utah, in 1939.

The spirit of pride of the people of Utah and Idaho was used as a means of reducing traffic accidents in the two states by a contest begun by the governors, each holding that his state would have a lower accident record than the other. The result of this agreement...
is to be determined by comparison of the 1940 accident records of each state.

Federal assistance in solving some of the problems of traffic accidents was made in 1938 by the United States Bureau of Public Roads, now by the Public Roads Administration, in its making a survey to determine conformity to traffic laws, investigation of accidents, examination of vehicles and drivers, accident reporting, filing, etc. The survey showed a marked lack of conformity. With the result of the study showing such condition, the Public Roads Administration is in a position to force upon the states, by reason of the power of grants-in-aid, compliance to rules leading to uniformity in all conditions pertaining to safety and convenience for traffic.

To sum up the situation in general, Utah's counties and cities are greatly lacking in all phases of a good traffic safety program; and only the State, through the mediums of the Road Commission and the Utah Traffic Safety Council, is, as of 1940, properly fitted to effect traffic safety in Utah.
CAUSES OF ACCIDENTS

Accidents, in the main, are caused by improper actions of drivers. And the improper actions are caused almost completely by external factors affecting the driver. Some of these external factors are high crowns in a road, glaring headlights, improperly lighted streets and highways, a complex and difficult-to-understand conglomeration of streets and intersections, lack of proper super-elevation on curves, aggravating and improper signing and signaling, dangerous road surfaces in connection with weather, poor mechanical condition of vehicles, and inappropriate actions of other drivers. The other main cause of improper action of drivers is the personal factors of the driver himself. He may be physically and mentally unfit to meet the requirements of driving in society or elsewhere.

A further classification of accidents is those due to the human element, the vehicle element, and the road element. The human element is found to be the greatest cause of accidents as compared with the other two. The road element is the next chief cause of accidents, and the vehicle element is last. A study of the causes of accidents, shown in Appendix I, verifies this assertion.

A number of valuable studies have been made of accidents which show the importance of considering the human element in causing accidents. The United States Bureau of Public Roads Highway Research Board found the 16 to 25-year age group the most accident-prone group. In this age group one finds the high school student, who is not generally considered capable of driving safely from a standpoint of judgment needed in driving a car safely in public, and the college student, noted similarly. The show-off type of driver is usually found to a great extent in this
age group. It is the transitional state between childish activities and the socially balanced activities of manhood. No wonder, then, that the human element is so active in this age group in causing accidents. A study of table 9 in Appendix I shows considerable agreement with the conclusions of the Bureau of Public Roads, but because of lack of complete state statistics on the number of drivers in each age group, a more rigorous comparison, in regards to percentage, is impossible.

It must not be assumed, however, that the human element involved in accidents deals only with the causes stated above. The human element involves the actions of those with personality maladjustment, actions of the mentally abnormal (now reduced to a minimum by the strict requirements of driver examination) and the normal actions themselves of the average individuals, who are generally thought to be normal. The Highway Research Board studies on accidents also showed that it is the average or normal driver who is causing the greatest number of accidents, simply because of the greater number of drivers in this group. The conclusion shows that accident reduction can be accomplished to a great extent by dealing with the normal or average driver.

The human element in regards to physical inabilities of the functions of the body is important in considering the cause of accidents. It is practically impossible for a driver to drive safely in society if blind; but defective vision short of blindness, deafness, and lack of a limb can be compensated for by use of certain aids or mechanical devices and a corresponding reduction in the speed of driving with a more intense use of the other physical facilities of the body. Such physical defects as tunnel-vision, near or far-sightedness, faulty depth-perception, color-blindness, and slow reaction time are common examples of defects which are capable of compensation. Heart trouble, insanity, epilepsy,
and chronic drunkenness or use of drugs are examples of conditions which are not capable of compensation and give rise to rejection in application for driving licenses. / 

Some of the human elements associated with the normal driver and pedestrian which often lead them into accidents are the following: The individual has a desire for mobility. The faster he can travel between two points, the better satisfied he is. He has a negative reaction to any form of restraint. He desires to travel in a straight line, which he knows in the shortest distance between two points. He has the characteristic of tending to expend the least amount of effort. His judgment of complex traffic systems is not comparable to that of the specialist in traffic engineering. He dislikes changing speeds. He sheers away from fixed and moving objects. He enjoys the feeling of power and often expresses it in inappropriate speed. He has a limited power of observation. He is subject to distraction. He has a limited knowledge of speed regulations, especially in locations foreign to him. He has the habit of repetition and will consistently follow the same route. He has the habit of estimating his speed by the sound of the motor of his car or the vibration. He does not generally drive his car to be driving; driving is his so-called second nature and his mind is on things other than safety.

Dr. T. W. Forbes (15) states that the clock signal showing how much time left for go or stop is psychologically unfit for practice from a standpoint of safety, because the driver has a tendency to "jump" the signal. He suggests that the tri-color semaphore is the better of the two systems. It has been found that the change of colors as used in the semaphore light system has the effect of increasing adrenalin
in the blood, but the effect could never be entirely eliminated and the production of adrenalin at such locations is not a useless drain on the system; for if it is needed at any time, it certainly is needed for the emergencies met at the intersection.

The medical profession has helped the color-blind individual in the adaption of colored lenses in the form of filters for some color-blindness. However, if a person is color-blind in only one of the colors used in semaphores, he can manage to understand any placement of the colors through a process of deduction. It has become standard practice in most states to use consistent equipment. This is especially needed in the case of color-blind persons who would appreciate the fact that the red light is located at the top of the signal, the green light at the bottom of the signal, and the yellow light in the center. A definite standard could likewise be set up for horizontally placed semaphores. As recommended by the American Association of State Highway Officials, the semaphores should consist of 3 lights, red, yellow, and green. The yellow light should be shown only after the green and before the red. This allows the intersection to clear.

One of the most important human elements affecting driving and capable of causing accidents is the aggravation of the driver by unreasonable speed restrictions. The driver, who in his own mind feels that the speed limit, to which he must conform or be arrested if caught is holding him back or retarding his instinct of mobility, will break the speed law and assume a speed he thinks is proper. This attitude was largely brought about by the posting of speed limits in a city or town by municipal authorities for the purpose of detaining the driver as long as possible in the municipality for purely selfish purposes;
often with the very purpose in mind of obtaining convenient funds for the town coffers by arresting and fining drivers aggravated to the point where they broke the law, and by the posting of signs with an over-balanced opinion of safety of the inhabitants by forcing slow speed on drivers. Uneccessary use of semaphores and stop signs likewise create this attitude in the driver. Like the story of the boy who called "Wolf", the driver is wary of all impediments to his mobility. Even properly placed and operated traffic controls are mistaken by the driver. A need is therefore seen to place only such controls as are absolutely necessary and to educate the driver to obey them for his own good.

The road element causing accidents deals to a great extent with engineering and will be included under this heading.

The vehicle element causing accidents includes the mechanical condition of the vehicle. The automobile manufacturers have continuously increased the average speed of the automobile. In 1918, the prevailing speed on the highways was 25 miles per hour, in 1928, it was 35 miles per hour, in 1938 it was about 45 miles per hour, and in 1939 it was about 50 miles per hour. Speed is an important factor in contributing to accidents. Some of the main vehicle elements directly causing accidents are mechanical failures, tire blow-outs, and lack of good lights, windshield wipers, and good riding characteristics.
The seven-point program now in operation in the State of Utah is absolutely necessary in all of its parts to effect traffic safety. It is fundamentally built around the traffic engineering department of the State Road Commission. The duties of the State Traffic Engineer have previously, but incompletely, been outlined by the statutes of the state. A more complete definition of duties of the traffic engineer, dealing also with the traffic engineer of the smaller units of government, are given by John Ackermann (1) as follows:

1. Keeps and analyses accident records to determine the location and causes of accidents. Maintains a spot map showing where accidents occurred.

2. Makes surveys and investigations to measure the flow of traffic and the facilities for carrying it. Makes studies of traffic volume and fluctuations; origin, direction, and destination of traffic; speed and delay of vehicles; cordon statistics; parking practices; street-car, bus, taxi, and railroad routings and their relation to traffic movement; existing truck and passenger vehicle routings; adequacy of streets to carry traffic; hazardous conditions; traffic violations; etc.

3. Prepares plans for the better utilization of existing facilities and for changes, improvements, and new construction which will increase traffic safety and mobility. Locates through streets, highway routes, one-way streets, and street-car and bus routes; plans and supervises the installation of traffic signs, signals, markings, street lighting, medall strips, safety islands, loading zones, taxi stands, parking meters, etc.

4.Consults with the engineering division and the city planning committee with respect to the planning, design, and construction of new streets and traffic facilities and in the repair and improvement of existing facilities, including street surfacing and reconstruction, grade separation, street extensions, street lighting, and traffic islands and circles, etc.

5. Acts as member and secretary of the traffic commission and drafts recommendations for proposed traffic ordinances and regulations.

6. Cooperates with civic organizations and gives addresses
for the purpose of public education in the objectives and methods of traffic engineering.

It is not the engineering duty of the traffic safety engineer to take over the functions of long established engineering departments of the various units of government, but to inject into those departments such safety engineering features as are lacking. Super-elevation on curves and better location are examples of safety engineering long strived for by the highway construction and maintenance engineer.

Some of the engineering features of traffic engineering, colored where necessary with the other outlined features of general traffic engineering, will be dealt with to the end that some causes and cures of traffic accidents will be arrived at.

A drunken driver was driving down the wrong side of a street at an excessive rate of speed without lights during a foggy night and crashed head-on with another when his faulty brakes were being applied. What was the cause of this accident? There are as many solutions, if not more, to the cause of this accident as there are adverse conditions to safety given. It is readily seen, however, if any one of the contributing factors had been removed, the accident would not likely have occurred. Education and enforcement are plainly lacking as a permanent means of eliminating such an accident. It is impossible to educate all people on all phases of driving safely, and it is impossible to have an enforcement body of the size required to inspect every car for brakes, lights, and the driver for his physical and mental condition and the speed of his car while he, one of thousands or more, is driving. But it is physically possible and financially practicable in a number of cases to initiate the medial strip down the center of the road making it unreasonable, if not impossible, for a driver to be on the wrong side
of the road. If the driver had been on his right side of the road the accident would not have happened. While enforcement and education as measures of safety may not always be present, the engineering traffic separation is permanent. Similarly, education of drivers to cross railroad tracks with caution can be practiced and enforcement of the measure carried out, but the better safety and long-run economy of the installation of a grade separation cannot be disputed.

It is the work of the traffic engineer to sponsor the removal of construction involving poor engineering, from a standpoint of present-day engineering, but it is impossible to remove all hazards to traffic safety as connected with engineering because of the enormous cost involved. However, with the cooperation of enforcement agencies, education agencies, and other agencies generally incorporated in a balanced safety program, the amount of safety engineering improvement required in previously built roads and those of the future is reduced to a minimum. With such a set-up, roads can be made safe for the reasonably careful driver.

Some of the features engineered into highways in the past have been contributory in causing accidents. The high crown was formerly considered a good feature from the standpoint of engineering in that it was a convenient way of draining destructive water from the surface of the road. It was and still is, even from the safety consideration that it reduces the amount of water on the road and thereby reduces the tendency of a vehicle to skid, but traffic engineering sees it differently. The high part of the crown, usually located at the center of the road or the dividing line of the direction of traffic, is conducive to cause the driver following the course of least effort to
drive his car astride the highest part of the crown with part of his vehicle in the path of opposing traffic, because steering is easier and safety is had from sliding off the road. Dangerous use of the high crown is often the result when the driver finds it expedient to ride the left side of the crown on left-hand curves, especially where the road is narrow.

Some examples of needed improvements related to engineering are wider curves to care for the widening effect of vehicles going around curves; widening of bridges and setting back of culvert heads; eliminating blind corners by removal of buildings, bushes, and trees; illuminating the roads better at night by more efficient tar headlights and street and highway lighting units and systems, lighter colored surfaces; reducing the slipperiness of road surfaces; widening road surfaces and shoulders; providing the safest type of guard rail; increasing both vertical and horizontal sight distances through better location and removal of attention-attracting advertising along the highways; and construction of medial barriers, channelizing islands, pedestrian-protection islands, and grade separations for intersecting highways and railroads and highways.

Bridges should be made wider than the road not only to care for future widening of the road, but also, because of the human element involved, i.e., that the driver will tend to shy away from the sides of the bridges with the result that his car will often be partly in the lane of opposing traffic. Culvert heads stand also in this category. Narrow shoulders, conducive to parking on the traveled roadway, and high embankments have the same effect. In general, there should not be a constriction of the width of the traffic way, except where financial reasons make it impractical, such as tunneling over
great lengths or deep cuts or fills. Where constrictions exist, the use of central barrier strips is imperative for safety.

Guard rails are a safety feature used on high fills and the outer side of curves. They serve their purpose best as a safety device when made of the spring type that will give a considerable amount with a rebound after the momentum of a vehicle has been slowly overcome. Such a type may be represented by a stretch of cables or metal bands attached to spring clips firmly anchored.

The absolute minimum sight distance at any curve should be twice the distance required to stop a car from a fixed maximum speed. Thus two approaching cars under forced conditions, such as those encountered in a three-lane highway with each car attempting simultaneously the passing use of the center lane, could stop before impact. Assuming 7 seconds as the time ordinarily taken for one car to pass another, the sight distance required for a maximum speed of 50 miles per hour is about 1150 feet. Whereas this practice is often impossible in mountainous terrain because of cost of earth work, it should be approached as near as possible. The greatest achievement of this nature is seen in the Pennsylvania Turnpike (31), in which vertical and horizontal curves are the ultimate in providing safe sight distances. This highway is the best safe highway of its type that exists at present in the United States.

Most cities in Utah are of the gridiron or checkerboard plan, in which right-angled intersections predominate. At corners the sight distance of a driver may be impaired by buildings, plants, shrubs, trees, other vehicles, etc. Thus, cross-traffic accidents are inevitable and sight distances are the controlling factor in this type of accident.
The National Safety Council has completed a study of speed control of vehicles at intersections based primarily on sight distances. The engineering department of the Council devised the plan shown on the following page wherein the factors of speed of cars on one street and the sight impairment on various corners are combined so as to designate the safe speed of cars on the intersecting street. The design is further based on a vehicle deceleration of 17 feet per second per second and a driver reaction time of one second. An example will illustrate the use of the critical speed diagram. Assume that an object impairing the length of sight distance is located 40 feet along one street from the intersection and 80 feet from the intersection in the direction of the other street, the distances being taken from the drivers sitting position in their cars in their proper traffic lanes to the object. The cross-hatched portion shown in black* is the location of the object impairing vision in this case. Then assuming a speed count on one of the streets, usually taken as the major street, shows the accepted speed to be 30 miles per hour; a line* shown in black is drawn through the corner of the object and the vertical speed scale at the point of 30 miles per hour intersecting the 30 mile per hour speed line at the upper part of the diagram at about 20 miles per hour. To use the diagram one must determine the location of the object on the checkerboard and also the speed of the vehicles traveling on one of the streets. This speed is that speed below which 90 percent of the cars travel, generally taken on the major street. The diagram can be used to determine analytically, if there is a view obstruction at the prevailing speeds, whether a stop sign or stated

*The author added these to the Council's diagram.
INSTRUCTIONS:
1. Locate obstruction on checkerboard.
2. Find \( V_a \) on vertical scale.
3. Find corresponding scale for \( V_b \).
4. Pass straightedge through \( V_a \) & obstruction.
5. Read value of \( V_b \) on proper scale.

CRITICAL SPEEDS AT STREET INTERSECTIONS
Reproduced at 3/4 scale from R.S.M. 73
National Safety Council
slow speed sign is needed, whether parking is proper as to location, whether a through street is necessary, and how far back to move a view obstruction. The diagram lends itself to use on other than right-angled intersections with sufficient accuracy. (Cont. on page 28)
by using distances of (a) and (b) measured parallel to the directions of respective travel. The Council found the critical speed at or below which a stop sign was required to be 8 miles per hour. It recommended the use of a through street when at least one-third of the intersecting streets required stop signs or had notable accident experience. A number of short cuts in the use of the method along with an example are shown in Public Safety Memo No. 73 of the National Safety Council, from which the above information was obtained.

Up to the present, comparatively little has been done in Utah in the engineering of proper lighting of highways and city streets. Highway lighting has been neglected because of the great amount of the road system of Utah being rural. Only one notable lineal highway installation, a sodium vapor system, has been made in the State on U. S. 91 between Salt Lake City and Murray City. Cities in the state have been lighted, although poorly, for a number of years. Except for the installation immediately south of Salt Lake City, no modern street or highway illumination exists in Utah. However, some intersectional installations have been made. By modern illumination is meant the type in which the driver sees objects in the road as silhouettes against a light background. Although the residential districts of Salt Lake City are lighted by arc lamps, the rest of the city and other municipalities in the state are lighted in general by inadequate incandescent lamps.

Modern illumination requires that the road surface be light-colored for reflection if the power used is to be a minimum. Tests have born this conclusion out in comparing reflecting ability of the black-top street and the white concrete street surfaces. However, in the case of rain or ice, the whiter type is little better because
of the specular effect of water or ice. But the black-top street surfaces can be made more light reflecting by the imbedding of light-colored gravel in the surface. Such a surface is likely to be a better reflector in specular conditions, especially in the case of water, with each rock becoming a reflector and allowing objects in the road to take on the aspects of the silhouette. Furthermore, this type of surface has been proven by Professor R. A. Moyer of Iowa State College to be one of the best types of friction surfaces under any weather condition. These values, recently observed of the black-top surfaces will undoubtedly result in their wider use, even as a surfacing on the warn-out, high-type concrete roads because of the relative economy in its use.

Lighting of highway obstacles and road edges by the reflector type of delineator is becoming more widely used on Utah highways. Notable installations of this type are found in the State on U. S. 91 in the vicinity of the Point of the Mountain south of Salt Lake City and on Bonneville Highway in Sardine Canyon. It is possible by using the reflector delineator to mark out the road 500 to 1000 feet ahead of the driver using only his own headlights. This type of safety device finds its best use on extensive and infrequently used rural highways.

Glare is one of the most important causes of the head-on and the pedestrian-vehicle accident. Tests show that glare closes the exposed pupils of the eyes of the average driver such that it takes about 6 seconds for them to open enough to see as he does ordinarily at night. In this time of recovery most of the pedestrians are killed on the rural highway. The words of the driver escaping death in a head-on collision are often "The lights of the on-coming car blinded me."
The use of polaroid glass in the windshields of cars in conjunction with polaroid glass being used in the glass of headlights is conducive to safety in that glare will be reduced. The wide use of such a lighting system is limited at present because of the inefficiency of such glass in transmitting light and the high cost of the glass. The use of polaroid sun-glasses by drivers during the daytime should be encouraged because of its property of reducing glare.

Ribbon development of cities is due mainly to the fact that state and county road rights-of-way are not wide enough and not properly zoned. Legislation in this respect has been lax. Besides attracting the attention of a driver, billboards and buildings present difficulties to sight distance on curves. As a result of the inaction of these units of government, hot-dog stands and the like have been erected by private interests almost on the highway. Like the billboards they are generally unblending with good landscaping; and most important of all, they give rise to all sorts of traffic frictions. A driver leaving the highway to patronize these stands adds to confusion on the highway, and very often the practice results in accidents. The solution to this problem lies entirely on the shoulders of the legislators. They must give the highway builders a wider right-of-way and a prerogative in building construction and landscaping of private property adjacent to a highway. Some progressive states have already done this and the so-called "freeway" is being built. In this type of highway, the number of feeders into the highway is reduced to a minimum, with a service road some distance away but paralleling the freeway. Stands are eliminated and only necessary service stations are located at appropriate intervals on the highway by road commissions
or highway departments who also have full control of adjacent land under zoning laws.

Road signs giving pertinent information to the driver, often from distant parts and not familiar with laws and routes of certain parts of the states, are necessary. These signs informing the driver of speed restrictions, dangers, and direction have in the past been placed at an arbitrary location on the highway, often at such a location as to be worse than useless. They should be placed to serve their purpose best. It is poor traffic engineering to force upon a driver the instantaneous decision of taking one of a number of roads by reason of placing a direction sign immediately at the intersection. These signs should be placed so that the driver advancing into an intersection will know what direction or road he will take sufficiently in advance of his arriving there so that his speed will not be reduced below the accepted speed of the highway to the distress of those behind him; and he will not be wavering as to decision in the intersection.

The distance which this sign should be placed in advance of the intersection can be approximated and so placed for the average driver by assuming a reaction time of one second for noticing the sign and adding to it the average time required to read the sign while in motion, using repeated signs staggered down the roadway where necessary, and placing the sign nearest the intersection so that at the accepted speed of travel, the driver will have about a minimum of 5 seconds to come to a decision. A similar method should be applied to danger signs, such as those warning of need for reduced speed and change of direction, as on a curve.

Signs should be used only where they are necessary and should
not impose needless care or expectation on the drivers if they are to be consistently obeyed. The case is illustrated where a blind curve could be approached even with due caution on the part of a driver, at a speed producing centrifugal force far in excess of the centripetal force attainable by the vehicle under certain road conditions. If a sign is placed merely saying "slow, curve ahead," a situation entirely too prevalent at present, the driver is likely to show down a little, often not enough to negotiate the curve safely, and the result is an accident. But, if a speed sign stating "curve, negotiate at 25 miles" had been properly placed so as to give sufficient time for warning and slowing down from the speed allowed on tangents, with general notice throughout the highway system that such posted speeds were actually arrived at from test; the normally safe or average driver intending to take no chances would be able to negotiate the curve safely. In arriving at such a safe speed, the traffic engineer should not attempt "guinea-pig tactics", using himself as the medium. A number of tests involving a number of different drivers should be used and their negotiated speeds recorded with the speed below which 90 percent of the drivers making the curve taken. Special care should be given to slippery conditions by speed changes only as these conditions present themselves.

The divided highway using the medial strip is the absolute method of preventing internal friction in traffic. Although some of Utah's cities have esplanades, none of the state's highways are so constructed, simply because no need has been yet had for them because the traffic volume is not great enough and the cost is still too great. Competent engineers connected with highway construction
feel that Utah's first divided highways will be built between Salt
Lake City and Ogden on U. S. 91 and on State Street between Salt
Lake City and Murray. The traffic count as of 1938 was about 10,000
vehicles per day on State Street and about 5,000 per day on U. S. 91
north of Salt Lake City.

Next to the best method of using physical barriers for separating
lanes of traffic is the use of painted median lines. Such a line
allows full use of the street for passing, but is conducive to ac-
cidents where eight distances are not sufficient to allow drivers to
tell where it is safe to pass. This difficulty can be overcome by
highway safety engineers determining safe passing distances from
highway speed limitations and reactions times and either placing signs
stating "passing areas" or use the system now in use by Idaho where the
median line is carried throughout the length of the highway with
another line, dotted or of a different color, placed on the side of
the median line in the lane in which passing is permitted. Such an
arrangement allows passing immediately after a curve or hill crest
has been negotiated, and restricts all dangerous passing before the
driver completes the curve or hill crest. This type of passing
guard or sign is generally obeyed because the driver knows that the
restrictions are placed only as absolutely needed. An extension of
the use of this type of passing control is merited likewise in Utah,
which can afford only two-lane highways and uses the single line as
a divider and a double line as a no-passing zone. The use of the
double line as a no-passing zone of the same color, or not showing
specific passing areas where direction is concerned, often leads to
contempt for the law; because after the curve or hill crest has been
negotiated and the driver comes on the tangent, he no longer should be held from passing because his sight distance then becomes enough that passing is the same as on an unchanging grade and straight road. The single line is used in the cities of Utah to demark traffic lanes in wide streets with double lines to divide such thoroughfares. Narrow streets are generally merely divided by the single line. The paint line requires much maintenance, depending on the amount of traffic; however, a painting of twice a year is found in Salt Lake City to be sufficient. The painted line is a valuable asset to the highway or street, since it aids the judgment of the driver and helps in the mitigation of law-suits. It finds further use in traffic control in channelizing traffic and giving the driver a proper and safe route to travel through a large plaza intersection. This type of channelization is an extemation of the use of the single and double lines on curves, hillscrests, and traffic arteries.

The best way to make a plaza safe from wandering, undecided drivers and prevent their assuming their own opinion of the shortest distance and safest path through the intersection is to use the raised barrier form of channelization. Although the painted line has considerable success to its credit in this respect, the curb and raised sections are more lasting and definite in control.

The present trend in channelization is to have traffic lanes intersect as near as possible at right angles. At such an angle one driver can best gage the relative movement of his car with respect to the other car, with the effect that possibility of accident is reduced. Where the lanes intersect at acute angles head-on, the sum-of-the-speed angle situation results between two cars and the possibility
of collision approaches its maximum.

Where a number of streets intersect the rotary type of channelization has been successfully used. An example of this is the traffic circle used in the intersection of the diagonals and grid streets in Washington D. C. With the rotary type intersection, traffic entering the circle always travels to the right and an orderly movement results. By elongating the circle, placed in the intersection, in the direction of the more intense travel, a more expedient type is effected in that travel on the greatest used streets is inconvenienced the least.

The pedestrian island is becoming more and more important in traffic safety engineering, since statistics are showing an increase in pedestrian deaths in auto-pedestrian accidents. The safest place for a pedestrian to cross the street is shown by statistics (see table 5, Appendix I) to be where signalization exists. These places could be made still more safe by using pedestrian safety islands, especially on wide streets where it is impossible for older people to cross the street completely during the red-light period. To lengthen the red-light period in favor of the slower walker would result in aggravation and consequent violation on the part of drivers and pedestrians. The following quotation taken from page 8 of Public Safety Memo No. 34 of the National Safety Council presents part of the solution to the problem:

At points where pedestrian traffic is dense and/or the street is unusually wide, pedestrian accidents may occur due to the fact that those pedestrians who start late in the cycle are unable to complete their crossing before the traffic changes. When it is too late to enter the intersection and complete a crossing before vehicular traffic starts in the intersecting direction, the pedestrian should be warned. This is commonly done by
installing a pedestrian Walk light with the word "Walk" illuminated, which is displayed simultaneously with the green for most of the Go interval, but terminates a few seconds before the green ends because of the difference in time required for vehicles and pedestrians to clear the intersection. For example, if there is a 4 second yellow at an intersection where 10 seconds are required for pedestrians to go from curb to curb, the Walk signal should end 6 seconds before the green light ends.

The rest of the solution lies in education and enforcement and the placing of pedestrian safety islands at points in the street, especially wide ones, which would enable the slower pedestrians to cross the street over the periods of two or more red lights for vehicles.

The use of mid-block pedestrian crossing is best from a standpoint of the mentality of the pedestrian in reducing pedestrian deaths and injuries in that at such a location the pedestrian has only to understand the simple relation of his crossing to vehicles passing in one direction at a time, whereas at the intersection he must not only understand his relation to cars going in one direction at a time, but also, his relation to cars going straight and cars turning and their combined relation to him. In wide plaza intersections, where mid-block crossing cannot be successfully used, the complication becomes so great, especially where more than two streets intersect, that pedestrian protection islands are beyond any doubt an absolute necessity.

The ultimate in pedestrian protection lies in the use of pedestrian tunnels or over-passes. However, most of the large cities will have to struggle with grade intersection problems involving pedestrians because of the cost of construction. Salt Lake City has installed one underpass on one of its main traffic arteries
for children with complete success. No pedestrians have been struck
down and cars are not retarded in any respect.

Utah's Place in Accidents

Figure 1a of Appendix II shows that Utah is above the national
average in auto accident deaths based on population since 1928. It
also shows that Utah is below the average of the 10 western states on
the same basis, except for the year 1938. That Utah was below the aver-
age of the western states was largely due to the high record of Nevada,
which has a small population but a large amount of interstate travel.

Figure 2a shows the trend, in general, that auto deaths have
varied with automobile registration in Utah.

Figure 3a shows that Utah on the mileage basis is above the national
and the western states average for all years after 1927. In the year
1938, Utah exceeded all states in the Nation in accidents per 100,000,000
miles traveled. The mileage basis is the best measure of relative ac-
cident records of states of the two mentioned here because it is a more
active comparison in accidents than the population. The discrepancy in
the case of Nevada is notable in this respect. It was also noticed that
the average of the western states and that of the nation were precisely
the same on the mileage basis.

Accident Analysis

One of the best tools the traffic engineer has to determine the
location of accidents is the traffic accident spot map. This map shows
the location at which accidents have occurred over a period of time.
The National Safety Council recommends that following scales for pin
maps: scale of largest map, one inch equals 400 feet; smallest map,
one inch equals 1600 feet. It also suggests one-eighth to five thirty-
seconds inch as the size of pin heads. Where a more intensive study is required of an accident location, especially in a city, a map of even a larger scale is entirely in order. The pin heads used may vary as to the kind of accident they represent. A bunching of the pins over a certain stretch of highway or at a location within 300 feet of each other is usually enough reason to merit a complete analysis. If specific information is available in the form of good accident reports, such an analysis is possible. If an accident report is to be of value, it must give accurate information. It should be made by an observer from an unbiased point of view. A trained traffic investigator will serve this purpose best. Since it is impossible that there be a force of trained investigators large enough to cover a whole highway system, it still remains the duty of the persons involved in the accidents to make out the reports. Unless the procedure of giving those reporting full assurance that the information that they give will not be used against them in court continues, the reports will be of little use to the traffic engineer.

The information given in each accident at the accident-prone location is plotted, not necessarily to scale, on collision diagrams, such as figures 42, 6a, and 7a of Appendix II. These diagrams were obtained from the Utah State Road Commission and represent the better diagrams as of February 1940 as used by the Safety Department of the Commission. Close observation of the accidents drawn on the collision diagrams shows a pattern of accidents, each of which might easily be the result of the same cause. It appears that the greater the number of accidents that can be recorded for a certain location, the more marked the accident pattern and the reason for such a type of accident. Along with the analysis of the collision diagram there should be included a
study of the physical features at an accident-prone location. Figure 52, obtained from the Road Commission also, shows the physical features at the Twenty-seventh South and State Street accident location in Salt Lake City. A study of this location shows that there is predominantly a great number of left-turn accidents, a few right-angle accidents, and a few rear-end collisions. The condition diagram shows that the intersection is protected by a semaphore. Experience in a number of states has shown that the installation of semaphores will not eliminate all types of accidents. As a matter of fact it may even increase the number of right-angle and rear-end collisions; but the severity of these accidents are reduced, and there is always a reduction of injury and death accidents. The solution of the accident problem at this location lies in channelization of the intersection to protect the driver going straight from accidents incident to left-turn drivers taking any path they desire for their left-turn, and vice versa. If channelization is resorted to, the drivers going straight and those making left-turns will know where to expect each other. Some of the street intersections in Salt Lake City showed a marked decrease in accidents involving the left-turn by channelization, using only the painted line type of channelization. Better success might be expected with the raised barrier type of channelization.

Figure 6a, showing the collision diagram at the second cross street south of Clearfield, Utah on U. S. 91, shows no right-angle accidents, and there is therefore no need for a critical speed test, especially since there is protection by stop signs on the minor street. This collision diagram shows little of an accident pattern, but with what there is, it is seen that the solution of the problem lies in
providing a medial dividing strip and better lighting.

The intersection shown in figure 7a is protected by a semaphore light with each street carrying much traffic. The diagram shows the usual pattern of accidents due to left-turning. Its solution lies in channelization for the reasons explained for figure 4a.

The use of condition and collision diagrams in accident analysis is not limited to intersections. They are used for any location where traffic exists. They might be used to locate and analyze dangerous curves, constrictions in the highway, etc.

It very often happens that the problem of traffic accidents cannot wait to be solved by the collection of accident reports. It is more important that if an accident can be prevented, much is saved. Therefore, the traffic engineer can investigate locations which are conducive to accidents and apply corrections. It is not absolutely necessary to have to wait till a series of accidents have taken place to ascertain whether a certain location is accident-prone.
APPENDIX I

The statistics presented in Appendix I are from the following sources: the national statistics, from the Travelers Insurance Company of Hartford, Connecticut; and the Utah statistics from the accident summary of the Utah State Tax Commission.
### Table 1. Types of accidents resulting in deaths for the Nation and the State of Utah in 1939

<table>
<thead>
<tr>
<th>Collision of motor vehicle with:</th>
<th>National</th>
<th></th>
<th>State</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian</td>
<td>12,470</td>
<td>33.9%</td>
<td>53</td>
<td>35.0%</td>
</tr>
<tr>
<td>Automobile</td>
<td>8,550</td>
<td>26.6%</td>
<td>35</td>
<td>22.0%</td>
</tr>
<tr>
<td>Non-collision</td>
<td>4,810</td>
<td>15.0%</td>
<td>46</td>
<td>28.9%</td>
</tr>
<tr>
<td>Fixed object</td>
<td>3,300</td>
<td>10.5%</td>
<td>2</td>
<td>1.3%</td>
</tr>
<tr>
<td>Railroad train</td>
<td>1,590</td>
<td>5.0%</td>
<td>9</td>
<td>5.7%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>780</td>
<td>2.4%</td>
<td>4</td>
<td>2.5%</td>
</tr>
<tr>
<td>Street car</td>
<td>160</td>
<td>0.5%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Horse-drawn vehicle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other vehicle</td>
<td>140</td>
<td>0.4%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>160</td>
<td>0.5%</td>
<td>8</td>
<td>5.0%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>32,100</td>
<td>100.0%</td>
<td>159</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

### Table 2. Types of accidents resulting in injuries for the Nation and the State of Utah in 1939

<table>
<thead>
<tr>
<th>Collision of motor vehicle with:</th>
<th>National</th>
<th></th>
<th>State</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobile</td>
<td>663,750</td>
<td>54.8%</td>
<td>1,509</td>
<td>49.8%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>295,810</td>
<td>24.3%</td>
<td>426</td>
<td>14.1%</td>
</tr>
<tr>
<td>Non-collision</td>
<td>96,820</td>
<td>8.0%</td>
<td>575</td>
<td>19.0%</td>
</tr>
<tr>
<td>Fixed object</td>
<td>83,910</td>
<td>6.9%</td>
<td>218</td>
<td>7.2%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>38,530</td>
<td>3.2%</td>
<td>110</td>
<td>3.6%</td>
</tr>
<tr>
<td>Street car</td>
<td>11,250</td>
<td>0.9%</td>
<td>14</td>
<td>0.1%</td>
</tr>
<tr>
<td>Railroad train</td>
<td>7,280</td>
<td>0.6%</td>
<td>55</td>
<td>1.8%</td>
</tr>
<tr>
<td>Other vehicle</td>
<td>5,820</td>
<td>0.5%</td>
<td>52</td>
<td>1.7%</td>
</tr>
<tr>
<td>Horse-drawn vehicle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>4,180</td>
<td>0.3%</td>
<td>4</td>
<td>0.0%</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>1,210,220</td>
<td>100.0%</td>
<td>3,044</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
### Table 3. Action of drivers resulting in deaths for Nation and State of Utah in 1939

<table>
<thead>
<tr>
<th>Action</th>
<th>National</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceeding speed limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On wrong side of road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not have right of way</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improper passing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing on curve or hill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failed to signal or improper signaling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing standing street on car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other causes*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>15,160</td>
<td>71</td>
</tr>
</tbody>
</table>

* Not correspondingly classified

### Table 4. Action of drivers resulting in injuries for Nation and State of Utah in 1939

<table>
<thead>
<tr>
<th>Action</th>
<th>National</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not have right of way</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exceeding speed limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On wrong side of road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failed to signal or improper signaling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improper passing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing on curves or hills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing standing street on car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other causes*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>607,930</td>
<td>950</td>
</tr>
</tbody>
</table>

* Not correspondingly classified
<table>
<thead>
<tr>
<th>Action</th>
<th>National</th>
<th>%</th>
<th>Killed</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossing between intersection</td>
<td></td>
<td></td>
<td>3,290</td>
<td>26.4</td>
</tr>
<tr>
<td>Walking in roadway</td>
<td></td>
<td></td>
<td>2,180</td>
<td>17.5</td>
</tr>
<tr>
<td>Crossing at intersection---no signal</td>
<td></td>
<td></td>
<td>1,780</td>
<td>14.3</td>
</tr>
<tr>
<td>Crossing at intersection---against signal</td>
<td></td>
<td></td>
<td>1,200</td>
<td>9.6</td>
</tr>
<tr>
<td>Coming from behind parked car</td>
<td></td>
<td></td>
<td>1,000</td>
<td>8.0</td>
</tr>
<tr>
<td>Crossing at intersection---diagonally</td>
<td></td>
<td></td>
<td>810</td>
<td>6.5</td>
</tr>
<tr>
<td>Children playing in street</td>
<td></td>
<td></td>
<td>810</td>
<td>6.5</td>
</tr>
<tr>
<td>At wade in road</td>
<td></td>
<td></td>
<td>340</td>
<td>2.7</td>
</tr>
<tr>
<td>Not in roadway</td>
<td></td>
<td></td>
<td>250</td>
<td>2.0</td>
</tr>
<tr>
<td>Crossing at intersection---with signal</td>
<td></td>
<td></td>
<td>210</td>
<td>1.7</td>
</tr>
<tr>
<td>Hitching on vehicle</td>
<td></td>
<td></td>
<td>160</td>
<td>1.3</td>
</tr>
<tr>
<td>Getting on or off other vehicle</td>
<td></td>
<td></td>
<td>140</td>
<td>1.1</td>
</tr>
<tr>
<td>Standing on safety</td>
<td></td>
<td></td>
<td>50</td>
<td>0.4</td>
</tr>
<tr>
<td>Waiting for or getting on or off street car</td>
<td></td>
<td></td>
<td>40</td>
<td>0.3</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td>210</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>12,470</td>
<td>100.0</td>
<td>57</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*The state data contain only 4 bicycle accident deaths.*
<table>
<thead>
<tr>
<th>Action</th>
<th>National</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Injured</td>
<td>%</td>
</tr>
<tr>
<td>Crossing between intersection</td>
<td>68,460</td>
<td>23.3</td>
</tr>
<tr>
<td>Crossing at intersection—no signal</td>
<td>42,310</td>
<td>14.4</td>
</tr>
<tr>
<td>Crossing at intersection—against signal</td>
<td>40,250</td>
<td>13.7</td>
</tr>
<tr>
<td>Coming from behind parked car</td>
<td>39,080</td>
<td>13.3</td>
</tr>
<tr>
<td>Playing in street</td>
<td>38,780</td>
<td>13.2</td>
</tr>
<tr>
<td>Crossing intersection diagonally</td>
<td>13,510</td>
<td>4.6</td>
</tr>
<tr>
<td>Crossing intersections with signal</td>
<td>13,220</td>
<td>4.5</td>
</tr>
<tr>
<td>Walking on roadway</td>
<td>10,870</td>
<td>3.7</td>
</tr>
<tr>
<td>Not on roadway</td>
<td>7,050</td>
<td>2.4</td>
</tr>
<tr>
<td>Working in roadway</td>
<td>6,760</td>
<td>2.3</td>
</tr>
<tr>
<td>Hitching on vehicle</td>
<td>4,410</td>
<td>1.3</td>
</tr>
<tr>
<td>Getting on or off other vehicle</td>
<td>2,940</td>
<td>1.0</td>
</tr>
<tr>
<td>Waiting for or getting on or off street car</td>
<td>1,760</td>
<td>0.6</td>
</tr>
<tr>
<td>Standing in safety isle</td>
<td>1,470</td>
<td>0.5</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>2,940</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>293,810</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*The State data include 103 bicycle injuries.*
Table 7. Condition of vehicles involved in fatal accidents in the Nation and the State of Utah

<table>
<thead>
<tr>
<th>Condition</th>
<th>National</th>
<th>%</th>
<th>State</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently in good condition</td>
<td>34,410</td>
<td>93.1</td>
<td>118</td>
<td>83.6</td>
</tr>
<tr>
<td>Defective brakes</td>
<td>670</td>
<td>1.9</td>
<td>7</td>
<td>5.0</td>
</tr>
<tr>
<td>Improper lights</td>
<td>660</td>
<td>1.8</td>
<td>6</td>
<td>4.2</td>
</tr>
<tr>
<td>Other defects in equipment</td>
<td>560</td>
<td>1.6</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Defective tires</td>
<td>440</td>
<td>1.2</td>
<td>7</td>
<td>5.0</td>
</tr>
<tr>
<td>Defective steering mechanism</td>
<td>150</td>
<td>0.4</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>36,880</td>
<td>100.0</td>
<td>141</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 8. Condition of vehicles involved in injury accidents in the Nation and the State of Utah

<table>
<thead>
<tr>
<th>Condition</th>
<th>National</th>
<th>%</th>
<th>State</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparently in good condition</td>
<td>1,219,820</td>
<td>95.7</td>
<td>2,433</td>
<td>93.9</td>
</tr>
<tr>
<td>Defective brakes</td>
<td>19,160</td>
<td>1.6</td>
<td>35</td>
<td>1.4</td>
</tr>
<tr>
<td>Improper lights</td>
<td>14,050</td>
<td>1.1</td>
<td>37</td>
<td>1.5</td>
</tr>
<tr>
<td>Defective tires</td>
<td>8,940</td>
<td>0.7</td>
<td>31</td>
<td>1.2</td>
</tr>
<tr>
<td>Other defects</td>
<td>7,660</td>
<td>0.6</td>
<td>31</td>
<td>1.2</td>
</tr>
<tr>
<td>Defective steering</td>
<td>3,830</td>
<td>0.3</td>
<td>20</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>1,273,460</td>
<td>100.0</td>
<td>2,557</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 9. Utah State data on age of drivers in total accidents and fatal accidents in 1939

<table>
<thead>
<tr>
<th>Age of driver</th>
<th>Total accidents</th>
<th>Fatal accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 21</td>
<td>856</td>
<td>33</td>
</tr>
<tr>
<td>21 - 25</td>
<td>1,108</td>
<td>33</td>
</tr>
<tr>
<td>26 - 30</td>
<td>726</td>
<td>19</td>
</tr>
<tr>
<td>31 - 35</td>
<td>525</td>
<td>15</td>
</tr>
<tr>
<td>36 - 40</td>
<td>440</td>
<td>14</td>
</tr>
<tr>
<td>41 - 50</td>
<td>701</td>
<td>25</td>
</tr>
<tr>
<td>51 - 60</td>
<td>370</td>
<td>15</td>
</tr>
<tr>
<td>61 - 70</td>
<td>157</td>
<td>2</td>
</tr>
<tr>
<td>Over 70</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>Not stated</td>
<td>1,030</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6,018</td>
<td>171</td>
</tr>
</tbody>
</table>
Table 10. Experience of drivers involved in fatal accidents in the Nation and the State of Utah for 1939

<table>
<thead>
<tr>
<th>Experience</th>
<th>National</th>
<th></th>
<th>State</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than three</td>
<td>110</td>
<td>0.3</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three to six</td>
<td>590</td>
<td>1.6</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six to twelve</td>
<td>880</td>
<td>2.4</td>
<td>5</td>
<td>5.2</td>
</tr>
<tr>
<td>months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One year or more</td>
<td>35,120</td>
<td>95.7</td>
<td>88</td>
<td>91.7</td>
</tr>
<tr>
<td>Totals</td>
<td>36,700</td>
<td>100.0</td>
<td>96</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 11. Weather conditions prevailing at fatal accidents in the Nation and the State of Utah for 1939

<table>
<thead>
<tr>
<th>Conditions</th>
<th>National</th>
<th></th>
<th>State</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>25,180</td>
<td>86.7</td>
<td>105</td>
<td>89.5</td>
</tr>
<tr>
<td>Rain</td>
<td>2,850</td>
<td>9.8</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>Fog</td>
<td>640</td>
<td>2.2</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>Snow</td>
<td>380</td>
<td>1.3</td>
<td>6</td>
<td>5.2</td>
</tr>
<tr>
<td>Totals</td>
<td>30,050</td>
<td>100.0</td>
<td>135</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 12. Road conditions prevailing at fatal accidents in the Nation and the State of Utah for 1939

<table>
<thead>
<tr>
<th>Conditions</th>
<th>National</th>
<th></th>
<th>State</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>23,120</td>
<td>79.6</td>
<td>115</td>
<td>85.6</td>
</tr>
<tr>
<td>Wet</td>
<td>4,450</td>
<td>15.3</td>
<td>9</td>
<td>6.7</td>
</tr>
<tr>
<td>Icy</td>
<td>960</td>
<td>3.3</td>
<td>7</td>
<td>5.2</td>
</tr>
<tr>
<td>Snow</td>
<td>520</td>
<td>1.8</td>
<td>6</td>
<td>4.5</td>
</tr>
<tr>
<td>Totals</td>
<td>29,050</td>
<td>100.0</td>
<td>135</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 13. Sex of drivers in fatal accidents in the Nation and the State of Utah for 1939

<table>
<thead>
<tr>
<th>Sex</th>
<th>National</th>
<th></th>
<th>State</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>34,280</td>
<td>95.4</td>
<td>153</td>
<td>92.7</td>
</tr>
<tr>
<td>Female</td>
<td>2,420</td>
<td>6.6</td>
<td>12</td>
<td>7.3</td>
</tr>
<tr>
<td>Totals</td>
<td>36,700</td>
<td>100.0</td>
<td>165</td>
<td>100.0</td>
</tr>
</tbody>
</table>
APPENDIX II
Figure 1a. Comparison of auto deaths in Nation, 10 Western States & Utah. Data source: P.S.Memo 95, N.S.C.
Figure 2a. Registration and auto deaths of Utah

Data source: U.S. R.C. & N.S.C.
Figure 3a. Comparison of auto deaths in Nation, 10 Western States, & Utah. Data source: P.S. Memo 95, N.S.C.
Figure 4a. Collision diagram at 27th So. and State Streets S.L.C. Ut.
Figure 5a. Condition diagram of 27th So. and State streets, SLC, Ut.
LEGEND

1. Death
2. Injury
4. Rear End Coll.

U.S. 91
1/4 mi. to Clearfield

4:00 a.m. 7-5 No light on wagon.
6:00 p.m. 11-8 Ped. walked into side.
2:30 a.m. 4-4 Failed to make small curve

8:30 p.m. 7-23 Intox. On wrong side of road.
Figure 7a. Collision diagram of 39th So. and State Streets SLC Ut.
BIBLIOGRAPHY

1. Ackermann, John and Thurston, John
   1939 Where to put the traffic engineer.

2. American Automobile Association
   1939 Previews of pedestrian protection.

3. Anonymous

4. Anonymous
   1939 Straight thinking about highways. 16 pp.

5. American Standards Association
   1939 Inspection requirements for motor vehicles. N. Y.

6. Automotive Safety Foundation

7. Benedict, Walter C.
   1939 Mimeographed lecture given on traffic engineering at Yale University. May 13.
   11 pp.

8. Connecticut State Department of Motor Vehicles
   1938 Traffic accident experience on Merrit Parkway. 50 pp.

9. Crum, R. W.
   1938 Accidental accidents. Washington D.C.,
   American Road Builders Association
   convention proceedings. 911 pp.

10. Dibble, W. W.
    1937 Student abstract No. 5. Harvard Uni-

11. Dudley, Ralph W.
    1937 Student abstract No. 6. Harvard Uni-

* A. Watson compiled a bibliography on highway safety in 1938.
The bibliography is selective and includes references to books,
periodical articles and publications of societies over the
period 1928 through May, 1937. It may be obtained from the
<table>
<thead>
<tr>
<th>No.</th>
<th>Author/Title</th>
<th>Location/Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Eaton, Ralph W., How Providence did it. Lecture given at Yale University.</td>
<td>14 pp.</td>
</tr>
</tbody>
</table>
24. Merryman, Harold W.  
1937  

25. National Safety Council  
1937  
Community safety. Chicago. 71 pp.

26.  
1938  
State laws on traffic accident reporting. Public safety memo No. 79. 11 pp.

27.  
1937  
Practical uses of accident records. Public safety memo No. 87. 2 pp.

28  
Setting up traffic planning in your city. Public safety memo No. 101. 9 pp.

29  
1938  

30. Neleey, Guy  
1939  
Channelization of street and highway traffic. Elizabeth N. J., Signal Service Corp. 31 pp.

31. Pennsylvania Turnpike Commission  
1939  

32. Port of N. Y. Authority  
1939  

33. Public Roads Administration  
1939  

34. Shapiro, Sidney M.  
1939  

35. Simpson, Hawley  
1939  
City traffic and public transportation. Mimeographed lecture given at Yale University. May 1. 7 pp.
36. Simpson, R. E.
   1939

   Forty-six percent fewer accidents
   on Hartford's relighted streets.
   American City, October

37. Upham, Charles
   1939

   Unemployment cure-all, a national
   super road program. American Road
   Builders Association. 5 pp.

38. Wichita Police Department
   1938

   The driver. Assistance of W.P.A.
   project No. 7042. December. 40 pp.